

**Impaired Driving: How effective are Canada's impaired
driving laws**

By

Adio Olalekan

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Supervisor: Ted McDonald, PhD, Economics

Examining Board: Weiqiu Yu, PhD, Economics

David Murrell, PhD, Economics

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ABSTRACT

Impaired driving has been a major cause of death and injuries in Canada for decades, and in response a succession of laws has been put in place to reduce cases of impaired driving. This report evaluates the effectiveness of a number of recent changes to impaired laws using econometric methods applied to a Census Metropolitan Area (CMA) level dataset over a 12-year period and makes recommendations about what approaches might be introduced in the future to reduce the cases of impaired driving. Results indicated that after controlling for changes in demographic, socioeconomic and geographic characteristics, as well as a secular trend in reduction in incidence over time, measures enacted to reduce the blood alcohol content level before charges applied and the duration of license suspension had no appreciable effect on the incidence of impaired driving. In addition, results indicated that police concentration appeared to have a positive effect on impaired driving incidence, likely indicating an increase in detection rather than any changes in underlying driver behavior.

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CHAPTER 1: INTRODUCTION

Drunk driving is a serious concern in Canada. According to Statistics Canada, police reported over 90,000 cases of impaired driving in 2011, an increase of 3,000 cases compared to the preceding year. Of the reported incidents 121 led to death, and another 839 cases led to bodily harm (Statistics Canada, 2013).

Drunk driving has been illegal in Canada since 1921, but in 1969 the Canadian parliament took it a step further and brought into existence the “per se law” which forbids the operation of a vehicle with a blood alcohol concentration (BAC) in excess of 80 mg of alcohol per 100 ml of blood. Drunk driving or impaired driving, as it is sometimes referred to, is the act of operating a motor vehicle under the influence of alcohol which is above the legal limit. The legal limit is determined by the blood alcohol concentration, and may differ across Canadian provinces.

The legal definition of drunk driving in Canada differs from the above definition of drunk driving, according to the Canadian criminal code, section 253 (1985): *every one commits an offence who operates a motor vehicle or vessel or operates or assists in the operation of an aircraft or of railway equipment or has the **care or control** of a motor vehicle, vessel, aircraft or railway equipment, whether it is in motion or not, (a) while the person’s ability to operate the vehicle, vessel, aircraft or railway equipment is impaired by alcohol or a drug; or (b) having consumed alcohol in such a quantity that the concentration in the person’s blood exceeds eighty milligrams of alcohol in one hundred millilitres of blood.* Care of control in this context was interpreted as “Care or control may be exercised without such intent where an accused performs some act or series of acts

involving the use of the car, its fittings or equipment, such as occurred in this case, whereby the vehicle may unintentionally be set in motion creating the danger the section is designed to prevent” (Judgements of the Supreme Court of Canada, Ford V. The Queen, [1982] 1 S.C.R. 231). The law regarding drunk driving in Canada can be classified into two jurisdictional levels: federal and provincial.

Impaired driving offences can be considered to be under federal jurisdiction under certain circumstances; a major one is driving or having care or control of a motor vehicle with a BAC of 0.08% or more. Other circumstances are impaired driving causing bodily harm or death.

Provinces in Canada have over the years reduced the BAC level, to levels which some consider more appropriate, and also come up with more punishments and fines to deter people from engaging in drunk driving. A key question that arises is the extent to which these regulations have proved to be effective in reducing BAC level and/or increasing fines have proved to be effective in reducing the incidence of impaired driving in Canada. The purpose of this report is to determine if there is any evidence that these Canadian impaired driving laws have been effective.

THEORETICAL BACKGROUND

The principle of deterrence provides a good foundation with respect to finding out how effective fines or punishments have been in curbing or reducing drunk driving. Deterrence theory has its roots or connections in ‘rational choice theory’. The rational choice theory is a framework that explains human behaviour and decision making, and humans are adjudged to be usually rational, i.e. will engage only in an activity whose

marginal benefit is at least equal to the marginal cost. With that in mind, deterrence theory states that appropriately determined fines and punishments for an offence will discourage repeat offenders from committing that offence and also discourage other people (would-be individuals) from engaging in such punishable acts in the first place. The punishment is expected to be 'appropriate' for the offence committed, since if it is too severe the punishment will be adjudged to be unjust, and if it is not severe enough, then it will be also be adjudged to be lenient and so not achieve the optimal level of deterrence

In a different vein, one of the principles of common law is that punishment be just, or commensurate with the severity of the act. With regards to punishment being termed as just and unjust, it is subjective and based on perception and social norms of the citizenry. It is termed just if the society believe that the punishment meted out is commensurate with the wrongdoing being committed, and unjust if they feel the punishment exceeds the wrongdoing committed. This leads to the discussion of what laws are just, and which ones are unjust, the just and unjust law is best explained by a quote from Martin Luther King, Jr. (Letter from a Birmingham jail, 1963) "*A just law is a man-made code that squares with the moral law or the law of God. An unjust law is a code that is out of harmony with the moral law. To put it in the terms of St. Thomas Aquinas: An unjust law is a human law that is not rooted in eternal law and natural law. Any law that uplifts human personality is just. Any law that degrades human personality is unjust*".

Key factors with deterrence theory are swiftness and certainty. With regards to swiftness the punishments are deemed more effective when offenders get punished

almost immediately after committing the offence (Bosworth, 2004). Certainty has to do with the probability of being apprehended and punished (i.e., convicted and sentenced) for committing an offense. According to Winters, Globokar and Robertson (2004) deterrence can be classified into two different categories: general deterrence and specific deterrence. General deterrence is that aspect of deterrence theory that suggests that the offensive acts can be mitigated by the threat or existence of punishment for such acts. The threat of punishment is assumed to prevent members of the public from perpetuating that offensive/illegal act. Specific deterrence is the aspect of deterrence theory that attempts to reduce recidivism rates of offences, so it targets the actual offenders and attempts to prevent them from committing such offences again, for example increasing punishment for repeat offenders.

The cost and benefit aspects of rational choice theory are worth noting. The perceived costs to the individuals are the monetary cost of whatever fine or suspension is incurred, the opportunity cost (monetary and psychic) if the individual gets imprisoned or has his/her license suspended, and any monetary cost if there's an accident (injuries inflicted on humans, or damage to properties). As for the benefits, the perceived benefits are the convenience of transporting one's self, the convenience of not having to retrieve one's vehicle at a later date, and the pleasure of drinking before the driving takes place, all of which are quite difficult to measure. While the average human is expected to be rational, and also risk averse it would seem that the average human being would not be expected to drive while drunk, because from the points listed, the costs of impaired driving should outweigh the benefits. However, if the perceived chances of being caught are close to zero, then it is more likely individuals will drive while impaired. It is also

known that alcohol could impair one's thinking, so it isn't surprising when rational humans, after consuming more than appropriate amount of alcohol, get 'impaired', and decide to drive while impaired. It is said that when in an impaired state, the individual could have the cost of drunk driving understated, and all of a sudden be more willing to 'gamble' at the prospect of impaired driving.

CHAPTER 2: LITERATURE REVIEW

Studies that employed econometrics in analyzing how effective laws were on deterring impaired driving appear to be in the minority, with most of the papers or studies being descriptive with little or no formal data analysis. Examples of such relevant literature with only descriptive analysis include *The effects of introducing or lowering legal per se blood alcohol limits for driving: an international review* by Mann, Macdonald, Bondy et al (2001), and *The effectiveness of legal sanctions in dealing with drinking drivers* by Nichols and Ross (1990).

LITERATURE FROM THE UNITED STATES

In the paper *Alcohol control policies and motor vehicle fatalities* Chalopuka, Saffer and Grossman (1991), studied the effects of impaired driving deterrents and other alcohol related policies on drunk driving in the US. The study was carried out using annual time series data from 1982-1988 of 48 states. Many early studies used interrupted time series analysis, which according to Chalopuka et al was deemed not the most suitable for this type of study, and also considered only one law. The authors used a reduced form equation, which took into consideration the following variables; implied

consent laws, illegal and administrative per se laws, minimum legal drinking ages for alcoholic beverages, beer tax, preliminary breath test laws, open container laws, administrative license suspension, no plea bargaining laws, laws specifying minimum penalties for conviction of driving under the influence; and bars statutes.

The motor vehicle fatality rate was included in the analysis as the dependent variable, because the authors believed that there would be a strong correlation between drunk driving and motor vehicle fatalities, even if all fatal motor vehicle accidents are not as a result of drunk driving. Fatal motor vehicle accidents were found to be three times higher in the 18-20 year old age group compared to the overall population. The percentage of fatal accidents that included drunk drivers was pegged at 75-90%, this was deduced by data obtained from National Highway Traffic Safety Administration on fatal accidents that occurred within 12.00am and 3.59am, which was termed the night driver fatality rate.

The authors used an empirical model that consisted of two equations. Equation one was a production function relating the probability of an accident (π) to an individual's alcohol consumption before or while driving (y), and a vector of additional variables (z). The vector included variables which measure traffic density, roadway conditions, vehicle quality and other motor vehicle safety measures.

$$\pi = \pi(y,z) \tag{i}$$

The second equation was a demand for alcohol before or while driving.

$$y = y(p, a, c, f, I) \tag{ii}$$

which is a function of the price of alcohol (p), the probabilities of apprehension (a), probabilities of conviction given arrest (c), a vector of penalties associated with apprehension and conviction (f), and another vector for other variables affecting alcohol demand (I). The alcohol demand equation is substituted into the production function, which produces a reduced form probability equation.

$$\pi = \pi(p, a, c, f, I, z) \quad (\text{iii})$$

According to the study the most effective policies were beer tax and administrative license action; an increase in beer tax real value (base year = 1951) by 100% (from 16 cents to 32 cents per six-pack) was estimated to reduce fatalities by 11.5%, while an administrative license action for a year will reduce fatalities by 9%. Other policies found to be effective to a lesser extent were having the legal minimum drinking age at 21, a preliminary breath test law, dram shop law¹, and a relatively high compulsory fine of \$500. Each of these changes was found to deter impaired driving by about 5-6%. Other policies such as no plea bargaining provisions and mandatory license sanctions upon convictions were found to have deterrent effects to a lesser extent of about 1%, while mandatory jail sentences, community service, illegal per se laws, and open container laws were found to have had no deterrent effect on drunk driving.

LITERATURE FROM CANADA

In the paper entitled *Do stricter penalties deter drinking and driving? An empirical investigation of Canadian impaired driving laws*. Sen (2001) empirically

¹ A statute or case law in some states in the US which makes a business which sells alcoholic drinks or a host who serves liquor to a drinker who is obviously intoxicated or close to it, strictly liable to anyone injured by the drunken patron or guest.

assessed how effective Canadian impaired driving legislation was in deterring drunk driving over the period 1976 to 1992. He used impaired driving fatality rates as the dependent variable, and had several independent variables including composite price index of alcohol, jail term, minimum legal drinking age, per capita income, provincial maximum highway speed limit, provincial unemployment rates, number of stores and agencies selling liquor, breath test laws, compulsory third party liability laws, weekly disability benefits, license suspension, impaired driving fatality rates, vehicle impoundment, real monetary fine, percentage of males aged between 15-24 years, percentage of population aged over 65 years, number of police officers, provincial population, and mandatory seatbelt laws.

Sen estimated OLS regressions in order to identify correlations between different variables and drunk driving fatalities and concluded that mandatory seatbelt legislation, monetary fines and jail time were significantly associated with reductions in the drunk driving fatality rate. Mandatory seatbelt legislation had the most impact in reducing impaired driver fatalities and, was correlated with a 27% reduction in impaired driver fatalities.

He posited reasons as to why the introduction of stricter penalties may not have significantly affected the level of impaired driver fatalities, including the possibilities that law enforcement officers might have been less willing to arrest individuals and charge them for impaired driving. This is because because it was at the time considered a 'less serious' crime that would nevertheless go on the driver's permanent record. In the same vein, courts do not often mete out the maximum punishment on erring drivers, given concerns about the negative effects of a prison sentence both on the offender and costs to

the state. This implies that enforcement is endogenous, an issue that complicates the identification of actual deterrence effects.

In the paper titled; *The Criminalization of Impaired Driving in Canada: Assessing the Deterrent Impact of Canada's First Per Se Law*, Asbridge, Mann, Flam-Zalcman et al (2004) set out to find out how effective the per se law was, the law that criminalizes driving with a BAC of 0.08%. The focus was on the province of Ontario from 1962 to 1996.

The authors used the rate of alcohol related crashes and non-drinking driver fatalities as the dependent variables, and had the following as independent variables: breathalyser law, mandatory seatbelt, emergence of MADD (Mothers Against Drunk Driving) Canada, alcohol consumption per capita, annual unemployment rate, trend and annual precipitation.

The authors employed an interrupted time-series autoregressive integrated moving average (ARIMA). The breathalyser law was found to lead to an 18% reduction in the number of fatally injured drivers, the mandatory seatbelt legislation led to a 15% reduction in non-drinking driver fatalities; and the emergence of MADD was associated with having 'substantial' decrease in both alcohol related crashes and non-drinking driver fatalities. The results did indicate that the per se law had a specific deterrent effect, which led to a reduction in cases of alcohol related crashes. The effect of the breathalyser law was found to be less precisely estimated, but it is suggested that the efficacy of the law could be due to the change of the public's attitude towards drunk driving.

The studies did point out that some legislative measures and policies have been successful at deterring drivers from driving while impaired. Legislation such as mandatory seatbelt usage and breathalyser laws proved to be very effective, and policies such as beer tax, license suspension, and monetary fines have also been effective to a lesser extent. The studies are from different periods, and they highlight the policies and progress that have been made to combat impaired driving. It should be noted that the papers reviewed all considered alcohol-related driving fatalities or crashes as the dependent variable, and so did not take into account impaired driving arrests that didn't lead to accidents or death. This could lead to an understatement of the actual incidence of drunk driving. The dependent variable used in this report was the rate of alcohol related crashes, which encompassed crashes, fatalities and routine stops, even this could also lead to an understatement because it does not factor in impaired drivers that were not caught. It should be noted that the Canadian studies focused on impaired driving incidents, policies and legislations from 1960s only to the early 1990s. While new policies and legislations have been set in motion to reduce impaired driving after that time period, there is no analysis as yet as to how effective those policies and legislations have been. It is one of the reasons why I set out to write this report.

CHAPTER 3: METHODOLOGY

The empirical model chosen is based on work in the literature that has conducted similar analysis in other jurisdictions and has used a similar type of data i.e. panel data. The empirical model is a reduced-form equation which captures socioeconomic,

demographic, environmental and policy factors that can have an impact either on the incidence of drunk driving or the likelihood of detection, though these factors cannot be disentangled. The scope of this analysis is at the Census Metropolitan Area (CMA) level. According to Statistics Canada “a census metropolitan area (CMA) or a census agglomeration (CA) is formed by one or more adjacent municipalities centred on a population centre (known as the core). A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the core.” There are currently 32 CMAs in Canada, all of which are included in my dataset. The estimating equation is stated below:

$$Y_{it} = \alpha_t + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + \beta_6 X_{6it} + u_{it} + e_{it}$$

where $i = 1, 2, \dots, 32$, and $t = 2001, 2002, \dots, 2012$; i representing CMAs and t representing year.

Y_{it} is the dependent variable; it is the rate of impaired driving convictions, and it is influenced by the independent variables. X_1 represents the percentage of the population who are teenagers that are eligible to drive, X_2 represents the percentage of the population who are teenagers that are eligible to buy alcohol legally, X_3 is the alcohol price index, X_4 is the percentage of the adult population with at least a university degree, X_5 is the rate of police officers per 100,000 of the population, X_6 is the unemployment rate and X_7 is a set of policy variables relevant to drunk driving. The equation also includes a time trend.

Ideally, we would use as the dependent variable a measure of the actual incidence of drunk driving. However the incidence of drunk driving isn't easily observed, hence the need for a proxy variable that can be obtained from published statistics. Similar studies

have used observable measures such as fatality rates, drunk driving arrest rates, rates of fatal driving accidents or rate of accidents that happened within 12.00am to 4.00am, as proxies for rate of drunk driving.

The fatality rate, which is usually weighted by population, refers to the rate of people that die in road accidents. According to the Traffic Injury Research Foundation of Canada, in 2010 2,541 people died in motor vehicle related crashes in Canada, and of the 2,312 of these cases where it was possible to determine if alcohol had anything to do with it, 895 or 38.7% were found to be alcohol-instigated.

According to Statistics Canada, 50% of impaired driving accidents occur between 11pm to 4am and this could explain why some researchers opt to use data on road accidents that occur within 12am to 4am as a proxy for drunk driving rates. It must be noted that even the rate or cases of drunk driving detected can be underestimated due to various forms of underreporting. For example alcohol tests may not have been administered by authorities. Using the rate of fatal driving accidents relies on the assumption that most driving accidents are caused or influenced by alcohol. There may well be accidents where alcohol was involved but that fact when unreported or undetected. As well, a driver may well have been under the influence of alcohol but the accident occurred for unrelated reasons such as mechanical faults, other driver error, and bad road conditions. For this analysis I will be using the rate of impaired driving, provided by Statistics Canada, which is the rate of impaired driving arrests per 100,000 people. It is a conservative estimate, due to the underreporting that results from the inability to conduct alcohol tests on surviving impaired drivers and from the need to rely on police reports. Another factor to consider will be the existence of a guilty plea

agreement, which means arrested drivers at times might be given the chance to plead guilty to a lesser offense, and be easily released without the criminal charge of driving while intoxicated being laid.

Independent variables include:

1. Three different age variables for teenage drivers, and young adult drivers. The first is within the ages of 16-17 for CMAs in Quebec, 16-18 for those in CMAs outside Quebec, to control for teenagers who are old enough to drive but not old enough to purchase alcohol legally. Also I included the age 18-21 group, which is to account for young and novice drivers, who are able to drive, and also purchase alcohol. It should be noted that people within this age group are by law expected to have no alcohol in their blood stream while in the care or control of a motor vehicle, i.e. they should have a BAC of 0.00. Being caught with a positive alcohol reading of any level will result in suspension of the individual's license. The age 22-25 variable is to control for young adults.

These variables were included because teenage and youth deaths from impaired driving have been quite significant in recent decades, according to Mothers Against Drunk Driving (MADD) Canada. "Motor vehicle crashes are the leading cause of death among 16 to 25 year olds, and alcohol and/or drugs are a factor in 55% of those crashes, 16-25 year olds constituted 13.6% of the population in 2010, but made up almost 33.4% of the impairment-related traffic deaths". Perhaps the reason behind the significant number of deaths

among teenagers and youths has been attributed to either peer pressure, or inexperience of handling motor vehicles. This statistics were certainly noted by provincial governments who as a result introduced a requirement that drivers under the age of 21, have a zero percent BAC.

2. The alcohol price index is an index that indicates yearly levels in alcohol prices. This variable was introduced to determine if the price of alcohol had any impact on the drunk driving rate. It is an annual average of alcohol prices (in index form) over the years. I expect it to have a negative relationship with drunk driving rates.
3. University degree measures the percentage of the adult population who at least have a university degree. It is possible that, people who are more educated or literate may also be less likely to take the chance of drinking and driving. So it is assumed that the more highly educated people are, the less incidence of drunk driving expected. A highly educated person is perhaps expected to be more rational, assess the pros and cons of an activity, and as in the case of drunk driving be more aware of potential risks and penalties. As well, for university graduates the opportunity costs of a conviction may be substantially larger. The variable measures the number of people in each CMA with at least a university degree, based on population census figures, and since census are conducted every five years, this figure had a constant figure for each five year interval.
4. The number of police officers refers to the extent of police presence in each CMA, and it is expressed as a ratio of the number of police per 100,000

people. The presence of a great concentration of police officers in an area could lead to different outcomes, such as an increase in the arrests of errant drivers, or it could deter people from driving impaired, thus the expected sign of this variable is indeterminate.

5. Unemployment rate refers to the rate of unemployed people in each CMA as a proportion of the workforce. It is based on the annual average of month-to-month unemployment rate data. This is included to determine whether employment status is a factor in an individual's decision to drive impaired.
6. License suspension refers to the number of days a drivers' license gets suspended when convicted for impaired driving. This is a policy aimed at deterring people from driving impaired, because it is assumed that for someone with a car, being unable to drive presents some sort of inconvenience.
7. BAC level refers to the blood alcohol level. It is a dummy variable that, takes the value of 0 before any change in BAC level in a CMA, and 1 after the BAC level changes. This is included to see if the change (increase) in BAC levels deterred drivers from driving impaired.
8. A time trend is, introduced to take account of exogenous trend changes, and to determine if impaired driving cases are on the decline in recent years because of general behavioral but unobservable trends.

There are some variables which might have been included, but due to the limitations of obtaining data at the CMA level, they had to be omitted from the analysis. Variables such as race, and marital status are available at the provincial and national

level, but not at the CMA level. As well, other policy variables of interest did not have any variation across CMAs in the sample period so could not be evaluated, such as breathalyser, alcohol ignition interlock, open container law, and mandatory seatbelt legislation.

3.1 Model specification

The specification of the model in this report and the nature of the variables and data available are based on the methodology used in similar studies. The log-linear OLS estimation method with fixed effects being applied is used after comparing it to that of a linear model with fixed effects included (see tables 3 and 6). Fixed effects is an estimation method that is used to analyse the impact of variables that vary over time, with an assumption that the individual specific effect is correlated with the independent variables. In contrast, random effects is an estimation method that is used when the variation across the variables is assumed to be random and also the individual specific effects are uncorrelated with the independent variables. A fixed effects approach was found to be more appropriate than random effects based on a Hausman test² to determine whether the fixed effect or random effect model should be used. As stated in table 5, that the $\text{prob} > \chi^2 = 0.02$, as long as the $\text{prob} > \chi^2$ is less than 0.05 it implies that fixed effects is the appropriate method. Also it was necessary to drop university degree because it was highly correlated with income, which implied that income is probably a good indicator of one's level of education.

² The Hausman test is based on a comparison of results from two estimation methods where under the null, both are consistent and under the alternative only one is. In this case, with an assumption of no correlation between unobserved time invariant effects and explanatory variables, both random and effects effects methods are consistent while if there is correlation only fixed effects methods are consistent.

A police lag variable was introduced to account for any possible joint determination bias that could exist between police presence and impaired driving rates. The presence of more police officers could lead to an increase in impaired driving incidents due to increased detection. It could also have a deterrent effect and lead to less impaired driving incidents, which is the effect we are interested in measuring. The use of a lagged police variable is helpful to test the presence of joint determination assuming there is no serial correlation in the police variable. Unfortunately there is likely going to be some form of serial correlation in police variables because police concentration adjusts slowly and increasing or decreasing police force size can take a significant amount of time.

CHAPTER 4: Estimation results and analysis

Table 1 shows the variable statistics, which highlights the mean, standard deviations, minimum, and maximum values of all the variables. Table 2 gives a brief description of the variables and the source from where the data for each variable was obtained. Table 3 shows the empirical results, and the results are summarised below.

The estimate for police indicates that a unit increase in the rate of police officers per 100,000 people will lead to a 0.35 increase in the rate of impaired driving. This strengthens the position that with more police officers, there will be an increase in the number of arrests, so that the detection effects appears to outweigh any deterrence effect that might be present. With a t stat of 1.67 the police variable, and p-value of 0.1, it is found to be just significant at the 10% level of confidence.

Log income is the logarithmic variable of the household median income across the census metropolitan area. The result indicates that a one percentage point increase in income will lead to a 2.07 increase in the rate of impaired driving (per 100,000), a coefficient that is significant at the 5% level. This shows that residents of CMAs where median real income increased were on average more likely to be caught driving impaired. This can be attributed to the fact that alcohol is not considered a basic necessity, but it can be considered a normal good, one whose consumption increases proportionally as income increases.

I included a flexible specification in age for teenage and young adult drivers. Teenage driver indicates the percentage of the sample who are teenagers, and not yet of the age of majority to purchase alcohol but are legally allowed to drive (age 16-18). The result indicates that a unit increase in the percentage of teenage drivers will lead to a reduction of 84.56 in the rate of impaired driving (per 100,000). This could be because teenagers on the average do not own cars, and possibly use the public transit more (buses, trains, etc.) and are also unable legally to purchase alcohol. With a t value of 3.13, and P-value of 0.002, this coefficient is quite significant at the 99% confidence.

The variable age 18-21 refers to the percentage of the sample who are in the 18-21 age range. The coefficient of the result, indicates that a unit increase on the percentage of teenagers within this age group will lead to 51.24 reduction in the rate of impaired driving (per 100,000). This runs contrary to my initial expectation, because it is assumed that teenagers are more likely to be found driving impaired, compared to other age groups. The reasons behind this could be due to the mandatory 0.00 BAC restriction for young, and novice drivers, and also the night time restriction for young and novice

drivers. According to Statistics Canada 50% of impaired driving incidents occur within 11pm to 4am, and with it being at its peak between 2am to 3am, which is an hour after bars close. Then it makes sense as to why young and novice drivers might not be found to be contributing to impaired driving, since it is illegal for novice drivers to drive at night. This can also be due to the availability of public transit. This is quite significant at 99% level of confidence with a t-stat value of 5.98, and p-value of 0.00.

Age 22-25 refers to the percentage of young adults within the ages of 22-25 who reside in CMAs. The coefficient indicates that a unit increase in the percentage of young adults will lead to 7.12 increase the rate of impaired driving. This is not in tandem with my expectation that young adults will be more aware about the ills of impaired driving, and will be less likely to drive impaired compared to teenagers. With a t-stat of 0.51 this is insignificant.

The coefficient on unemployment indicates that a percentage point increase in unemployment, will lead to a corresponding 5.09 increase in the rate of impaired driving cases per 100,000 population. It could be said that since unemployed have more leisure time, they thereby have more time to drink, or the opportunity cost of being caught is perceived to be lower. As well according to Baklien and Samarasinghe, (2011) on average low-income people devote a higher percentage of their income on alcohol. The unemployment variable does have a t-stat of 1.98, and P-value of 0.05. This indicates that the coefficient of the unemployment variable is statistically significant at the 95% level of confidence.

The alcohol price index is used to measure the price of alcohol. The result indicates that a unit increase in the alcohol price index point will lead to 0.16 decrease in the rate of impaired driving cases (per 100,000), a result that is insignificant. Alcoholic products like other goods, can be abused, which means alcoholics on the average would probably not change their consumption pattern of alcoholic products. The elasticity i.e. the responsiveness of consumption to change in price, is inconclusive as pointed out in Nelson, J.P. (1997). This may explain why the variable is insignificant.

I focus attention on two policy change variables. The first is BAC change, which gives the blood alcohol content level at which a charge can be laid. The result indicates that an increase in BAC level, will lead to 8.52 decrease in impaired driving cases. The result is not significant at conventional levels although it suggests that decreasing the limit has a larger effect on detection and conviction than deterrence.

The second policy variable, license suspension, measures the number of days that a license gets suspended following an arrest and conviction. A one day increase in the number of days a license gets suspended leads to a 1.17 increase in the rate of impaired driving cases. While it is contrary to expectations, the estimate is also insignificant. The insignificance could be, due to the fact other policies set out to reduce impaired driving were not included in my dataset due to lack of variation. Policies such as the seat belts adherence, open container laws, and alcohol ignition interlock have been in effect nationwide before 2001. These policies in tandem with low BAC level and license suspension will show a decrease in impaired driving cases, but the magnitude of the changes observed over the study period is too minor to lead to continued reductions in the drunk driving rate.

In order to account for a possible secular trend in drunk driving or time varying unobservables that might obscure the effects of other time varying variables, a simple linear time trend is included in the model. The variable trend has an estimated coefficient of 1.13, which is significant. It shows that impaired driving convictions are on the rise, other things equal including the changing age composition of the population. This can be ascribed to different reasons, amongst them are improved legislation, improved technology, and better policing. Improved legislation, will include the criminalization of impaired driving, lowering of the blood alcohol content, and imposing more stiff penalties. Improved technology implies that with the advancement in breathalysers, this makes it easier to detect if an individual is impaired.

Overall the fixed effects model yields an r-square of 0.02, this indicates that only 2 percent of the variance in the dependent variable is explained by the independent variables after accounting for time invariant differences in CMAs. The low value suggests that omitted variables may be very important, raising concerns about the unbiasedness of the estimates reported here. Alternative estimation methods could also have been employed that could account for more complicated error structures, and could test for stationarity in the key variables.

CHAPTER 5: Conclusions

From my findings I conclude that policies such as reduction of blood alcohol content and license suspension alone are not enough to deter people from driving impaired, but with my conclusion comes the caveat that the results could have been

different if the omitted policy variables were included, variables such as seatbelt legislation, alcohol ignition interlock, breathalyser, and the open container law. Although those are some of the measures put in place by provincial governments to reduce cases of impaired driving could be observed and tested, due to lack of variation in other measures (ignition interlock, open container, and no alcohol tolerance for novice and young drivers) such changes could not be examined. I observed that an increased presence of teenagers will lead to a reduction in cases of drunk driving, a result contrary to expectations that, I attribute to the fact the scope of this report focused on cities where there are public transit options. The presence of police was found to deter people from engaging in impaired driving and was, attributed to the detection effect as mentioned earlier that the more police officers available, the more impaired arrests likely to be made. Income and unemployment are also seen to be factors. People who earned higher income and those who were unemployed were found to engage more in impaired driving.

Due to data limitations, the scope of my study only covers census metropolitan areas. Studies also need to be carried out in rural areas and smaller towns, to see how effective these laws and policies are. Since in those rural areas and smaller towns public transportation is either unavailable or limited this would decrease the options individuals have for getting home after consuming alcohol. Also my results might be somewhat biased because of measurement error in the dependent variable. For the rate of impaired driving arrest as a proxy variable for cases of impaired driving omits instances where impaired drivers were not stopped or arrested by police officers. Regarding data, it will be also beneficial if data on repeat offenders were available. That will also be a good

measure to see if these laws and policies reduce recidivism. And if the data was available for a longer time period, that would have allowed other changes to be evaluated.

Future work could incorporate more characteristics of public and private transit options available to residents of CMAs. The scope of this study can also be expanded further, to look at effects of impaired and distracted driving, due to the widespread use of mobile phones, recent introduction of smartwatches and Google glasses.

Table 1: Variable statistics

Variable	#	Mean	Std Dev.	Min	Max
Impaired driving	365	203.6392	90.5812	64.94	584.19
Police	396	125.952	66.7915	0	234
Log_Income	396	9.3434	4.0712	0	11.48
Age18_21	396	4.3493	.3753	3.58	6.24
Age22_25	396	5.816	.5918	4.44	7.95
Unemployment	396	6.7292	1.6391	3.28	13.71
Teenage driver (16-18)	396	3.787	.6652	2.1	4.95
BAC change	394	.2614	.44	0	1
License_susp	396	6.1692	11.3228	0	30
Trend	396	6.5	3.4564	1	12
Alcohol_pi	396	108.9939	7.2692	94	134.2

= number of observations

Table 2: Description of dependent and independent variables

Dependent variable

Impaired driving rate Impaired driving rate per 100,000 people in CMAs. Referred to rate of convictions. Data obtained from *Incident-based crime statistics, by detailed violations*, Statistics Canada. CANSIM table 252-0051

Independent Variables

Police Number of police officers per 100,000 of people. Data obtained from Statistics Canada *Police-reported crime rate, by census metropolitan area 2002-2012*.

Log_income Logarithmic value of household median income. Source: Statistics Canada, CANSIM, table 111-0009.

Teenage driver Percentage of teenagers who are legally allowed to drive, but not legally allowed to purchase alcohol. Ages 16-17 for Quebec, and 16-18 for other provinces. Source: Statistics Canada, CANSIM, table 051-0056.

Age18_21 Percentage of people aged 18-21 in Quebec CMAs, and 19-21 in CMAs outside Quebec. Source: Statistics Canada, CANSIM, table 051-0056.

Age22_25 Percentage of people aged 22-25. Source: Statistics Canada, CANSIM, table 051-0056.

Unemployment	Annual average of unemployment in CMAs. Source: Statistics Canada, CANSIM, table 282-0135.
BAC level	BAC level in CMAs, 1 if there's a change in BAC level and 0 if there's no change in BAC level. Source: Transport Canada and http://www.changetheconversation.ca
License suspension	Number of days license are suspended for first time impaired drivers. Source: Transport Canada and http://www.changetheconversation.ca
Alcohol_pi	Annual average of alcohol price index. Source: Statistics Canada, CANSIM, table 326-0020
Uni_rate	Percentage of adults that possessed at least a university degree. Source: Statistics Canada, National Household Survey, catalogue 99-012-X2011037.

Table 3: Coefficient of dependable variables using **fixed** effect

Variables	Coef	Std Error	t	P> t
Police	.35	.21	1.67*	0.096
Log Income	2.07	.95	2.17****	0.031
Age 18-21	-54.24	16.38	-3.13****	0.002
Age 22-25	7.13	14.07	0.51	0.613
Unemployment	5.09	2.58	1.98**	0.049
Teenage Driver	-84.56	14.14	-5.98****	0.000
BAC change	-8.52	11.11	-0.77	0.444
License Suspension	1.17	3.09	0.38	0.704
Trend	1.13	2.2	0.51	0.608
Alcohol PI	-0.16	-1	-0.16	0.872

R-square: 0.02

*, **, and **** means significant at 90%, 95% and 99% level respectively

Table 4: Coefficient of dependable variables using **random** effect

Variables	Coef	Std Error	z	P> z
Police	.23	.20	1.14	0.254
Log Income	1.78	0.94	1.89*	0.06
Age 18-21	-33.39	15.23	-2.19***	-63.26
Age 22-25	17.17	12.73	1.35	0.18
Unemployment	4.46	2.56	1.74*	0.08
Teenage Driver	-78.3	13.79	-5.68***	0
BAC change	-1.12	9.53	-0.12	0.91
License Suspension	-2.8	1.25	-2.23**	0.03
Trend	.63	2.2	0.29	0.77
Alcohol PI	0.37	0.99	0.71	-1.57

R-square: 0.06

*, **, and *** means significant at 90%, 95% and 99% level respectively

Table 5: Hausman test

Variables	b Fixed	B Random	b-B Diff	Std Error
Police	0.35	0.23	.12	0.05
Log income	2.07	1.78	.29	5.57
Age18_21	-51.24	-33.39	-17.85	6.01
Age22_25	7.13	17.17	-10.05	5.98
Unemployment	5.09	4.46	0.63	0.26
Teenage driver	-84.56	-73.3	-6.26	3.15
BAC change	-8.52	-1.12	-7.40	5.71
License suspension	1.17	-2.8	3.97	2.82
Trend	1.13	0.63	0.5	0.12
Alcohol PI	0.16	0.37	0.53	0.11

b = consistent under Ho and Ha; Obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\text{chi2}(6) = (b-B)'[v_b_v_B]^{-1}(b-B)$$

$$= 0.82$$

$$\text{Prob}>\text{chi2} = 0.02$$

Table 6: Coefficient of dependable variables using **fixed** effect (linear income)

Variables	Coef	Std Error	T	P> t
Police	-0.3	0.58	-0.52	0.6
Income	0	0	2.91****	0
Age 18-21	-51.36	16.37	-3.14****	0
Age 22-25	7.87	14.01	0.56	0.58
Unemployment	5.19	2.57	2.02**	0.04
Teenage Driver	-84.22	14.08	-5.98****	0
BAC change	-7.09	11.08	-0.64	0.52
License Suspension	1.55	3.09	0.5	0.62
Trend	0.85	2.14	0.4	0.69
Alcohol PI	-0.1	0.99	-0.1	0.92

*, **, and **** means significant at 90%, 95% and 99% level respectively

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CURRICULUM VITAE

Candidate's full name: Adio Olalekan

University attended: BSc. Economics

University of Ibadan (2004-2009)

Ibadan, Oyo state, Nigeria.