Graduated Driver Licensing and Fatalities in Canada

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1. Introduction

Motor vehicle collisions involving teens and young adults have long been recognized as a serious public health and road safety concern in Canada. Important gains were made during the 1980s and 1990s in reducing the magnitude of the problem. For example, the motor vehicle collision fatality rate fell from 44.7 percent in 1987 to 20.3 percent in 2000, a decline of 54 percent.[1] Figures 1(a) and 1 (b) present the historical trend of motor vehicle collision fatalities in Canada for drivers aged 15 to 24. However, progress in reducing the crash risk for young drivers appears to have stalled in recent years and motor vehicle collisions remain the leading cause of death for young Canadians.[2]

In response to this continued public health and road safety concern, provincial governments, beginning with Ontario in 1994, have implemented graduated driver's licensing legislation.[3] The intent of this legislation is to lengthen the learning process for new drivers by requiring them to advance through beginner and intermediate stages before graduation to full licensure. In addition, graduated licensing legislation imposes a set of restrictions on new drivers. These restrictions are intended to address conditions known to put inexperienced drivers at risk

[1] The decline in motor vehicle collision fatalities can be attributed to a diverse set of factors including provincial and federal policy initiatives such as mandatory seatbelt legislation, impaired driving regulations, minimum legal drinking ages, improvements in emergency medical services and a variety of changes in vehicle and roadway design (Traynor 2009).

[2] In 2007, 672 young people were killed in motor vehicle collisions in Canada, 301 of which were teens aged 15 to 19, and 371 young adults aged 20 to 24 (Transport Canada 2007).

[3] Graduated licensing legislation was first introduced in 1987, in New Zealand. Since then Australia, the United States and, most recently, Canada have enacted their own versions. Between 1994 and 2005 all provinces enacted some version of graduated licensing legislation. The enactment dates and structure and content of graduated driver's licensing systems in Canada can be found in Table 1: Beginner Stage and Table 2: Intermediate Stage.

and provide a protective environment for new drivers to acquire critical driving skills and experience.[4]

Proponents of graduated licensing legislation argue that it will reduce the risk of motor vehicle collisions by limiting the amount of driving done by inexperienced drivers and by improving driver quality. To date, only a few studies have examined the implications of graduated licensing legislation. Recent literature evaluating programs in the United States finds graduated licensing legislation to be an effective traffic safety measure. For example, Dee et al. (2005) examine the introduction of graduated licensing legislation in the United States and find that it was responsible for a 5.6 percent reduction in fatal motor vehicle collisions involving 15 to 17 year olds. Another study, Eisenberg et al. (2003) finds that graduated licensing legislation in the United States was responsible for reducing total driver motor vehicle collision rates by 4 percent and fatal motor vehicle collision rates involving 16 to 20 year old drivers by 9.2 percent.

Since graduated licensing legislation has only recently been introduced in Canada, little is known about its effects in the Canadian context. This study will add to the existing literature by examining the effects of the introduction of provincial graduated licensing legislation on fatal motor vehicle collisions in Canada.

This study contributes to the existing literature in a number of ways. It is the first, to my knowledge, Canadian study to examine the effects of provincial graduated licensing legislation on motor vehicle collision fatalities. Second, as the existing literature focuses almost exclusively on teenage motor vehicle collision involvement and fatalities, this study attempts to assess the overall impact of graduated licensing legislation on motor vehicle collision fatalities by

[4]Warren and Simpson (1976) argue that experience is important in the development of driving skills because increases in experience result in decreases in the risk of collision.

estimating its effect on motor vehicle collision fatalities of older drivers.[5] Finally, as graduated licensing places restrictions on alcohol consumption, night and highway driving, this study examines the effectiveness of graduated licensing in reducing fatalities related to these restrictions; namely, impaired driver fatalities, highway driver fatalities, and night time driver fatalities.

Using the variation in the timing of the introduction of provincial graduated driver's licensing programs in Canada, I find that the introduction of graduated licensing legislation is not responsible for any reduction in fatal motor vehicle collisions in Canada. Although the results indicate the expected negative correlation between graduated licensing legislation and motor vehicle collision fatalities, the correlation is not statistically significant.

This paper proceeds as follows. In Section 2 I discuss graduated driver's licensing systems in Canada. The existing related literature is examined in Section 3. The estimation model and data employed are presented in Section 4, and Section 5 presents the main results. Finally, the conclusion is presented in Section 6.

2. Graduated Driver Licensing in Canada

Graduated driver's licensing systems in Canada require new drivers to advance through restrictive beginner and intermediate stages before graduation to full licensure. The beginner's stage involves a period of supervised driving ranging from six months, in Nova Scotia to a year in British Columbia. When this stage is completed, drivers move to the intermediate stage. During this stage, young drivers can drive under certain restrictions unsupervised. Once the intermediate stage is completed, they exit the graduated licensing system and become fully

[5] As motor vehicle collisions often include other vehicles we would expect not just a decrease in teen and young adult fatalities, but also a decrease in total motor vehicle collision fatalities.

licensed (Emery et al. 2008). Restrictions and limitations that are characteristic of graduated licensing systems include; minimum entry ages and duration periods, blood alcohol concentration limitations, night time driving restrictions, passenger restrictions, supervisor requirements, and roadway limitations. These restrictions and limitations are intended to address potential circumstances and conditions known to put inexperienced drivers at risk and vary across jurisdictions (Emery et al. 2008).

Graduated licensing programs also include a penalty structure. Penalties are applied for unsafe driving or other violations of the program and include; hearings, fines, demerit points, license suspensions and driving prohibitions. The severity of punishment may vary across jurisdictions however a popular sanction in Canada is to extend the graduated licensing period by withholding full driving privileges for a longer period of time. The structure and content of each graduated driver's licensing system in Canada is summarized in Table 1 (a) Beginner Stage and (b) Intermediate Stage.[6]

3. Related Literature

Among the existing literature examining the effects of graduated licensing legislation, there is variation in the data and methods employed. However, on a whole the literature indicates that graduated licensing legislation has been effective in reducing motor vehicle collision fatalities.

A study by Dee et al. (2005) used data from the Fatal Analysis Reporting System (FARS) between 1992 and 2002 to determine if the restrictions imposed by graduated driver's licensing legislation are effective in reducing the motor vehicle collision fatality rates of teenage drivers in

[6] Tables 1 (a) and (b) are replicated from Emery et al. (2008).

the United States. [7] The authors report a 5.6 percent reduction in fatal motor vehicle collisions involving 15 to 17 year olds and found that states with more restrictive graduated licensing legislation observed a greater reduction in motor vehicle collisions.

A study by Karaca-Mandic et al. (2010) used state-by-year panel data from the State Data System (SDS) from 1990 to 2005 to understand the mechanisms through which graduated driver's licensing programs influence motor vehicle collision rates. The authors look at whether graduated licensing programs improve teen driving behaviour, or just reduce the number of teenage drivers on the road. The authors find that graduated licensing programs reduce the number of teenage motor vehicle collisions by limiting the amount of teenage driving rather than by improving the quality of teenage driving. Specifically, they find that graduated licensing reduces relative teen prevalence on the roads by 5 percent during the day and 15 percent at during the night. Furthermore the authors provide evidence that stricter graduated driver's licensing policies are responsible for greater reductions in motor vehicle collisions, especially night time restrictions.

A Canadian study by, Carpenter (2005) used individual level data from the Ontario Student Drug Use Survey to determine whether the Zero Tolerance policy introduced with Ontario's graduated driver's licensing legislation reduced self reported drinking and alcohol involved driving among youth within Ontario. The author found that the rates of drunk driving reported among 16 to 17 year olds were about 5 percentage points lower after the law was implemented. However, when he reduced the number of years in the sample to only those years

[7] To isolate the casual effects of graduated licensing legislation the authors employ "difference-in-difference" specifications, this strategy relies on within-state variation in states that did not implement graduated driver's licensing legislation to control for the within-state variation in states that did. As an alternative strategy, the authors also employ "difference-in-difference-in-difference" specifications. This strategy eliminates unobserved determinants by relying on the outcomes of older cohorts who were not directly affected by graduated driver's licensing legislation.

just before and after the policy change, the estimates became statistically insignificant indicating that tough drinking and driving laws in Canada were not responsible for the observed reduction in alcohol involved driving and highway fatalities of Canadian youths during the 1980s and 1990s. These results suggest that further research needs to be done in order to better understand the reduction in alcohol involved driving by Canadian youth. [8]

Other studies which have examined the effectiveness of preventative behavioural policies such as mandatory seatbelt legislation, strengthening impaired drinking and driving legislation and increased restrictions to graduated drivers licensing legislation provide indirect evidence of the effects of traffic safety initiatives.

Eisenberg et al. (2003) attempted to evaluate the effectiveness of traffic safety policies and initiatives on reducing fatal motor vehicle collisions in the United States.[9] The authors found that graduated licensing legislation is one of the most effective policies, reducing total driver motor vehicle collision rates by 4 percent and fatal motor vehicle collision rates involving 16 to 20 year old drivers by 9.2 percent.

Traynor (2009) examined the relationship between motor vehicle collision fatality rates and state behavioural regulations regarding graduated driver's licensing, seatbelt use and drinking and driving in the United States. The author reports that more restrictive graduated driver's licensing and drinking and driving legislation significantly reduced motor vehicle collision fatality rates.

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[8] Young drivers in the beginner and intermediate stages of the graduated licensing system in Ontario are subject to the Zero Tolerance policy. This legislation prohibits new drivers from driving with any alcohol in their bloodstream.

[9] The authors also used data from FARS for the years between 1982 and 2000. The prevention polices and initiatives that the authors look at include, graduated drivers licensing, the 0.08 BAC law and the Mothers Against Drunk Driving (MADD) organization.

Finally, Sen (2001) examined the deterrence effects of stricter drinking and driving legislation in Canada. The author found that the enactment of stricter penalties does not significantly affect impaired driver fatality rates. Instead, he found that mandatory seatbelt legislation is correlated with a 27 percent decline in impaired driver fatality rates and concluded that initiatives aimed at enhancing vehicle safety may be more beneficial to society.[10]

4. Objective and Methodology

In this paper, motor vehicle collision fatally rates per 100,000 licensed drivers are used to assess the effectiveness of graduated driver's licensing systems in Canada. I argue that this is a relevant measure for identifying the effects of graduated driver's licensing systems, since these programs are designed to reduce the number of motor vehicle collisions for new drivers.[11]

To this end, I estimate the following regression;

$$\ln(y_{it}) = \beta_0 + \beta_1 g_{it} + \boldsymbol{z}_{it}\boldsymbol{\beta}_2 + p_{it}b_3 + t_{it}b_4 + v_{it} \qquad (1)$$

where $i = 1, \ldots, 10$ and $t = 1987, \ldots, 2007$; i being a province and t being a year.

The dependent variable $\ln(y_{it})$ is the natural logarithm of the ratio of motor vehicle traffic fatalities within a province and year per 100,000 licensed drivers.[12] As I am concerned

[10] The author employed impaired driver fatality rates obtained from the Traffic Injury Research Foundation as a measure of impaired driving for the years between 1976 and 1992.

[11] The existing literature focuses almost exclusively on motor vehicle collision fatalities as an outcome measure. The reason for this is because it is the most accurate and comprehensively available data. Other possible measures of the effectiveness of graduated licensing legislation could be per driver injury rate, driver crash rate, per capita crash rate, or the per capita causality crash rate.

[12] The data on fatality rates have been obtained from the Traffic Injury Research Foundation. The sample is available for all provinces from 1987 to 2007.

with the overall policy impact of graduated licensing legislation, I include any fatality in the calculation of the dependent variable that is a fatality of a passenger, a pedestrian or a driver.[13]

The independent variable of interest g is an indicator for graduated driver's licensing legislation. The variable indicates the enactment of graduated licensing legislation in a province i in year t.[14] For graduated driver's licensing programs that came into effect during a calendar year, the appropriate fractional value is used.

The additional control variables; $\boldsymbol{z}_{it}$ includes exogenous variables that measure traffic density, economic conditions, and demographic trends.[15] The $\boldsymbol{z}_{it}$ variables are included to control for other factors that are correlated to provincial motor vehicle collision fatalities. For example, the provincial unemployment rate is employed to measure provincial economic conditions as earlier work has recognized the importance of controlling for macroeconomic factors in analysis of motor vehicle collision fatalities.[16, 17] A description all variables and additional details pertaining to the construction of the dependent variables is listed in Table 2.

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[13] In the construction of driver fatality rates, if in a given year there was a province with no fatal motor vehicle collisions, the missing value in the dataset was replaced by 0.0000000001. This was done because the dependent variable is in natural logarithm form and one cannot take the logarithm of 0.

[14] American studies such as Dee et al. (2005) use the Insurance Institute for Highway Safety (IIHS) Taxonomy of Licensing Systems for Young Drivers, to measure the restrictiveness of state graduated driver's licensing programs. IIHS ranks graduated driver's licensing programs into four categories; good, fair, marginal and poor. No comparable ranking for Canadian programs exists.

[15] Dee et al. (2001) used maximum state highway speed limits, mandatory seatbelt legislation, impaired driver laws, and state unemployment rates to control factors that may influence motor vehicle collision fatality rates. Sen (2001) included the minimum legal drinking age in his model to capture the effect of alcohol control policies, as previous literature has shown that an increase in the minimum legal drinking age may decrease motor vehicle collision fatalities by reducing alcohol consumption. I attempted to include these variables in my model, however, there was no variation over time, and they could not be included in my model.

[16] Ruhm (2000) finds that there is a statistically significant negative relationship between the unemployment rate and health. Specifically, he finds that a 1 percentage point increase in the unemployment rates is associated with a 0.5 to 0.6 percent reduction in total mortality in the United States.

[17] Sen (2001) included mandatory seatbelt legislation, maximum highway speed limits and blood alcohol concentration legislation to control the effects of provincial highway safety legislation on motor vehicle collision fatalities. However, since the time period of this study is over the introduction of graduated licensing legislation, it excludes the variation in the introduction of other traffic safety legislation in Canada. For example, provincial

The remaining variables include; p which control for province effects; t which control for time effects and v_{it} is the error term. All variables, except the binary variables, are in natural logarithms. The means and standard deviations of all the variables are presented in Table 3.

5. Results

In this section I evaluate the effectiveness of graduated licensing legislation by estimating their impact on motor vehicle collision fatality rates. Table 4 (a) and (b) present the results of estimating equation (1), using ordinary least squares. The dependent variable is the natural logarithm of the motor vehicle collision fatality rate of drivers aged 15 to 24 and 25 and over, respectively.

Column 1 presents the results of the simplest specification; graduated licensing on motor vehicle collision fatality rates. Year fixed effects are introduced in Column 2. In Column 3, province fixed effects are introduced and year fixed effects are excluded. Both province and year fixed effects are included in Column 4. The provincial unemployment rates, provincial population estimates for 15 to 24 year olds, and urban population figures are introduced in Columns 5 to control for other factors that may influence traffic safety among teens and young adults. In Column 6, I concentrate the estimation on years surrounding the enactment of graduated licensing legislation in Canada.[18] Finally, Column 7 reduces the number of provinces in the sample by removing smaller provinces that may not observe as many fatalities as larger provinces simply due to population size. Specifically, New Brunswick, Newfoundland, Nova Scotia and Prince Edward Island are omitted.

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governments enacted mandatory seatbelt legislation between 1976 and 1987. As a result provincial highway traffic legislation variables were not included in my model.

[18] Carpenter (2005) reduced the sample of his study focusing on the years directly before and after 1994, when Zero Tolerance and graduated licensing legislation was enacted. The years prior to 1993 are excluded as well as 2007.

From Column 1 in Table 4 (a), the statistically significant estimate indicates that the introduction of graduated licensing legislation is associated with a 57 percent reduction in fatal motor vehicle collision rate of 15 to 24 year olds. However, when provincial and time effects are introduced in Column 5 the correlation remains negative, but becomes statistically insignificant. In Column 6 with the reduction of years, and Column 7 with the reduction of provinces the estimates remain negative statistically insignificant.

Since, attempting to evaluate the effects of graduated driver's licensing legislation on motor vehicle collision fatalities for teen and young adult drivers may not be a sufficient strategy to assess their overall impact, as motor vehicle collisions often include more than one vehicle, it would be interesting to examine the effects of graduated licensing legislation using the motor vehicle collision fatality rates of older drivers. Table 4 (b), contains the ordinary least squares estimates of equation (1) using the natural logarithm of the motor vehicle collision fatality rates of drivers aged 25 year olds and older as the dependent variable.

In Column 1, the statistically significant estimate indicates that the introduction of graduated licensing legislation is responsible for a 26.8 percent reduction in the motor vehicle collision fatality rate of drivers 25 years old and older. However, the estimate becomes statistically insignificant with the introduction of provincial and time effects in Column 5. This suggests that the introduction of graduated licensing legislation did not reduce the motor vehicle collision fatality rate of drivers aged 25 years and older.

As discussed above graduated licensing places restrictions on new drivers regarding alcohol consumption, night and highway driving. Table 5 (a) examines the effectiveness of graduated licensing in reducing driver fatalities of 15 to 24 year olds related to these restrictions;

specifically, impaired driver fatalities, highway driver fatalities, and night time driver fatalities. Table 5 (b), examines the effectiveness of graduated licensing legislation on reducing motor vehicle collision fatalities of drivers aged 25 and older.

Column 1 replicates the results from total driver motor vehicle collision fatalities from Tables 4 (a) and (b) Column 5. Column 2 presents the results of estimating equation (1) using impaired driver motor vehicle collision fatality rates as the dependent variable.[19] Highway driver motor vehicle collision fatality rates are used as the dependent variable in Column 3 and night time driver motor vehicle collision fatality rates are used as the dependent variable in Column 4.[20, 21]

None of the estimates for graduated licensing legislation are statistically significant in Table 5 (a) and (b). The results indicate that the introduction of graduated licensing legislation is not responsible for any reduction to the impaired driver, night time driver or highway driver motor vehicle collision fatality rate in Canada. These results are interesting as one would expect to find improvements in these fatality rates due to the specific restrictions imposed by graduated licensing legislation, especially among teen and young adult drivers.

Table 6 presents the results of estimating equation (1) using the natural logarithm of male and female driver motor vehicle collision fatalities aged 15 to 24 as the dependent variable. The first column presents the results of female drivers and the second, male drivers. The results

[19] In Canada a driver is impaired if their blood alcohol concentration level is 0.08 percent. The impaired driver fatality rate is constructed from motor vehicle collision fatalities where the driver had a recorded blood alcohol concentration of 0.08 percent or greater (Sen 2001). In the dataset, if the blood alcohol concentration was not tested then it was assumed to be 0 as there was no indication that alcohol was involved and if the blood alcohol concentration was recorded as unknown it was dropped from the dataset.

[20] Night time restrictions are typically imposed from midnight to 5 am. The night time fatality rate is constructed from motor vehicle collision occurring between 12 pm and 5 am.

[21] The road type where a motor vehicle collision occurred is recorded by TIRF. The highway driver fatality rate is constructed from motor vehicle collision fatalities where the driver crashed on a highway. If the location was unknown it was dropped from the dataset.

presented in the first column are not statistically significant and indicate that the introduction of graduate licensing legislation is not responsible for any reductions in the motor vehicle collision fatality rate of female drivers aged 15 to 24. However, the results presented in the second column suggest that the introduction of graduated licensing legislation is responsible for a 17.5 percent reduction in the motor vehicle collision fatality rate among males aged 15 to 24. This is the only specification in which the introduction of graduated licensing legislation has had a statistically significant negative relationship with motor vehicle collision fatality rates.

With respect to the covariates, only unemployment rates are found to have a negative statistically significant relationship with motor vehicle collision fatalities. Specifically, the results indicate that a 1 percent increase in the unemployment rate reduce motor vehicle collision fatalities by 0.34 percent, Table 4(a) Column 5 among drivers aged 15 to 24, and 0.22 percent, Table 4 (b) Column 5 among drivers aged 25 and over. Furthermore, the results indicate that unemployment rates have a negative statistically significant relationship with impaired driver motor vehicle collision fatalities. Specifically, the results indicate that a 1 percent increase in the unemployment rate reduces impaired driver motor vehicle collision fatalities aged 15 to 24 by 0.61 percent, Table 5 (a) Column 1 and 0.28 percent among drivers aged 25 and over, Table 5 (b) Column 1. Urban population and population estimates of 15 to 24 years were not found to be statistically significant in the regressions.

Sen (2001) found similar results in that tougher legislation for impaired driving is not responsible for reductions in impaired driver fatalities. The only significant policy initiative was mandatory seatbelt legislation. In this study, the results indicate that graduated licensing legislation is not responsible for any reductions in fatal motor vehicle collisions and that only macroeconomic factors are statistically significant in reducing motor vehicle collision fatalities.

6. Conclusion

Graduated licensing legislation has been enacted, over the last several years, by provincial governments in an effort to improve traffic safety among teens and young adults in Canada. The intent of graduated licensing legislation is to improve driver quality and thus traffic safety, by allowing new drivers to acquire critical driving skills and experience in a protective environment. The purpose of this study is to evaluate the effects of graduated licensing legislation on motor vehicle collision fatalities.

I estimate the effects of graduated licensing legislation on motor vehicle collision fatalities of drivers aged 15 to 24 and in order to understand the overall impact of graduated licensing legislation, I estimate its effects on motor vehicle collision fatalities of older drivers aged 25 and over. The results indicate the expected negative correlation between graduated licensing legislation and motor vehicle collision fatalities however the effects are not statistically significant. These results suggest that graduated licensing legislation is not responsible for any reductions in fatal motor vehicle collisions in Canada.

Furthermore, I explore different measures of fatalities targeting the specific areas where one may find improvements due to the restrictions imposed by graduated licensing legislation. Specifically, I estimate the effects of graduated licensing legislation on motor vehicle collision fatalities of impaired drivers, night time drivers and highway drivers. Again, the results indicate the expected negative correlation between graduated licensing legislation and motor vehicle collision fatalities however the effects are not statistically significant. As one would expect to find a significant reduction in the fatalities associated with the specific restrictions imposed by

graduated licensing legislation, this result provides additional support that graduated licensing legislation is not responsible for any reductions in fatal motor vehicle collisions in Canada.

Although one specification, male drivers 15 to 24, suggests a negatively statistically significant relationship between graduated licensing legislation and motor vehicle collisions, the results of this study remain unchanged. The introduction of graduated licensing legislation is not responsible for any reductions in motor vehicle collision fatalities.

The results of this study are not consistent with the existing literature examining similar graduated licensing legislation in the United States which consistently find that the legislation to meaningfully decrease motor vehicle fatalities.

There are several reasons why the introduction of graduated licensing legislation may not have significantly affected motor vehicle collision fatalities in Canada. For example, as many of the restrictions imposed by graduated licensing legislation are difficult to monitor and enforce, the degree of compliance and enforcement may be an important determinant in the effectiveness of graduated licensing, Dee et al. (2005). However, since studies have found that graduated licensing is an effective safety measure in the United States, this is an unlikely reason.

Alternatively, variation in the content and structure of graduated licensing systems may be an important factor in determining the effectiveness of graduated licensing. For example, graduated licensing in the United States is aged-based and only applicable to teens whereas in Canada graduated licensing is time-based and applicable to all new drivers. Furthermore, time discounts, which reduce the beginner's stage, for participation in driver's education are offered in Canada. As research has proven that experience is critical in the development of driving skills

and as graduated licensing legislation offers time discounts, reducing the learning process this may be a key determinant in the effectiveness of graduated licensing in Canada.[22]

Additionally, the existing literature indicates that more restrictive policies achieve greater reductions in fatal motor vehicle collisions.[23] Therefore, the strength of the conditions and restrictions imposed by graduated licensing legislation is to an important determinant in the effectiveness of graduated licensing. As provincial governments design graduated licensing legislation, it is not surprising then that systems vary within Canada. Some graduated licensing legislations impose many restrictions and others are only graduated licensing in name. As there is variation in graduated licensing within Canada, one would also expect differences between Canadian and American systems. However, there is no comparable way to determine the restrictiveness of Canadian graduated licensing systems, or to compare them to systems in the United States. Perhaps the diversity in graduated licensing legislation between Canada and the United States is responsible for the variation in its effects and improvements to the existing Canadian graduated licensing legislation may induce significant reductions in fatal motor vehicle collisions. Future studies may wish to investigate further into the differences between graduate licensing systems in Canada and the United States.

Regardless of the reason behind the statistically insignificant effects of graduated licensing legislation in Canada, the results of this study indicate that the introduction of graduated licensing legislation has not been effective in reducing motor vehicle collision fatalities in Canada. However, graduated licensing legislation may have meaningful effects on

[22] British Columbia, Ontario, Quebec, Newfoundland, New Brunswick, Nova Scotia all offer time discounts to novice drivers who complete graduated licensing legislation. See Table 1(a).
[23] Dee et al. (2005), Karaca-Mandic et al. (2010) and, Eisenberg et al. (2003) all found that greater restrictions are responsible for larger reduction in fatal motor vehicle collisions.

other outcomes such as the relative number of collision, either fatal or non fatal or injury rates. Future research may wish to focus on these outcome measures.

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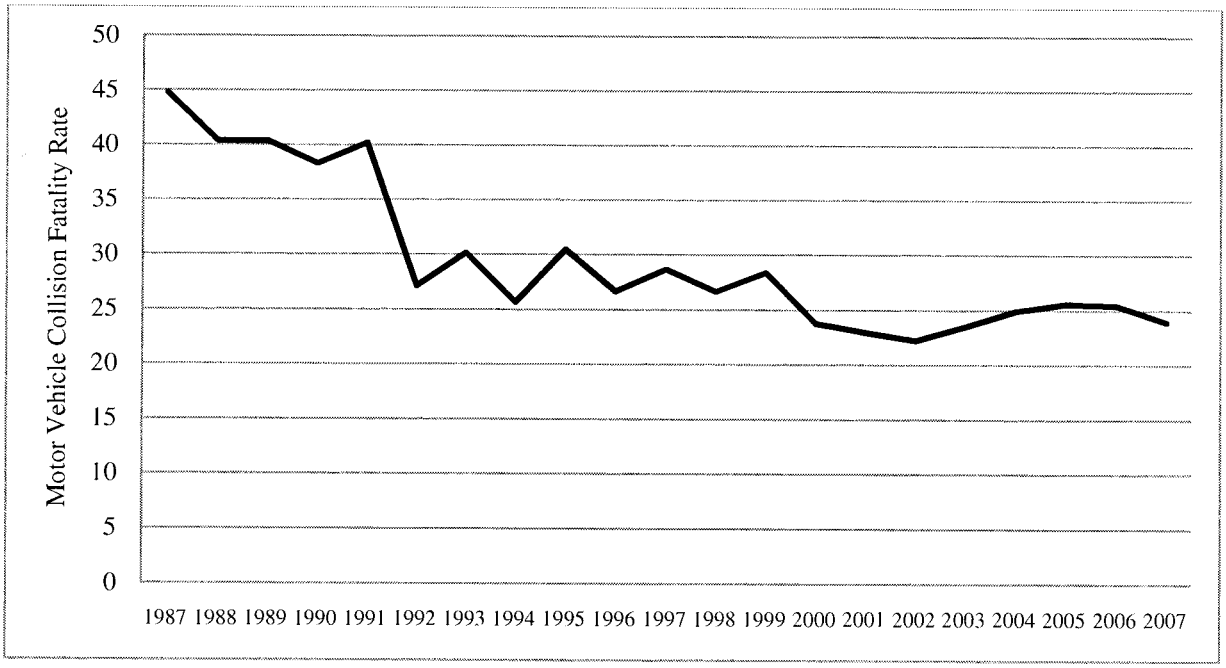
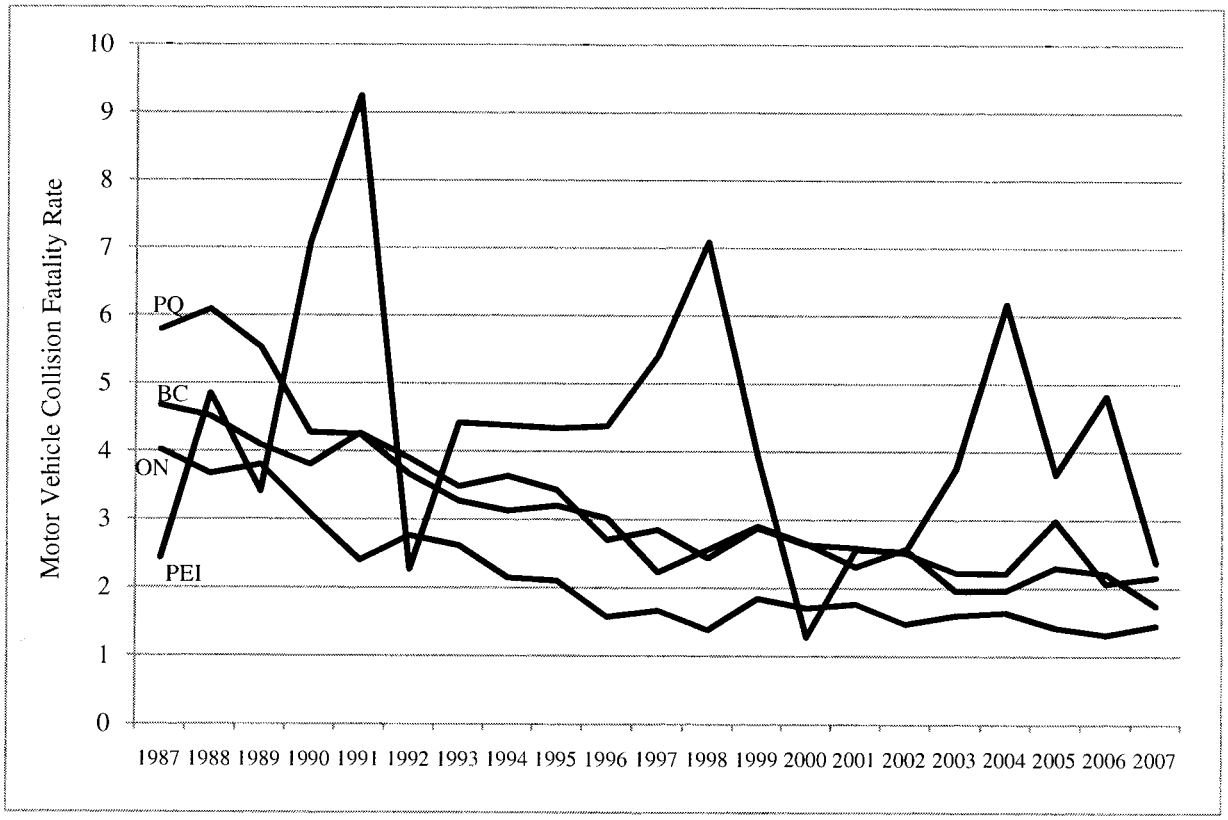
Figure 1(a): Driver Motor Vehicle Collision Fatality Rates per 100,000 Licensed Drivers in Canada Aged 15-24, 1987-2007



Source: Traffic Injury Research Foundation

Figure 1(b): Driver Motor Vehicle Collision Fatality Rate per 100,000 Licensed Drivers in Select Provinces Aged 15-24, 1987-2007



Source: Traffic Injury Research Foundation

Table 1(a): Canadian Graduate Driver's Licensing Programs
Structure and Content of the Beginner Stage

Component	BC	ALB	SASK	MAN	ONT	PC	NFLD	NB	NS	PEI
Implementation Date	1998	2003	2005	2003	1994	1997	1999	1996	1994	2000
Entry Age	16	14	16	16	16	16	16	16	16	16
Entry Tests: Vision	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Knowledge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental Consent:	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Age Applied	under 19	under 18	under 18	under 18	N/A	under 18	under 19	under 18	under 18	under18
Minimum Duration:										
Without Driver Ed	12 mo	12 mo	9 mo	9 mo	12 mo	12 mo	12 mo	12 mo	6 mo	6 mo
With Driver Ed	9 mo	N/A	9 mo	N/A	8 mo	8 mo	8 mo	4 mo	3 mo	6 mo
Maximum Duration	2 years	None	None	None	5 years	None	2 years	None	1 year	1 year
Supervisor: Age	25 or over	18 or over	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
License Type	Class 1-5	Fully	Class 5+	Fully	Fully	Fully	Class 5	Fully	Fully	Fully
Time Licensed	N/S	N/S	1 year	3 years	4 years	2 years	2 years	N/S	N/S	4 years
BAC Level	N/S	N/S	>.04	>.05	>.05	>.05	>=.08	N/S	N/S	>.08
Minimum Driving	None	None	None	None	None	None	None	None	None	None
Driver Education:										
Voluntary	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
BAC Level	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero
Night Restrictions	12am-5am	12am-5am	None	None	12am-5am	None	12am-5am	None	None	None
Passenger Restrictions:										
Number	2	N/A	N/A	N/A	N/A	N/A	1	1	1	1
Incl. Supervisor	Yes	N/A	Yes	N/A	N/A	N/A	Yes	Yes	Yes	Yes
Limit to # seatbelts	N/A	Yes	Yes	Yes	Yes	N/A	N/A	N/A	N/A	Yes
L Sign/Plate	Man.	None	None	None	None	None	Man.	None	None	None
Road Restriction	None	None	None	Yes	Yes	None	None	None	None	None
Penalties for GDL Violations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lower Demerit Point Threshold	2-6 instead of 15-19	8 instead of 15	Yes	Yes	9 instead of 15	4 instead of 15	6 instead of 12	Yes	Yes	6 instead of 12
Suspensions/ Probations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Start Stage Over/Extended	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes
Driver Improvement	None	Yes	Yes	Yes	Yes	Yes	Yes	None	Yes	Yes
Other Features	None	None	Yes	Yes	None	Yes	Yes	None	None	Yes
Minimum Exit Age	16 & 9 mo	16	16	16 & 3mo	16 & 8mo	16 & 8mo	16 &8mo	16 & 4 mo	16 &3 mo	16 with DE

Table 1 (a) reproduced from Emery et al. (2008)

Table 1(b): Canadian Graduate Driver's Licensing Programs
Structure and Content of the Intermediate Stage

Component	BC	ALB	SASK	MAN	ONT	PC	NFLD	NB	NS	PEI
Entry Age	16 & 9 mo	16	16	16 & 3 mo	16 & 8 mo	16 & 8 mo	16 & 8 mo	16 & 4 mo	16 & 3 mo	16
Entry Requirements:										
Road Test	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental Consent:	No	No	No	No	No	Yes	No	No	No	Yes
Age Applied	N/A	N/A	N/A	N/A	N/A	under 18	N/A	N/A	N/A	under18
Minimum Duration:	24 mo	24 mo	18 mo	15 mo	12 mo	24 mo	12 mo	12 mo	24 mo	24mo
Maximum Duration	5 years	None	None	None	5 years	24 mo	12 mo	20 mo	5 years	N/A
BAC Level	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero	Zero
Night Restrictions	None	None	None	None	None	None	12am-5am	None	None	None
Passenger Restrictions:										
Number	1	N/A	1	Yes	Yes	N/A	N/A	N/A	Yes	1st yr 3 pass
Limit to # seatbelts	N/A	Yes	Yes	Yes	Yes	N/A	Yes	N/A	Yes	2nd year
L Sign/Plate	Man.	None	None	None	None	None	None	None	None	None
Road Restriction	None	None	None	Yes	None	None	None	None	None	None
Penalties for GDL Violations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lower Demerit Point Threshold	2-6 instead of 15-19	8 instead of 15	Yes	Yes	9 instead of 15	4 instead of 15	6 instead of 12	Yes	Yes	6 instead of 12
Suspensions/ Probations	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Start Stage Over/Extended	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
Driver Improvement	None	Yes	Yes	Yes	Yes	Yes	Yes	None	Yes	Yes
Other Features	None	Yes	Yes	Yes	None	None	Yes	None	Yes	Yes
Exit Requirements:										
Road Test	Yes	Yes	No	No	Yes	No	No	No	No	N/A
Course	No	No	No	No	No	No	No	No	Yes	N/A
Minimum Exit Age	18 & 9 mo	18	17 & 6 mo	17 & 6mo	17 & 8mo	18 & 8mo	17 &8mo	18 mo	18 &3 mo	18

Table 1 (b) reproduced from Emery et al. (2008)

Table 2
Variables and Empirical Construction

Variable	Description and Source
Fatality Rates	Total Driver, Impaired Driver, Highway Driver, Night Time Driver fatalities per 100,000 licensed drivers. (Dependent variables) Fatalities obtained from the Traffic Injury Research Foundation for the years between 1987 and 2007. Information on licensed drivers obtained from CANSIM Table 405-0001.
Population	Provincial population figures. Data obtained from CANSIM Table 051-001.
Population 15-24	Provincial population of 15 to 24 year olds. Data obtained from CANSIM Table 051-001.
Unemployment Rate	Provincial unemployment rate. Data obtained from CANSIM Table 282-008.
Urban Population	Percentage of province's population living in cities with population exceeding 100,000. Data obtained from CANSIM Table 051-0036.

Table 3
Descriptive statistics for provincial panel data: 1987-2007

Variables	Mean	Standard Deviation
Total Driver Motor Vehicle Collision Fatality Rates 15-24	47.77	50.61
Total Driver Motor Vehicle Collision Fatality Rates 25 & over	140.07	146.35
Impaired Driver Motor Vehicle Collision Fatality Rates 15-24	21.76	25.55
Impaired Driver Motor Vehicle Collision Fatality Rates 25 & over	60.52	68.59
Female Driver Motor Vehicle Collision Fatality Rates 15-24	9.00	9.22
Male Driver Motor Vehicle Collision Fatality Rates 15-24	38.76	42.05
Highway Driver Motor Vehicle Collision Fatality Rates 15-24	17.11	21.24
Highway Driver Motor Vehicle Collision Fatality Rates 25 & over	60.35	73.16
Night Driver Motor Vehicle Collision Fatality Rates 15-24	38.76	42.05
Night Driver Motor Vehicle Collision Fatality Rates 25 & over	22.32	24.40
Graduated Licensing Legislation	0.41	0.49
Population 15-24	415,367	474,991
Provincial Unemployment Rate	9.75	3.79
Urban Population	1,817,789	2,518,081
(N=210)		

Table 4 (a)

The estimated effects of graduated licensing legislation on the driver motor vehicle collision fatality rate 15-24

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Graduated Licensing Legislation	-0.571***	-0.341***	-0.565***	-0.203*	-0.119	-0.157	-0.0786
	(0.0701)	(0.0922)	(0.0741)	(0.118)	(0.0894)	(0.138)	(0.103)
Unemployment Rate					0.0572	0.0360	-0.472**
					(1.273)	(2.636)	(0.229)
Urban Population					-0.205	-0.162	-0.0553
					(0.390)	(0.485)	(0.0746)
Population 15-24					1.781	1.740	-0.235
					(1.648)	(3.220)	(0.527)
Year	No	Yes	No	Yes	Yes	Yes	Yes
Province	No	No	Yes	Yes	Yes	Yes	Yes
Constant	1.193***	1.542***	1.075***	1.375***	-12.55	-12.85	5.688
	(0.0432)	(0.0881)	(0.0644)	(0.0636)	(16.57)	(21.87)	(6.230)
Observations	210	210	210	210	210	140	126
R-squared	0.117	0.165	0.215	0.268	0.278	0.193	0.784

Notes

The dependent variable is the natural logarithm of total driver fatalities per 100,000 licensed drivers aged 15 to 24. Column 1 presents the results of the simplest specification; graduated licensing on motor vehicle collision fatality rates. Year fixed effects are introduced in Column 2. In Column 3, province fixed effects are introduced and year fixe effects are excluded. Both province and year fixed effects are included in Column 4. The provincial unemployment rates, provincial population estimates for 15 to 24 year olds, and urban population figures are introduced in Columns 5 to control for other factors that may influence traffic safety among teens and young adults. Column 6 reduces the number of years in the sample to create a smaller sample around the enactment dates of graduated licensing legislation in an effort to identify an effect. Column 7 reduces the number of provinces. New Brunswick, Newfoundland, Nova Scotia, and Prince Edward Island are omitted. Population weights are used in all specifications. All variables except binary ones are in natural logarithm form. Standard errors in parentheses *** denotes significance at 1 percent; ** denotes significance at 5 percent; and * denotes significance at 10 percent.

Table 4(b)
The estimated effects of graduated licensing legislation on the driver motor vehicle collision fatality rate 25 and over

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Graduated Licensing Legislation	-0.268***	-0.0971*	-0.266***	-0.0104	-0.0256	0.0143	-0.0392
	(0.0407)	(0.0537)	(0.0307)	(0.0512)	(0.0543)	(0.0603)	(0.0610)
Unemployment Rate					-0.218*	-0.858*	-0.197
					(0.119)	(0.514)	(0.124)
Urban Population					-0.0345*	-0.0508*	-0.0403*
					(0.0187)	(0.0264)	(0.0205)
Population 15-24					0.277	0.157	0.951**
					(0.268)	(0.577)	(0.414)
Year	No	Yes	No	Yes	Yes	Yes	Yes
Province	No	No	Yes	Yes	Yes	Yes	Yes
Constant	2.176***	2.255***	2.098***	2.140***	7.353*	10.36*	-0.375
	(0.0305)	(0.0720)	(0.0262)	(0.0375)	(3.742)	(6.024)	(6.744)
Observations	210	210	210	210	210	140	126
R-squared	0.037	0.141	0.378	0.475	0.487	0.436	0.407

Notes
The dependent variable is the natural logarithm of total driver fatalities per 100,000 licensed drivers aged 25 and over. Column 1 presents the results of the simplest specification; graduated licensing on motor vehicle collision fatality rates. Year fixed effects are introduced in Column 2. In Column 3, province fixed effects are introduced and time effects are excluded. Both province and year fixed effects are included in Column 4. The provincial unemployment rates, provincial population estimates for 15 to 24 year olds, and urban population figures are introduced in Columns 5 to control for other factors that may influence traffic safety among teens and young adults. Column 6 reduces the number of years in the sample to create a smaller sample around the enactment dates of graduated licensing legislation in an effort to identify an effect. Column 7 reduces the number of provinces. New Brunswick, Newfoundland, Nova Scotia and Prince Edward Island are omitted. Population weights are used in all specifications. All variables, except binary ones are in natural logarithm form. Standard errors in parentheses *** denotes significance at 1 percent; ** denotes significance at 5 percent; and * denotes significance at 10 percent.

Table 5(a)

The estimated effects of specific fatalities drivers aged 15 to 24

Variables	Driver Fatality Rate aged 15-24	Impaired Driver Fatality Rates	Highway Driver Fatality Rates	Night Time Driver Fatality Rates
Graduated Licensing Legislation	-0.119	-0.122	0.320	0.184
	(0.0894)	(0.125)	(0.162)	(0.282)
Unemployment Rate	0.0572	-0.617***	0.0514	-0.0991
	(1.273)	(0.196)	(0.212)	(0.358)
Urban Population	-0.205	-0.159**	-0.0884	-0.0413
	(0.390)	(0.0641)	(0.0876)	(0.0909)
Population 15-24	1.781	1.093	1.074	2.514
	(1.648)	(1.189)	(1.768)	(2.479)
Constant	-12.55	-11.27	-41.03	-60.44
	(16.57)	(16.65)	(24.97)	(71.88)
Year	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
Observations	210	210	210	210
R-squared	0.278	0.310	0.991	0.274

Notes

Column 1 replicates Column 5 in Table 4(a). The dependent variable in Column 2 is impaired driver fatalities per 100,000 licensed drivers aged 15 to 24. The dependent variable in Column 3 is highway driver fatalities per 100,000 licensed drivers and in Column 4 it is night time driver fatalities per 100,000. Population weights are used in all specifications. All variables are in natural logarithm form. Standard errors in parentheses *** denotes significance at 1 percent; ** denotes significance at 5 percent; and * denotes significance at 10 percent.

Table 5(b)
The estimated effects of specific fatalities drivers aged 25 and over

Variables	Driver Fatality Rates aged 25 and over	Impaired Driver Fatality Rates	Highway Driver Fatality Rate	Night Time Driver Fatality Rate
Graduated Licensing Legislation	-0.0317	-0.0523	0.0697	-0.772
	(0.0710)	(0.102)	(0.602)	(1.364)
Unemployment Rate	-0.355*	-0.209	-0.596	3.906
	(0.187)	(0.269)	(1.587)	(3.594)
Urban Population	0.0140	0.0241	0.00878	0.301
	(0.0573)	(0.0826)	(0.486)	(1.101)
Population 15-24	-0.332	-0.160	-0.0521	3.235
	(0.242)	(0.349)	(2.055)	(4.653)
Constant	7.353*	3.754	-24.47	-60.44
	(3.742)	(5.387)	(31.74)	(71.88)
Year	Yes	Yes	Yes	Yes
Province	Yes	Yes	Yes	Yes
Observations	210	210	210	210
R-squared	0.487	0.534	0.970	0.274

Notes
Column 1 replicates Column 5 in Table 4(b). The dependent variable in Column 2 is impaired driver fatalities per 100,000 licensed drivers ages 25 and over. The dependent variable in Column 3 is highway driver fatalities per 100,000 licensed drivers and in Column 4 it is night time driver fatalities per 100,000. Population weights are used in all specifications. All variables except binary ones are in natural logarithm form. Standard errors in parentheses *** denotes significance at 1 percent; ** denotes significance at 5 percent; and * denotes significance at 10 percent.

Table 6

The estimated effects of graduated licensing legislation

Variables	Females	Males
Graduated Licensing Legislation	0.135	-0.175*
	(0.415)	(0.0943)
Unemployment Rate	-0.692	-0.294*
	(0.666)	(0.155)
Urban Population	-0.389*	-0.0738
	(0.231)	(0.0528)
Population 15-24	0.311	1.167
	(3.676)	(1.183)
Constant	2.222	-12.11
	(53.05)	(15.23)
Year	Yes	Yes
Province	Yes	Yes
Observations	210	210
R-squared	0.297	0.291

Notes

In Column 1 the dependent variable is female driver fatalities per 100,000 licensed drivers ages 15 to 24. The dependent variable in Column 2 is male driver fatalities per 100,000 licensed drivers. Population weights are used in all specifications. All variables except binary ones are in natural logarithm form. Standard errors in parentheses *** denotes significance at 1 percent; ** denotes significance at 5 percent; and * denotes significance at 10 percent.