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# Analyzing the Restricted Phase of the Graduated Driver's Licensing System: The Effect of Driving Experience

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# ANALYZING THE RESTRICTED PHASE OF THE GRADUATED DRIVER'S LICENSING SYSTEM: THE EFFECT OF DRIVING EXPERIENCE

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## ABSTRACT

Beginning in 1996, states began adopting what is known as the graduated driver's licensing system (GDL) in an attempt to reduce traffic hazards for teenagers. This was a response to previous literature which suggested teens had an elevated risk for motor vehicle hazards, compared to all other age groups. The GDL system is split into three separate stages, in an attempt to ease the teenagers into the driving process. These stages are known as the permit stage, the restricted stage, and the unrestricted stage. While much of the past literature has focused on whether or not the GDL system is effective, few, if any, studies have tested the effect of driving experience on reducing driving fatalities. To answer this question, I collected FARS crash fatality data from 1996-2009 for drivers aged 16-22 for all 50 states and the District of Columbia. I find that driving experience does have a statistically significant effect on reducing driving fatalities, even more so than age. I also find no significant difference in the long run (5 years +) between daytime driving experience and nighttime driving experience, while daytime experience is more effective in the short run (1-4 years). Current policies in most states force the individual to have more daytime than nighttime experience, due to restrictions placed on what time the individual can drive at night. My findings indicate that nighttime restrictions are a hindrance to an individual's driving ability.

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## BACKGROUND

Beginning in 1996, states started adopting what is known as the graduated driver's licensing system for its new, youth drivers. The goal of the graduated drivers licensing system is to reduce traffic accidents and fatalities through practice and restrictions to young drivers. Since Florida became the first state to adopt a graduated driver's licensing system, all 49 other states and the District of Columbia have followed suit, in some form or another.

The graduated driver licensing system is currently as follows. As a student reaches a certain age, he or she is eligible to get a driving permit. With this driving permit, the individual can practice driving, but only under the supervision of a parent or legal guardian. After a certain time frame of permit driving, the individual is eligible for a restricted license. After another waiting period, the student is eligible to get his or her unrestricted license.

While the system previously mentioned may seem simple, it is actually more complex then stated. Before an individual can obtain a restricted license, that individual must do a number of things:

1) He or she must meet a minimum number of hours driven with his or her parent or legal guardian; and,
2) Some fixed percentage of those hours must be driven in hazardous weather, or at night time.

Once the individual obtains the restricted license, a new set of rules apply:

1) Each new driver is allowed no more than a certain number of passengers in the car at any given time; and,
2) Each new driver is restricted from driving during some portion of the night.

Each state has its own laws when it comes to permit regulation. Some, like South Dakota, require only three months of supervised driving before one can get his or her restricted license. Others, like Alaska, require a two-year waiting period. The waiting times also vary on full licensure. New York only requires a span of one year from when the student is permit eligible until the student is eligible for the full license; Arkansas takes four years. Lastly, the age which one can first obtain a permit varies state to state as well.

States also vary with the restrictions they put on teenage drivers. These restrictions are the same as previously mentioned, and include:

1) The amount of passengers one can have;
2) How many hours of driving are required before one can obtain the license;
3) How many hours of night driving are required ; and,
4) The amount of time each driver is not allowed to drive at night.

This whole process is known as the Graduated Driver Licensing system, or GDL. Currently, every state has some form of the components of the GDL in place, while the majority of states have all 3 stages, with the restrictions mentioned above. However, since the policies vary across states, research is needed to determine an “optimal” policy which has the greatest impact of reducing teen driving fatalities.

The Insurance Institute for Highway Safety (IIHS) has developed a model which it uses to determine whether a given state has an acceptable GDL system. The way the model works is the IIHS grants a certain number of points for various factors, such as night driving or passenger restrictions. These points are tallied for each state at a given point in time. The states with more points have a more strict GDL system, which presumably decreases teenage driving fatalities. The chart for the actual system is shown below:

**IIHS Criteria for Ranking GDL policies**

| Components | | IIHS points |
|---|---|---|
| Learner's Entry Age | minimum age of 16 | 1 |
| | | |
| Learner's Holding Period | >6 months | 2 |
| | 3-5 months | 1 |
| | <3 months | 0 |
| | | |
| Practice Driving Restrictions | >30 hours | 1 |
| | | |
| Night Driving Restrictions | Not allowed after 9pm | 2 |
| | Not allowed after 10pm | 1 |
| | | |
| Passenger Restrictions | 1 or less underage passenger | 2 |
| | 1-2 passengers | 2 |
| | 3 or more passengers | 0 |
| | | |
| Duration of Restrictions | min. unrestricted license age minus the min. intermediate license age is more than 12 months | 1 |

**Good** systems score at least 6 points; **Fair** systems 4-5 points; **Marginal** systems 2-3 points; **Poor** Systems <2 points

As of May 2007, there were a total of 30 states with a "good" rating, 12 with a "fair" rating, 9 with a "marginal" rating, and 0 with a "poor" rating.

This paper contributes to the GDL literature by evaluating the restrictive phase of the GDL system. I first determine whether driving experience or a driver's age has a greater impact in reducing driving fatalities. However, my main focus is to determine whether nighttime driving experience differs from daytime driving experience. I also analyze the trade-off between driving fatalities today vs. driving fatalities in the future, which arises due to differences in licensure policies. This is done through a collection of

Fatality Analysis Reporting System (FARS) data from 1996-2009, and relies on data from all 50 states and the District of Columbia.

## LITERATURE REVIEW

Over the past 10-15 years, there has been a significant amount of research done on the GDL system. Various studies agree that teenagers are among the riskiest groups of drivers. While it is not known for sure where this risk stems from, previous literature suggests it is because their lack of experience driving, different perception of risky situations [Tränkle et al (1990], distractions due to passengers [Presusser et al (1998)], or because they normally drive during riskier times (nights and weekends).

Given that each state has its own set of regulations, and the majority of these regulations effect on individuals ages 15-18, the majority of the studies have focused on this age range, or a fraction of it. For example, Ulmer et al (1999) focused on the number of 15-year-olds in crashes in Louisiana. They found that the GDL system reduced the number of total crashes by 33%, as well as 51% at night. Ulmer et al (2001) later went on to find a 22% reduction in fatal/injury crashes to 16-year-olds in Connecticut. Shope et al (2001) look at Michigan, and find a 25% reduction in 16-year-old crashes post-GDL there as well. Williams (2008) looks at various ages in New Jersey, and tries to determine at which age the GDL has the most effect. The figure is listed below:

| Figure 1 Drivers in fatal crashes per 100,000 population in New Jersey, before and after graduated licensing | | | |
|---|---|---|---|
| Age | Pre-GDL (1992-2000) | Post-GDL (2002-06) | Percent change |
| 16 | 3.9 | 2.2 | -44 |
| 17 | 30.6 | 20.6 | -33 |
| 18 | 32.1 | 25.7 | -20 |
| 19 | 25.7 | 27.1 | +5 |
| 20-24 | 27.4 | 26.4 | -4 |
| 25-59 | 15.2 | 14.2 | -7 |

However, it has not been made clear whether GDL policies reduce the total number of deaths, or rather simply delay teenage exposure. Kakara-Mandic et al (2008) attempt to solve this problem, using two-car crash data from 12 different states. They find GDL policies reduce the number of accidents for 15-17 year-olds by limiting the amount of teenage driving, rather than by improving teenage driving. Tränkle et al (1990) studied risk perception in teens vs. adults, and found that given the same scenario, teens rated the scenario as less risky. Therefore, perhaps a delay in licensure is all that is needed. Other studies seem to agree. Foss et al (2003) mention the major crash reductions due to GDL systems result from the protective restrictions during high risk driving situations, those involving multiple passengers and driving at night. McKnight et al (2002) argue that increasing the length of the learner's permit period, as well as the amount of practice required, has reduced crash risk. Part of this reduction has come by the way of improved performance, and part due to delayed licensure.

While the majority of the literature focuses on a single given state, there are a few studies which look across multiple states for answers. Dee et al (2005) use FARS data from 1992-2002, and determine GDL policies reduce traffic fatalities involving 15-17 year-olds by at least 5.6%. They also find these reductions are primarily due to GDL restrictiveness, not improved teenage driving. Chen et al (2006) also use the FARS system from 1994-2004, and compare states with a GDL to states without one. They find a reduction of fatal crashes by 16-21% for 16-year-olds, but no significant reduction for any age between 20 and 29.

McCartt et al (2003) look at driving experience and teens. They surveyed approximately 1000 high school students every 6 months from their freshman year until their senior year. They found that the highest risk of getting into a crash took place the first month of licensure (5.3% vs. 2.5% as a mean for all other months combined). Also, the likelihood of a first citation during the first month of licensure (2.3%) was higher than during any of the subsequent 11 months (mean risk per month: 1.2%). They proved that experience plays a key factor when it comes to teen driving; the longer a teen has been driving, the fewer accidents and citations that teen will accumulate.

A number of studies have also tried to determine GDL effectiveness on teenage nighttime driving, teenage rural driving, and teenage weekend driving. Morrisey et al (2006) use FARS and find an 8% reduction of fatalities on rural roads. Kakara-Mandic et al (2008) look at weekend and nighttime driving, and they determined that the greatest impact of the GDL system is its restrictions with nighttime driving, especially weekend nights. Foss et al (1999) also found that a restriction on nighttime driving reduces the number of fatalities in New Zealand.

Morrisey et al (2006) also look to compare states with “good” GDL policies to states with “fair” or “marginal”, as rated by the IIHS. They find states with a “good” rating have reduced fatalities by 19.6%, where as “marginal” states have no significant effect on youth drivers. States with a “fair” rating reduce nighttime fatalities by 12.6%, but have no overall effect on daytime driving. Baker et al (2007) find states with more comprehensive programs saw a crash reduction of 38-40%, compared to an 11-19% reduction in the national average during the same time period. This was only significant for 16-year-olds however, and 20+ year-olds saw no significant difference. They also found no significant statistical difference between male and female drivers.

Shope (2007) did a literature review concerning GDL studies from 2002-2007. The review included 21 studies of individual jurisdictions, and six of the United States as a whole. Shope stated that almost every study agreed that the presence of a GDL policy reduced the number of deaths. All of the studies focused on 15-20 year olds, with the majority from the United States, and the remaining from Canada. Shope did discover that none of the studies found a shift in crashes to older generations. That is, by delaying licensure at 17, that same individual would not get into more crashes when he or she is 19. Another literature review was done concerning all studies pre 2002 [Shope et al (2003)] and similar results were found[1].

However, few, if any, studies look at the relationship between first year drivers in state A and state B. Most just compare a single age group, for example 16-year-olds, across a single or multiple states. This seems to make little sense, because a 16-year-old in Montana is at a very different part of the licensure stage compared to a 16-year-old in Connecticut. In the former a teenager must be only 16 to get the unrestricted license, where that same individual must be 18 in the latter. If all 16-year-olds were compared, the 16-year-old in Connecticut would still have limitations on nighttime and passenger restrictions; whereas the 16-year-old in Montana would have no limitations at all. Thus, the 16-year-old in Montana has the capability of driving much more, which in turn will result in increased risk and more fatalities. Therefore, in order to determine if GDL programs improve teenage driving, it is important to consider someone in their first year of driving in state A to someone in their first year of driving in state B. This can be done pre-unrestricted licensure, or 5 years post-unrestricted licensure.

1) Literature included in the Shope 2007 review: Wiggens (2004), Rios et al (2006), Falb (2005), Hallmark et al (2006), Strategic Research (2006), Friedlander et al (under review), Shope et al (2004), Margolis et al (2007), Foss et al (2007), Mayhew et al (2003), Carpenter (2006), Mayhew et al (2002), Coben et al (2003), Willis (2006), Hyde et al (2005), Fohr et al (2005), Masten et al (2004), Rice et al (2004), Cooper et al (2005), Zwicker et al (2006), Males (2006), Eisenberg (2003), Dee et al (2005), Williams et al (2005), Chen et al (2006), Morrisey et al (2006), Baker et al (2007)

## DATA

### *Crash and Fatality Rates*

Data on teenage driving were collected from the Fatality Analysis Reporting System (FARS). FARS is a database that contains all fatal accidents that happen in the United States. The database is compiled by the National Highway Traffic Safety Administration (NHTSA), which receives data about motor vehicle fatalities from police reports in each of the 50 United States, as well as the District of Columbia. FARS allows for the user to query data specific to the crash, to the persons involved, and to the vehicles involved. It provides information on the topics just mentioned from 1994-present, but has been collecting data since 1975.

The data I used was from the 1996-2009 timeframe. There are a couple reasons why this time period was selected for my paper. First of all, I wanted to test the most recent data available. There have been numerous papers covering the topic of the graduated drivers licensing system, but the majority stopped collecting their data by 2005. Many would agree that cars have gotten safer over the last few years (NHTSA). I would like to see how the increase in safety features has affected driving fatalities for youth drivers, if at all.

Most importantly, at the beginning of 1996, no state had a graduated drivers licensing program. Therefore, if I push the beginning of the observation period back to that year, I will be able to capture any change in policy to any state, including going from a non-GDL system to a GDL system.

The dependent variable in this model is deaths per 10,000 teens at a given age in a given state in a given year[1]. The 2000 Census data was used to calculate the teen population at each given age. The Census provides users with an estimate of the current population in a given state. Also provided is the percent of the population under 18. Although the exact population numbers were not used, an estimate was, which was calculated by (% under 18) * (total population) / (18). This provides the teen population for every age and year for a given state. From this number the dependent variable was easily obtainable by the equation (deaths in state s in year t for age a) / (teen population) / (10,000).

The age range selected for the model was 16-22 year olds. Over the last 14 years, there have been on average 20,000 driving fatalities annually of people aged 16-22 years old. The reason why this age range was chosen is relatively simple. In the vast majority of the states in that time period (1996-present), a teen needed to be at least 16 in order to obtain his or her unrestricted drivers license. Therefore, that age provides a logical starting point to begin the testing. In most states, if you get caught doing certain illegal things while driving, such as getting a DUI, your license is suspended until you turn 21. Since this is the case, age 21 must also be included in the model, in order to account for some of the worst drivers. Age 22 was selected as the upper bound to make sure the majority of the drivers who got their license revoked were included in the study.

### *Licensure System*

The IIHS was also used to get the following information:

1) The ages at which a teen in a given state is able to get his or her restricted and unrestricted licenses;
2) Any law changes that may affect the age of obtaining an unrestricted license;
3) The GDL rating level as of May 2007;
4) The maximum speed limit in rural areas; and,
5) The maximum speed limit in urban areas.

In order to determine the age which a state allowed a teen to get his or her restricted or unrestricted license, four different steps were used. First, the restricted license age was calculated by taking the age at which a teen could get their permit, and adding any mandatory waiting period before that individual could get their restricted license. When it comes to unrestricted licensure, there are 2 different components: nighttime restrictions, and passenger restrictions. The IIHS lists the minimum age before each of the two restrictions is lifted, and each was used separately in the model. Lastly, I wanted to determine how long until all restrictions were lifted. For this, I used the longer of the two restrictions, nighttime or passenger. For example, in Idaho in 2008, the nighttime restriction lasted until the teen was 16 years old, where as the passenger restriction only lasted until the teen was 15 years and 6 months. Therefore, the minimum age that the teen could get an unrestricted license was 16 years old.

The ages for which an unrestricted license was able to be obtained were rounded up. In other words, the only ages available became 15, 16, 17 and 18. The rounding point was 3 months into the current year, however only one state (Connecticut from 1997-2003) was affected by this decision (all other states were rounded the common way, .5-.999 goes up)[2]. For example, if the unrestricted licensure age in state A was 16 year and 3 months, and the unrestricted licensure age in state B was 16 and 4 months, then state A would have a value of 16 for unrestricted licensure age, while state B would have a value of 17. The rounding was done for simplicity.

The IIHS was also used for any policy change that would change the age at which a teen could get the unrestricted license. Similar to the rounding rules described in the previous paragraph, any change in policy after April 1st was counted towards the next year, and not the current one[3].

The reason the GDL rating level was calculated as of May 2007 is due to insufficient knowledge prior to that time period. May 2007 was the earliest I was able to track down a rating for each state. In the IIHS data, each state has the same GDL rating from 1996-2009, even though each state's rating most likely changed in that time period. Due to this problem, GDL data was ultimately excluded from use in the final model

The maximum speed limit, both in rural and urban areas, was used on the basis of state characteristics. That is, a law that differs by states that may have a major influence on the number of driving fatalities. Also used was a binary variable on whether the state had a zero-tolerance alcohol policy for minors[4]. After controlling for state fixed effects, these three variables were left out of the empirical model.

Table 1 shows the summary statistics for the model. There are 4998 observations in total. The mean individual in the data possesses 3.3 years of driving experience, based off of unrestricted licensure. There are also 7.74 deaths/10,000 teens in state s in year t for age a. Observed deaths in each individual state range from 0 (observed 14 times) to approximately 30 (18-year-olds in Wyoming in 2009) in any given year (1996-2009) for any given age (16-22).

On average, 12.13% of the driving fatalities occurred to 16-year olds, 14.39% to 17-year-olds, 16.69% to 18-year-olds, 15.73% to 19-year-olds, 14.21% to 20-year-olds, 14.20% to 21-year-olds, and 12.65% to 22-year-olds. Also worthy of note, 76.62% of the state-year observations did not have a zero-tolerance policy.

1) The reason why deaths/10k was chosen instead of just deaths or deaths/100k was due to the fact that the vast majority of the numbers fell between 1-25. With deaths/10k, it makes it easier to compare solutions post-regression
2) The reason why CT was rounded up was due to a change in the GDL policy that shifted unrestricted licensure, but only by 3 months. From 1997-2003 Connecticut had an unrestricted licensure age of 16 years and 4 months. From 2004-2005, Connecticut had an unrestricted licensure age of 16 years 7 months. Because of such a small change in GDL policy, it seemed easier to group Connecticut as having no significant change to the GDL policy over the time period.
3) For example, if New Jersey had a change in policy that changed passenger restriction take place on June 1st 2005, that change in policy would be reflected in the 2006 data.
4) Needed to be 0.0 and not 0.1 or 0.2, because every state has a zero-tolerance policy of 0.2 or lower. The data was obtained from http://dui.findlaw.com/dui/dui-overview/dui_law.html

## EMPIRICAL MODEL

The empirical model that is used is the Ordinary Least Squares (OLS) method, which is run through the STATA program. The dependent variable, deaths per 10k teens, was regressed on several variables. They include:

1) Age dummies, ranging from 16-22;
2) A linear year term;
3) State dummies, for all 50 United States and the District of Columbia; and,
4) Experience dummies, for how long the drivers have been able to drive, ranging from 0-9. To calculate, I took (age - unrestricted licensure age + 1). In other words, 0 means the individual can't drive, 1 means it's the individuals first year of driving, 2 is the 2nd, et cetera.

As was previously mentioned, the regression was run for 4 different cases. They include:

Case 1: When each new driver can get a restricted license;

Case 2: When each new driver can get an unrestricted license based on the nighttime restriction;

Case 3: When each new driver can get an unrestricted license based on the passenger restriction; and, Case 4: When each new driver can get a full unrestricted license. This is the case when both the nighttime and the passenger restriction are lifted.

All of the four different cases are set up the same manner. The only difference is the experience term, which varies with the age at which the individual can get the restricted/unrestricted license. Table 2 contains the results for all ages, with 18-year-olds being dropped, South Carolina being dropped, the first year of experience being dropped, and is run on Case 4. Numerous regressions showed the year variable to be relatively constant, so instead of year dummies a linear term for year was used in all four of the regressions. Table 3 shows the results for the nighttime restriction, Table 4 the results for the passenger restriction, and Table 5 the results for the ability to get a restricted license (drive alone).

Table 6 shows the mean driving fatalities for each age, controlling for experience, over 1996-2009, and run for Case 4. In other words, this is what the data looks like before any regression is run. The easiest way to read the table is on a diagonal. The top diagonal are states where the minimum age to get a full unrestricted license is 18, the 2nd diagonal is 17, 3rd is 16, and bottom is 15. As one can see, experience is important here, but only within the same group. For example, take an 18-year-old with one year of experience. As the individual gets older and accumulates more experience, the probability that same individual will get in a fatal car accident goes down. However, the same cannot be said across states. That is, a 19-year-old with 3 years of experience (can get unrestricted license at 17) does not have a lower probability of being in a fatal accident than a 19-year-old with 2 years of experience (can get unrestricted license at 18). State fixed effects were included in the model to determine if this is really the case, or if something the state offers (speed limit, GDL level, type of terrain) has an impact on driving fatalities, which would be unaccounted for in the raw data.

Age and experience dummies are included to see each variables effect on reducing driving fatalities. If age has a greater effect during the unrestricted phase, then it would benefit the states to delay licensure. If experience has the greater effect, it would benefit the states to expedite the licensure process, so the individuals driving can maximize their experience. During the restricted phase, the same can be said true as well.

I was also interested in determining which kind of experience, day or night, had a greater effect in reducing the amount of driving fatalities. In order to determine this, both day and nighttime experience dummies were included into the model and run for Case 1[1]. Then another regression was run, this time with the linear version of the two variables day and nighttime restrictions. The final model looked like the following for Cases 1-4:

1) Reg $\text{Deaths}_{a,s,t}$ /10,000 $\text{teens}_{a,s,t} = \alpha + \tau(\text{Year}_t) + \sum_{i=0}^{9} \beta i(\text{iYearsExperience}_{a,s,t}) + \sum_{s=0}^{50} \delta_s + \sum_{a=16}^{22} \lambda_a + \varepsilon_{a,s,t}$

The following two regressions were used to determine whether the experience obtained from daytime or nighttime driving had more of an effect for lowering driving fatality rates.

1) Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau$ (Year$_t$) + $\sum_{i=0}^{9} \beta i$(iYearsExperience$_{a,s,t}$) + $\sum_{i=0}^{8} \gamma i$(iYearsExperienceNight$_{a,s,t}$) + $\sum_{s=0}^{50} \delta_s$ + $\sum_{\alpha=16}^{22} \lambda_a$ + $\varepsilon_{a,s,t}$
2) Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau$ (Year$_t$) + □(YearsExperience$_{a,s,t}$) + $\gamma$(YearsExperienceNight$_{a,s,t}$) + $\sum_{s=0}^{50} \delta_s$ + $\sum_{\alpha=16}^{22} \lambda_a$ + $\varepsilon_{a,s,t}$

The following variables and terms are used in the model:

1) Deaths $_{a,s,t}$/10,000 teens$_{a,s,t}$ = The dependent variable. How many deaths occurred in state s during year t for age a. This term was then divided by 10,000 teens in order to compare across states
2) $\tau$ (Year$_t$) = Linear year term, which has values ranging from 1996-2009
3) $\sum_{i=0}^{9} \beta i$(iYearsExperience$_{a,s,t}$) = Day driving experience dummies, ranging from 0-9, in state s during year t for age a
4) $\sum_{i=0}^{8} \gamma i$(iYearsExperienceNight$_{a,s,t}$) = Night driving experience dummies, ranging from 0-8, in state s during year t for age a
5) $\sum_{s=0}^{50} \delta_s$ = State dummies, ranging from 0-50

6) $\sum_{a=16}^{22} \lambda_a$ = Age dummies, ranging from 16-22

7) $\varepsilon_{a,s,t}$ = Random error term

8) $\alpha$ = a constant

1) Case 1 was chosen because it represents how long the individual has been able to drive alone during the day. In order to get how long the individual has been able to drive at night, I took the experience dummies from case 2 and included them in case 1 as well. This model was also run with linear terms as well for day and nighttime restrictions.

## **RESULTS**

### *Age vs. Experience*

Case 4:

Tables 2, 3, 4, and 5 show the results for Cases 1-4, as was mentioned in the empirical methods section. Taking a look at Table 2 (Case 4), one can see two main trends very quickly. The first trend is the older a driver gets, the less accidents that individual will have. The second trend is the more experience a driver gets, the less accidents that driver will have. Intuitively both of these make sense. As an individual practices a certain task more, that same individual should get better at that task over time. The data confirms this finding, but not as much as was hoped.

For the first few years of driving without restrictions, experience has very little effect (if any) on preventing driving fatalities. However, the first statistically significant improvement occurs during year 5 of driving. That would include 22-year-olds who got their full unrestricted license at 18, 21-year-olds who got it at 17, 20-year-olds at 16, and 19-year-olds at 15. This was not exactly the result I was looking for, but does provide hope that experience is at least negatively correlated with driving fatalities.

The age term in Case 4 seems to be jumping all over the place. However, under more careful examination, it does make some sense. The data tells us that the most fatal age at which to drive is 18, and the least fatal age is 16. However, that assumes that everyone who can get their license at age 16 does, and they never lose their license later due to bad behavior (DUI, jail, exc.). More likely, the following scenario takes place.  In a state where the licensure age is 16, drivers get phased in over a couple years, until the majority of the teens have their driver's license by the time they are 18.

At age 21, two separate factors could lead to an increase in driving fatalities. The first factor, which probably has the stronger weight between the two, is drivers are now legally able to consume alcohol.  With an increase in the percentage of the population being able to consume alcohol, there will be an increase in DUI-related fatalities.  The second factor is drivers who had their license revoked due to bad behavior get their license back as well.  Our data complete supports these claims.  As age goes from 16-18, the amount of driving fatalities increases until the majority of the teens in the state have their unrestricted license.  From ages 18-20, the number of fatal accidents decrease, due to experience and practice.  At age 21, there is another spike in accidents, as youth who had their license revoked can finally get back onto the road. Since these drivers are on average worse than their counterparts, due to having their license revoked, this is not that surprising at all.  Also, at age 21 drivers are now legally able to consume alcohol, which could cause the rise in accident rates as well.  From ages 21-22, driving fatalities decrease again due to more experience, mainly for the revoked cohort.  If ages 23-30 were included in the regression as well, I am pretty certain this decrease in driving fatalities would continue, until some sort of plateau was hit.

Case 1:

While analyzing solely Case 4 is helpful, Cases 1-3 should also be examined to determine if driving experience is more important than age, and whether day driving experience is more important than night driving experience. Table 5 shows us the results for Case 1, the regression run on the amount of time an individual can get his or her restricted license in state s in year t. The experience terms here let us know how long the individual has been able to drive alone, without a parent or a legal guardian. Both passenger and nighttime restrictions do not matter in this model.

There are both some similarities and some differences in the experience term in this case vs. our first case, Case 4. Similar to Case 4, there is a reduction in the amount of fatal crashes when a driver cannot drive (0 years experience) compared to the first year driving. This is what we would expect. In fact, if no one were allowed to drive, there would be no driving fatalities. However, the difference major difference is what makes Case 1 interesting. In our fully unrestricted case (Case 4), the experience term was stagnant until the driver hit 5 years of driving experience. That is not the case here. The first year of experience is statistically significantly different than the second. In fact, going from the first year of unsupervised driving to the second year of unsupervised driving leads to a reduction of .6 deaths/10,000 drivers (mean deaths/10,000 drivers is roughly 7.74). In other words, after an individual has driven unsupervised for one whole year, the individual has roughly a 7.75% fewer chance of getting into a fatal accident.

After the 7.75% reduction from one year of experience to two, there is another plateau, similar to Case 4. From 2-4 years of experience, there is only a reduction of .1 deaths/10k drivers. This leads me to believe a driver will get rid of most of his or her bad driving habits in his or her first year of driving. Although there is reduction in years 2-4 of roughly 1.3%, the reduction is not statistically significant in the model.

Similar to Case 4, there is another statistically significant reduction in driving fatalities from 4 to 5 years of experience, and any single year leap thereafter. From years 4-5, the reduction is .57/10,000 drivers, or about 7.4%. Each year after, there is a decrease of roughly .9 a year, or about 11.6%.

The coefficients of the regression in Case 1 for the age dummies look very similar to the coefficients in Case 4 for the age dummies. For ages 16-18, deaths/10,000 drivers increases, then decreases from 18-20, then increases again from 20-22. Except for 22 year olds, this is the exact same situation as Case 4, and the reason stands the same as well. The odd case is that 22-year-olds are actually found to have an increase in the amount of deaths from 21-year-olds. While no reasoning is probable for this increase, it could be the case that individuals who had gotten their license revoked for bad behavior waited past 21 before attempting to drive again.

Case 2:

Case 2 (Table 3), the regression run on the nighttime restriction, is relatively uninteresting. Remember Case 4, which was full unrestricted licensure. The definition of full licensure was the longer wait time from either nighttime or passenger restrictions. However, the longer wait time in almost all states in any given year was the nighttime restriction. This means Cases 2 and 4 are extremely related, and the data shows us this as well. The coefficients from the regression are very similar, and so are the patterns. Therefore, Case 2 tells us nothing we already didn't know about the effect of experience or age on driving fatalities.

Case 3:

The last case to look at is Case 3 (Table 4), the regression run on passenger restrictions. Passenger restrictions almost always expire before or at the same time as the nighttime restrictions for a given state in a given year. However, the experience coefficients from the regression are not what were expected. In fact, there is a slight increase in driving fatalities from 1-4 years of experience, with year 5 also boasting a positive coefficient as well. In fact, there is not a statistically significant decrease in our dependent variable until 9 years of experience is hit. Also, only one of the years (year 4) is statistically significant at the 10% level in showing an increase in fatalities based on experience.

While the age coefficients look similar to Cases 2 and 4, the lack in similarity from the experience term, as well as the lack of significance in most cases, leads me to believe that passenger restrictions have very little, if any, benefit in reducing driving fatalities. The data suggests that it could take close to 10 years before the effects kick in, and even then it's questionable. This leads me to believe there are only 2 different cases we are looking at here. The first case is Case 1 (Table 5), and that is when the individual can get a restricted license. In other words, this case is when the individual can first drive alone during the day. The second case is Case 2 (Table 3), and that is when the individual can get an unrestricted license, based on the nighttime restriction. In other words, this case is when the individual can first drive alone at night.

*Daytime Experience vs. Nighttime Experience*

I thought it would be interesting to see which carried more weight when it came to the experience term. Are driving during the day and driving at night substitutes, or are they more like compliments. Would someone have a smaller chance of getting into a fatal accident of they had:

1) 4 years of day driving and 2 years of night driving

Or

2) 3 years of day driving and 3 years of night driving

In order to test which experience term is more significant in reducing driving fatalities, I combined data from Case 1 and Case 2. I took the experience term from Case 2 (nighttime), and added it to the Case 1 (daytime) data sheet. I was able to do this because the experience term is calculated as (age of individual) – (age when restriction is lifted) +1. After the addition, I could now run a regression based on how long each individual has been able to drive alone during the day, and alone during the night.

This regression was very similar to the previous regressions run, except for there now being two experience sets, instead of one. The regression was also set up in two different ways as well. The first way, both day and night experience were set up as dummies, as was done before. In the second regression, day and night experience were changed to a linear term, to see if either term carried much more statistically significant power. The regressions looked like the following:

1) Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau$ (Year$_t$) + $\sum_{i=0}^{9} \beta i$(iYearsExperience$_{a,s,t}$) + $\sum_{i=0}^{8} \gamma i$(iYearsExperienceNight$_{a,s,t}$) + $\sum_{s=0}^{50} \delta_s$ + $\sum_{a=16}^{22} \lambda_a$ + $\varepsilon_{a,s,t}$
2) Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau$ (Year$_t$) + ?(YearsExperience$_{a,s,t}$) + γ(YearsExperienceNight$_{a,s,t}$) + $\sum_{s=0}^{50} \delta_s$ + $\sum_{a=16}^{22} \lambda_a$ + $\varepsilon_{a,s,t}$

The results from these two regressions were quite interesting. When the regression was run on the dummy version, day experience had a statistically significant drop in every year, based on the first year of experience. Each year was significant to 10%, with the majority being significant at 1-2%. The results are listed in Table 7. From years 1-2, the reduction in driving fatalities based on daytime experience is .835 deaths/10,000 drivers. Given the mean of 7.74 deaths/10,000 drivers, it seems one year of daytime experience reduces deaths by approximately 10.8%.

Nighttime driving experience should be thought of similar to an experience premium. If nighttime experience has no overall effect on a person's driving ability, then the coefficients of the dummy variables should read 0, which is similar to leaving the term out of the regression all together. If having the ability to drive at nighttime hinders a driver's ability, then the coefficients will be positive, and if nighttime driving helps a driver's ability, the coefficients will be negative.

What I do find is nighttime experience does seem to have a positive effect in reducing driving fatalities. However, there is more of a delayed effect than an instantaneous one similar to day driving experience. Going from years 1-2 of nighttime experience, there is an increase of .1 deaths/10,000 drivers, although the number is nowhere near statistically significant. In fact, it takes until 5 years of nighttime experience before there is any significant decrease in driving fatalities. After 5 years, the numbers seem similar for both day and nighttime experience.

However, when the second regression was run (the one which included a linear term instead of dummies for experience) it was found that nighttime driving had a much greater impact than in the first regression. While the coefficients on both terms are only about 14% different (daytime=-.243 nighttime= -.276), daytime experience is only basically significant at the 10% level with a p-stat of .093, whereas nighttime has a p-stat of 0. This regression seems to suggest daytime and nighttime driving experience have a very similar effect in reducing driving fatalities, with nighttime experience being more statistically significant.

## POLICY IMPLICATIONS

While both age and experience seem to have a positive effect on reducing the amount of driving fatalities, experience seems to have a greater impact. In every case (excluding Case 3 with passenger restrictions we already ruled out), as a person acquired more than 5 years of driving experience, that person will have statistically significant fewer crashes. However, it is not certain that a 20-22 year old will be the same way. In every case, at 21-years-old there is a jump (increase) in our dependent variable. Age 22 is not significant in Case 1 as well as the two regressions run to determine if day or nighttime experience has more significance. And while age 20 is always negative, it is only significant half of the time.

Since experience is proven to have more of an impact in reducing driving fatalities, a policy regarding getting drivers the most experience possible should be in order. But what exactly does that mean? Should the policy change just move the current system forward a year or two, or would it be better to shorten the restriction periods, or would a combination of the two be best? In order to figure out the answer, we need to know if daytime or nighttime driving experience is more helpful in reducing driving fatalities.

In our current system, every individual is going to have the same or more daytime driving experience compared to nighttime. If nighttime experience is found to be significant, a policy reducing or eliminating the nighttime restriction could be in order. If only daytime experience is found to be significant, a policy which moves the restriction phase forward a year or two could be in order.

My findings show nighttime experience does have a statistically significant effect on reducing driving fatalities. In fact, the experience one gets from driving at night is similar to what that individual acquires from driving during the day, if not slightly greater. It seems that day driving and night driving can be thought as substitutes, with night driving experience acting as a premium if an individual does both.

Where does that leave us? It seems to me if an individual would want to maximize the probability of not getting into a fatal accident, then that individual should maximize the amount of driving experience he or she acquires. While nighttime restrictions do prevent fatal accidents through lack of driving, in the long run the experience acquired through nighttime driving outweighs the costs of doing so. While the first four years of driving at night may not affect the youth driver's experience, from years 5 and later the driver will be positively impacted by having driven at night. Since daytime and nighttime experience from years 5 and later are basically the same, a driver will be able to become twice as "good" if he or she drives at night and during the day, compared to solely driving during the day. The sooner an individual can drive during both the day and at night, the more experience they accumulate, and the lower the probability becomes of that driver getting into a fatal driving accident.

I know the previous paragraph makes it sound like everyone should be able to drive as soon as they are born. Of course, this is not true, because no one would be physically or mentally “ready”, which in turn would cause more driving fatalities. However, a policy which maximizes experience could be a viable option in reducing the total fatalities of youth drivers.

One can think of a “deaths now vs. deaths later” trade-off. If individual A is able to get an unrestricted license at age 16 instead of waiting until age 18, individual A will have a higher probability of getting into a fatal accident today. However, individual A acquires experience during this time. The experience gained by individual A will allow him/her to have a smaller chance of getting into a fatal accident in the future. The opposite is true if there is a delay in licensure. If individual B has to wait until age 18 to get an unrestricted license instead of being able to obtain one at age 16, individual B will have a smaller chance of getting into a fatal accident compared to individual A at ages 16-17. However, since individual A acquired experience during these years while individual B did not, individual B will have a higher probability of getting into a fatal accident in the future. In the long run, experience is more efficient in reducing driving fatalities than a delay in licensure, and individual A will be made better off than individual B.

The tricky part occurs when determining the correct age to allow an individual to be able to get an unrestrictive license. I am going to assume most states have done research on this topic, and are relatively correct when choosing such an age. Therefore, I feel somewhere between 16.0 and 17.0 would be an appropriate age. This allows the individual enough time to mature and grow before being allowed to drive alone, but also allows them enough time to maximize their driving experience as well.

## CONCLUSION

In this model, I first tested to see if driving experience or driving age has a greater impact in reducing driving fatalities. I used FARS data from 1996-2009 for individuals aged 16-22 years old to perform my test. I found that while both have a negative effect (do reduce fatalities), age coefficients jump around and are less statistically significant than experience coefficients, which seem to stay in a linear, decreasing pattern.

I also tested to see whether daytime and nighttime experience have a similar effect on reducing driving fatalities. I found out they do, with nighttime driving experience actually having a much larger effect in the long run (5+ years of experience) than in the short run (less than 5 years of experience). Nighttime driving experience acts as a premium to daytime experience in my model. In the long run, an individual who has driven six years during both the day and night will have much smaller chance of getting into a fatal accident than an individual who has driven only six years during the day and four at night.

As for policy implications, a policy which maximizes driving experience could be in order. The data shows nighttime experience is just as important as daytime experience, so a policy restricting one but not the other is making the drivers worse off in the long run. The estimated age at which states should allow teens to get their unrestricted license is between 16.0-17.0 years of age. Further tests need to be done to determine the ideal age of licensure, as well as the optimal amount of time an individual should have a permit before being able to obtain a restricted or unrestricted license.

**Table 1**

*Summary Statistics*

| Variable | Observations | Mean | Standard Deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|
| Year | 4998 | 2002.5 | 4 | 1996 | 2009 |
| Age | 4998 | 19 | 2 | 16 | 22 |
| Deaths | 4998 | 56.1 | 61 | 0 | 420 |
| Number of Teens at Given Age | 4998 | 81,176.55 | 94,045.56 | 6,330 | 523,624 |
| Maximum Speed Limit in Rural Areas | 4998 | 69.02 | 4.5 | 55 | 75 |
| Maximum Speed Limit in Urban Areas | 4998 | 63.24 | 6.5 | 50 | 75 |
| The Individual Can't Drive | 4998 | 0.11 | 0.31 | 0 | 1 |
| First Year of Driving | 4998 | 0.137 | 0.34 | 0 | 1 |
| Second Year of Driving | 4998 | 0.143 | 0.35 | 0 | 1 |
| Third Year of Driving | 4998 | 0.143 | 0.35 | 0 | 1 |
| Fourth Year of Driving | 4998 | 0.143 | 0.35 | 0 | 1 |
| Fifth Year of Driving | 4998 | 0.143 | 0.35 | 0 | 1 |
| Sixth Year of Driving | 4998 | 0.118 | 0.32 | 0 | 1 |
| Seventh Year of Driving | 4998 | 0.06 | 0.23 | 0 | 1 |
| Eighth Year of Driving | 4998 | 0.005 | 0.07 | 0 | 1 |
| Deaths per 10,000 Teens in State s in Year t for Age a | 4998 | 7.74 | 3.43 | 0 | 29.94 |
| Years of Driving Experience based on unrestricted licensure | 4998 | 3.3 | 2.1 | 0 | 8 |

## Table 2

*Fully Unrestricted Licensure*

Compared to 18-year-olds in their first driving year

| **Age** | **16** | **17** | **18** | **19** | **20** | **21** | **22** |
|---|---|---|---|---|---|---|---|
| **Coef** | **-1.81** | **-0.91** | **0** | **-0.4** | **-1.06** | **-0.59** | **-0.76** |
| **P-Stat** | 0 | 0 | N/A | 0.007 | 0 | 0.033 | 0.027 |
| **Stnd Error** | 0.21 | 0.15 | N/A | 0.15 | 0.21 | 0.28 | 0.34 |

| **Years exp.** | **Coef** | **P-Stat** | **Stnd error** |
|---|---|---|---|
| **0** | **-0.38** | 0.05 | 0.19 |
| **1** | **0** | N/A | N/A |
| **2** | **0.05** | 0.738 | 0.15 |
| **3** | **0.07** | 0.867 | 0.41 |
| **4** | **-0.14** | 0.382 | 0.16 |
| **5** | **-0.52** | 0.04 | 0.25 |
| **6** | **-1.12** | 0.001 | 0.33 |
| **7** | **-1.98** | 0 | 0.41 |
| **8** | **-2.27** | 0 | 0.64 |

| | | | | | | |
|---|---|---|---|---|---|---|
| -2.19 | -1.29 | -0.38 | -0.78 | -1.44 | -0.97 | -1.14 |
| -1.81 | -0.91 | 0 | -0.4 | -1.06 | -0.59 | -0.76 |
| -1.76 | -0.86 | 0.05 | -0.35 | -1.01 | -0.54 | -0.71 |
| -1.74 | -0.84 | 0.07 | -0.33 | -0.99 | -0.52 | -0.69 |
| -1.95 | -1.05 | -0.14 | -0.54 | -1.2 | -0.73 | -0.9 |
| -2.33 | -1.43 | -0.52 | -0.92 | -1.58 | -1.11 | -1.28 |
| -2.93 | -2.03 | -1.12 | -1.52 | -2.18 | -1.71 | -1.88 |
| -3.79 | -2.89 | -1.98 | -2.38 | -3.04 | -2.57 | -2.74 |
| -4.08 | -3.18 | -2.27 | -2.67 | -3.33 | -2.86 | -3.03 |

The regression used for this table was:
Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau\,(\text{Year}_t) + \sum_{i=0}^{9} \theta i(\text{iYearsExperience}_{a,s,t}) + \sum_{s=0}^{50} \delta_s + \sum_{a=16}^{22} \lambda_a + \varepsilon_{a,s,t}$
Years experience (Years) is calculated by (age - unrestricted licensure age + 1). In other words, 0 means the individual can't drive without restrictions, 1 means it's the individuals first year of driving without restrictions, 2 is the 2nd, and ex cetera.

# **Table 3**

*Nighttime Restriction*

Compared to 18-year-olds in their first driving year

| Age | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|
| **Coef** | **-1.91** | **-0.97** | **0** | **-0.34** | **-0.93** | **-0.39** | **-0.5** |
| **P-Stat** | 0 | 0 | N/A | 0.022 | 0 | 0.155 | 0.143 |
| **Stnd Error** | 0.21 | 0.15 | N/A | 0.15 | 0.21 | 0.28 | 0.34 |

| Years exp. | Coef | P-Stat | Stnd Error | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | **-0.33** | 0.035 | 0.16 | -2.24 | -1.3 | -0.33 | -0.67 | -1.26 | -0.72 | -0.83 |
| **1** | **0** | N/A | N/A | -1.91 | -0.97 | 0 | -0.34 | -0.93 | -0.39 | -0.5 |
| **2** | **0.01** | 0.96 | 0.15 | -1.9 | -0.96 | 0.01 | -0.33 | -0.92 | -0.38 | -0.49 |
| **3** | **-0.04** | 0.847 | 0.21 | -1.95 | -1.01 | -0.04 | -0.38 | -0.97 | -0.43 | -0.54 |
| **4** | **-0.29** | 0.297 | 0.28 | -2.2 | -1.26 | -0.29 | -0.63 | -1.22 | -0.68 | -0.79 |
| **5** | **-0.76** | 0.025 | 0.34 | -2.67 | -1.73 | -0.76 | -1.1 | -1.69 | -1.15 | -1.26 |
| **6** | **-1.42** | 0 | 0.41 | -3.33 | -2.39 | -1.42 | -1.76 | -2.35 | -1.81 | -1.92 |
| **7** | **-2.31** | 0 | 0.48 | -4.22 | -3.28 | -2.31 | -2.65 | -3.24 | -2.7 | -2.81 |
| **8** | **-2.66** | 0 | 0.7 | -4.57 | -3.63 | -2.66 | -3 | -3.59 | -3.05 | -3.16 |

The regression used for this table was:

Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau\,(\text{Year}_t) + \sum_{i=0}^{8} \gamma i(\text{iYearsExperienceNight}_{a,s,t}) + \sum_{s=0}^{50} \delta_s + \sum_{a=16}^{22} \lambda_a + \varepsilon_{a,s,t}$

Years experience (Years) is calculated by (age - restricted licensure age based on nighttime restrictions + 1). In other words, 0 means the individual can't drive at night, 1 means it's the individuals first year of driving at night, 2 is the $2^{nd}$, and ex cetera.

# **Table 4**

*Passenger Restriction*

Compared to 18 year olds in their first driving year

| **Age** | **16** | **17** | **18** | **19** | **20** | **21** | **22** |
|---|---|---|---|---|---|---|---|
| **Coef** | **-1.43** | **-0.73** | **0** | **-0.63** | **-1.49** | **-1.18** | **-1.52** |
| **P-Stat** | 0 | 0 | N/A | 0 | 0 | 0 | 0 |
| **Stnd error** | 0.22 | 0.16 | N/A | 0.16 | 0.23 | 0.3 | 0.37 |

| **Years exp.** | **Coef** | **P-Stat** | **Stnd error** |
|---|---|---|---|
| **0** | **-0.82** | 0 | 0.17 |
| **1** | **0** | N/A | N/A |
| **2** | **0.13** | 0.405 | 0.16 |
| **3** | **0.44** | 0.189 | 0.33 |
| **4** | **0.56** | 0.06 | 0.3 |
| **5** | **0.41** | 0.267 | 0.37 |
| **6** | **-0.01** | 0.974 | 0.44 |
| **7** | **-0.55** | 0.285 | 0.51 |
| **8** | **-0.97** | 0.135 | 0.65 |

| | | | | | | |
|---|---|---|---|---|---|---|
| -2.25 | -1.55 | -0.82 | -1.45 | -2.31 | -2 | -2.34 |
| -1.43 | -0.73 | 0 | -0.63 | -1.49 | -1.18 | -1.52 |
| -1.3 | -0.6 | 0.13 | -0.5 | -1.36 | -1.05 | -1.39 |
| -0.99 | -0.29 | 0.44 | -0.19 | -1.05 | -0.74 | -1.08 |
| -0.87 | -0.17 | 0.56 | -0.07 | -0.93 | -0.62 | -0.96 |
| -1.02 | -0.32 | 0.41 | -0.22 | -1.08 | -0.77 | -1.11 |
| -1.44 | -0.74 | -0.01 | -0.64 | -1.5 | -1.19 | -1.53 |
| -1.98 | -1.28 | -0.55 | -1.18 | -2.04 | -1.73 | -2.07 |
| -2.4 | -1.7 | -0.97 | -1.6 | -2.46 | -2.15 | -2.49 |

The regression used for this table was:

$\text{Reg Deaths}_{a,s,t} / 10{,}000\ \text{teens}_{a,s,t} = \alpha + \tau\,(\text{Year}_t) + \sum_{i=0}^{9} \beta i(i\text{YearsExperience}_{a,s,t}) + \sum_{s=0}^{50} \delta_s + \sum_{a=16}^{22} \lambda_a + \varepsilon_{a,s,t}$

Years experience (Years) is calculated by (age - restricted licensure age based on passenger restrictions + 1). In other words, 0 means the individual can't drive with passengers, 1 means it's the individuals first year of driving with passengers, 2 is the 2nd, and ex cetera.

## Table 5

*Ability to Drive Alone, Restricted License*

Compared to 18 year olds in their first driving year

| Age | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|
| **Coef** | **-2.62** | **-1.13** | **0** | **-0.39** | **-0.79** | **0.08** | **0.21** |
| **P-Stat** | 0 | 0 | N/A | 0.099 | 0.041 | 0.879 | 0.758 |
| **Stnd error** | 0.39 | 0.24 | N/A | 0.24 | 0.39 | 0.54 | 0.69 |

| Years exp. | Coef | P-Stat | Stnd error | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | **-0.27** | 0.352 | 0.29 | -2.89 | -1.4 | -0.27 | -0.66 | -1.06 | -0.19 | -0.06 |
| **1** | **0** | N/A | N/A | -2.62 | -1.13 | 0 | -0.39 | -0.79 | 0.08 | 0.21 |
| **2** | **-0.58** | 0.015 | 0.24 | -3.2 | -1.71 | -0.58 | -0.97 | -1.37 | -0.5 | -0.37 |
| **3** | **-0.64** | 0.101 | 0.39 | -3.26 | -1.77 | -0.64 | -1.03 | -1.43 | -0.56 | -0.43 |
| **4** | **-0.67** | 0.216 | 0.54 | -3.29 | -1.8 | -0.67 | -1.06 | -1.46 | -0.59 | -0.46 |
| **5** | **-1.21** | 0.082 | 0.69 | -3.83 | -2.34 | -1.21 | -1.6 | -2 | -1.13 | -1 |
| **6** | **-2.12** | 0.012 | 0.85 | -4.74 | -3.25 | -2.12 | -2.51 | -2.91 | -2.04 | -1.91 |
| **7** | **-3.07** | 0.002 | 1 | -5.69 | -4.2 | -3.07 | -3.46 | -3.86 | -2.99 | -2.86 |
| **8** | **-3.93** | 0.001 | 1.17 | -6.55 | -5.06 | -3.93 | -4.32 | -4.72 | -3.85 | -3.72 |

The regression used for this table was:
Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau\,(Year_t) + \sum_{i=0}^{9} \theta i\,(iYearsExperience_{a,s,t}) + \sum_{s=0}^{50} \delta_s + \sum_{a=16}^{22} \lambda_a + \varepsilon_{a,s,t}$
Years experience (Years) is calculated by (age - restricted licensure age + 1). In other words, 0 means the individual can't drive alone, 1 means it's the individuals first year of driving alone, 2 is the 2nd, and ex cetera.

## Table 6

*Mean Death Rates for Each Age Controlling for Experience, Years 1996-2009*

| | **Driving Experience** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Age** | | **16** | **17** | **18** | **19** | **20** | **21** | **22** |
| | **0 years** | 5.58 | 5.96 | | | | | |
| | **1 year** | 8.43 | 7.47 | 6.78 | | | | |
| | **2 years** | 9.26 | 9.23 | 8.51 | 6.62 | | | |
| | **3 years** | | 10.14 | 10.18 | 8.05 | 6.16 | | |
| | **4 years** | | | 11.65 | 9.45 | 7.36 | 6.1 | |
| | **5 years** | | | | 12.22 | 8.23 | 7.51 | 5.49 |
| | **6 years** | | | | | 9.95 | 8.18 | 6.69 |
| | **7 years** | | | | | | 9.34 | 7.27 |
| | **8 years** | | | | | | | 8.67 |

The data is this table is an average of the raw data, not run on any regression. Driving experience is calculated by (age - unrestricted licensure age + 1). In other words, 0 means the individual can't drive without restrictions, 1 means it's the individuals first year of driving without restrictions, 2 is the 2$^{nd}$, and ex cetera

**<u>Table 7</u>**

*Day vs. Nighttime Experience Terms*

| Sig. level | Day | Experience | Night | Sig. level |
|---|---|---|---|---|
| | 0.03 | **0** | -0.42 | ** |
| | 0 | **1** | 0 | |
| *** | -0.84 | **2** | 0.11 | |
| ** | -0.97 | **3** | -0.02 | |
| * | -0.9 | **4** | -0.3 | |
| * | -1.23 | **5** | -0.69 | * |
| ** | -1.83 | **6** | -1.24 | *** |
| ** | -2.3 | **7** | -2.04 | *** |
| ** | -2.77 | **8** | -2.22 | *** |
| *** | -6.14 | **9** | N/A | |

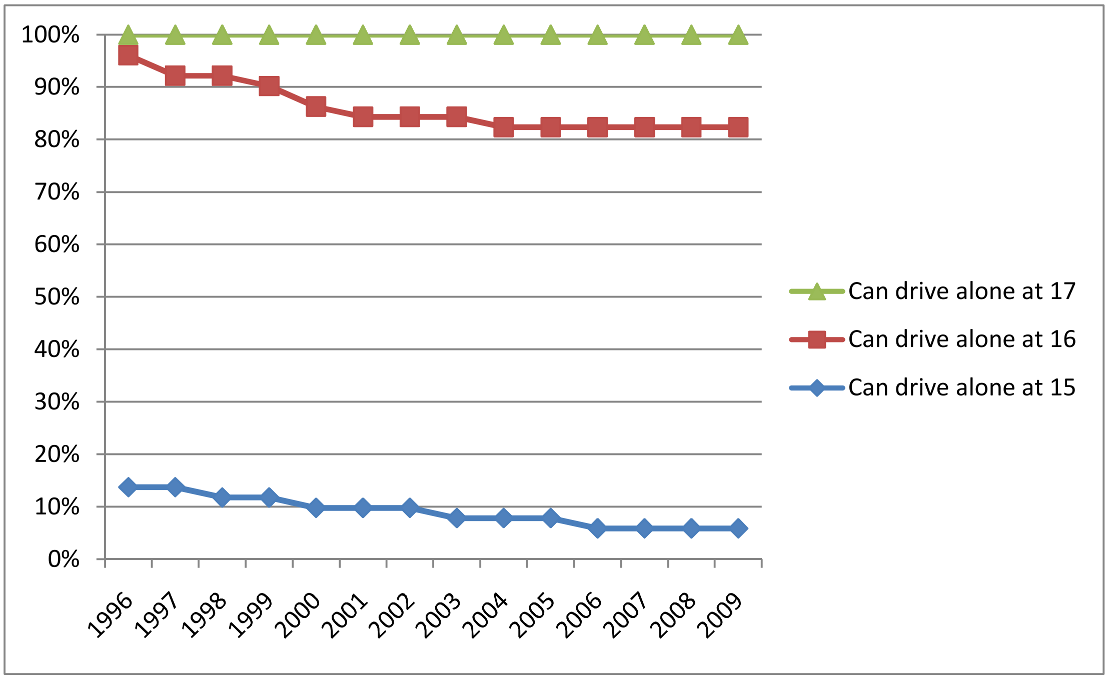
*,**,*** denotes significance levels of 10%, 5% and 1% respectively

The regression used for this table was:
Reg Deaths $_{a,s,t}$ /10,000 teens$_{a,s,t}$ = $\alpha + \tau$ (Year$_t$) + $\sum_{i=0}^{9} \beta i$(iYearsExperience$_{a,s,t}$) + $\sum_{i=0}^{8} \gamma i$(iYearsExperienceNight$_{a,s,t}$) + $\sum_{s=0}^{50} \delta_s$ + $\sum_{a=16}^{22} \lambda_a$ + $\varepsilon_{a,s,t}$
Years experience is calculated by (age - restricted licensure age + 1) for day and (age-unrestricted licensure age based on nighttime restriction + 1). In other words, 0 means the individual can't drive, 1 means it's the individuals first year of driving, 2 is the 2$^{nd}$, and ex cetera.

**Table 8**

*Policy Changes Over Time*

Percentage of states that allow drivers to meet the criteria



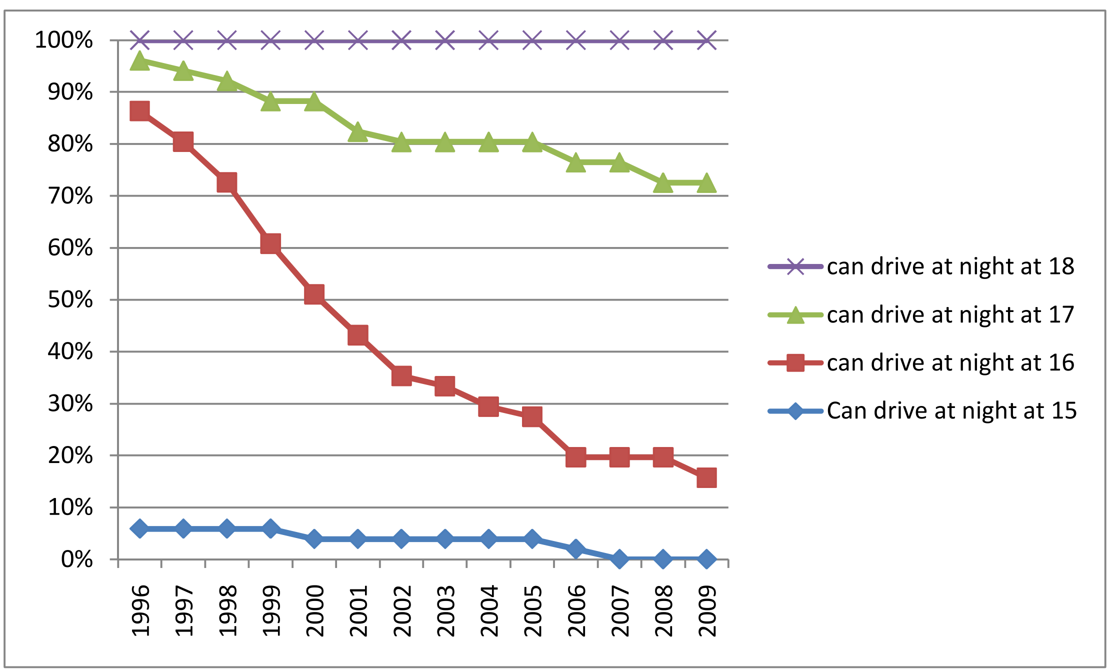



**Table 9**

*Expected Death Rate Scenarios*

Expected death rate (deaths per 10,000 teens) for states with various scenarios compared to 18-year-olds having the ability to drive at 18 during the day and 18 at night

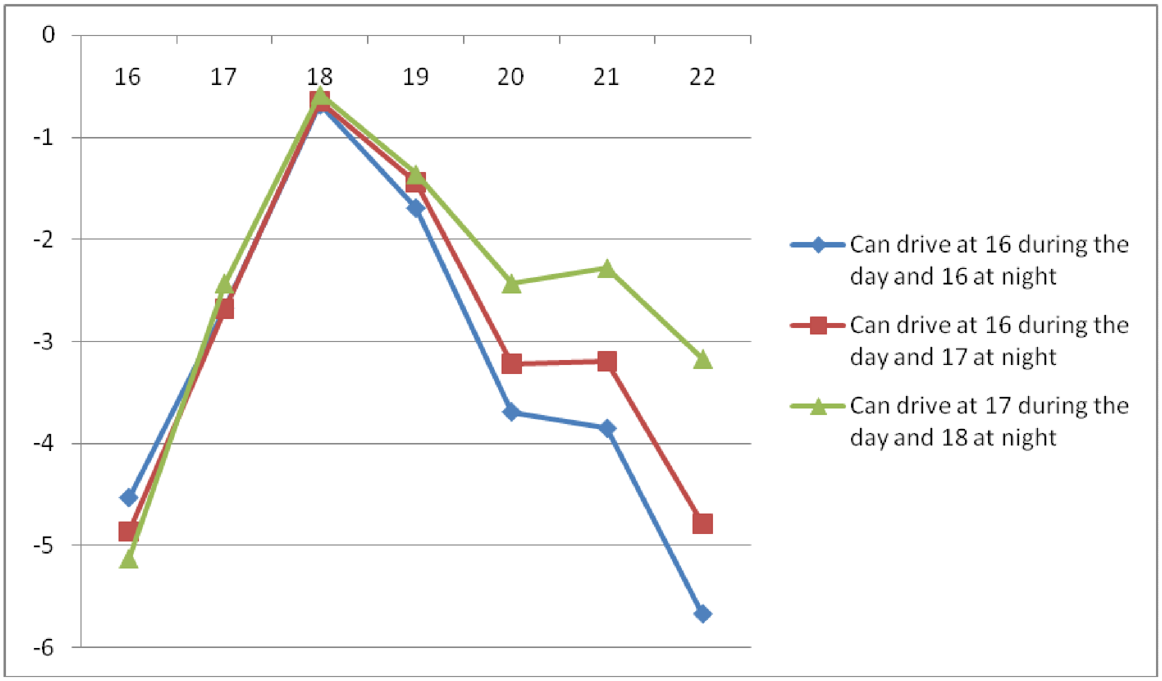


**Table 10**

*Probability of Getting Into a Fatal Accident From Ages 16-22 for All Licensure Types*

| **Restricted license age** | **15** | **15** | **16** | **16** | **16** | **17** | **17** |
|---|---|---|---|---|---|---|---|
| **Unrestricted nighttime license age** | **15** | **16** | **16** | **17** | **18** | **17** | **18** |
| **Probability through age 16** | 0.0264% | 0.0263% | 0.0321% | 0.0288% | 0.0288% | 0.0261% | 0.0261% |
| **Probability through age 17** | 0.0760% | 0.0764% | 0.0828% | 0.0794% | 0.0761% | 0.0825% | 0.0792% |
| **Probability through age 18** | 0.1438% | 0.1467% | 0.1534% | 0.1505% | 0.1471% | 0.1542% | 0.1508% |
| **Probability through age 19** | 0.1942% | 0.2018% | 0.2139% | 0.2135% | 0.2106% | 0.2175% | 0.2146% |
| **Probability through age 20** | 0.2190% | 0.2332% | 0.2544% | 0.2587% | 0.2583% | 0.2681% | 0.2677% |
| **Probability through age 21** | 0.2395% | 0.2626% | 0.2933% | 0.3024% | 0.3085% | 0.3227% | 0.3270% |
| **Probability through age 22** | 0.2481% | 0.2747% | 0.3140% | 0.3338% | 0.3447% | 0.3618% | 0.3727% |

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