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Road through Geography:  
Is the Swedish Traffic Safety Policy Working Equally Regardless of the  
Region?

Piotr Widulinski

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Supervisor: Maria Stanfors  
Examinator: Martin Dribe

## **Abstract**

Vision Zero was introduced as an innovative traffic safety policy that has the eradication of mortality and severe injuries caused by traffic accidents as its final goal. The process of achieving that goal is through a set of measures, rules and regulations that change not only the way of thinking and acting of traffic members (and drivers, in particular), but also of car and road designers. Since Vision Zero was created as a nation-wide policy, then the question is whether it is working equally well for different regions in Sweden. In this case three regions are analyzed: North, Center and South. These regions differ in the amount of inhabitants, the ratio of urban and rural areas as well as the density of woodlands and wilderness areas. For the purpose of this analysis I make use of the data that is openly available but which has not yet been used to answer such specific research question. To examine the functioning of the policy and various causes of the traffic accident outcomes, I use fixed effect panel models along with OLS regressions. The results point out that males are severely injured in traffic due to excessive alcohol consumption, whereas women are killed as a result of high traffic congestion. This takes place in the South for males and in the South and Center for women. Additionally, lower educated males in the South are also contributing to the amount of deadly car accidents.

**Keywords:** Vision Zero, traffic, safety, accidents, Sweden, regions

## Contents

<b>1. Introduction</b> .....	<b>3</b>
<b>2. Background</b> .....	<b>4</b>
2.1. More details about Vision Zero .....	4
2.2. Previous research .....	7
<b>3. Theoretical considerations</b> .....	<b>10</b>
3.1. Humans in traffic .....	10
3.2. Traffic density .....	13
3.3. Regions .....	13
3.4. Problems .....	15
3.5. Aim and hypothesis .....	16
<b>4. Data and variables</b> .....	<b>17</b>
4.1. Data sources .....	18
4.2. Data discrepancies .....	19
<b>5. Methods</b> .....	<b>20</b>
5.1. Unit root testing and diagnostics .....	21
<b>6. Results</b> .....	<b>23</b>
6.1. Model I – lethal accidents for men .....	27
6.2. Model II – lethal accidents for women .....	29
6.3. Model III – severe accidents for men .....	31
6.4. Model IV – severe accidents for women .....	32
6.5. Conclusion of the results .....	34
<b>7. Discussion</b> .....	<b>35</b>
<b>8. Conclusion</b> .....	<b>38</b>
<i>References</i> .....	<i>40</i>
<i>Appendix</i> .....	<i>42</i>

## 1. Introduction

Vision Zero, or Nollvisionen in Swedish, is a policy created by the National Road Administration in close cooperation with the government. In reality it is more a vision than a policy in its strict meaning due to the fact that goals of Vision Zero are mostly long-term and the guidelines are being constantly updated. Ultimately, the end-result of the policy is that there should be no fatalities or serious injuries in the national traffic. This means that Vision Zero aims at decreasing overall mortality in Sweden.

In order to reach the bespoken target many changes were and are still made within Swedish traffic and infrastructure. The changes that are worth mentioning consist of rebuilding crossroads into roundabouts which are said to be more collision-free due to the impact weaker and coming from a safer angle. Another part of that goal is to decrease the speed limits in urban areas and to build broader roads where every member of traffic is safely isolated from others. Many express roads are now equipped with a median guardrails that serve as a protection against head-on collisions of cars traveling from the opposite directions. In addition, in the northern parts of the country, where wildlife is denser, fences are built around the roads. Overpass bridges are built for such animals as moose or reindeer to provide them with safety and mobility opportunities.

Since the ratification of the said policy in 1997 there have been a lot of controversies and discussions around it. Part of it comes as a consequence of people seeing the ideas of Vision Zero as utopian and unreachable, while another part is due to the fact that the goals are long-term and as such the results are not delivered all at once, but rather gradually and across longer time-spans. In addition, people find it controversial that the efforts to minimize traffic deaths may in fact result in an increase in mortality in other areas. Moreover, some see the shift of the responsibilities from the driver to the road designer, and so to the government, as a factor that diminishes the public freedom of human beings instead of it being seen as a safety-increasing procedure. Additionally, Swedes are arguing that the new adjusted-for-safety vehicles that are equipped with many more airbags, stronger seatbelts, interlocks and better brakes are starting to be quite expensive, especially in connection to the increasing gas prices. Not everybody is happy that their comfort, freedom and speed are traded for safety and much stricter traffic rules with an extensive amount of police controls.

The process of eliminating all traffic deaths and heavy injuries is clearly not an instant one and, therefore, smaller sub-goals are set for shorter time periods. These goals and rules within the policy are constantly being updated and accordingly corrected when the time of each sub-goal has passed dependent of the results. Needless to say, the policy seems to be working quite well, albeit much slower than it was anticipated in 1997. However, the policy was created as nation-wide one, while Sweden, due to its geographical characteristics, stretches itself quite far from south to north and the weather, infrastructure and living conditions can vary quite dramatically dependent on the part of the country in question.

This paper has an aim of checking whether or not Vision Zero is working equally in all three parts of the country (North, Center and South). I perform the said analysis by checking the amount of car accidents that had resulted in the death or severe harm of at least one of the involved individuals. This is done for each region of Sweden across a time period before and after the confirmation of the policy.

The rest of this work proceeds in the following manner: The next section gives a comprehensive review of the previous research done on the topic of Vision Zero as well as it will provide a more detailed description of the policy itself. Then the theoretical considerations that link my research question with my data are thoroughly described. Afterwards, a detailed explanation of the data sources and chosen variables is put forth. The section after that consists of the detailed description of the selected statistical methods that are used in order to get the correct and worthwhile results. The latter are presented afterwards. Finally, a discussion of the results is provided and the paper ends with a section on concluding remarks.

## **2. Background**

Before analyzing the functioning of Vision Zero in each of Sweden's geographical regions, I provide some background knowledge about the policy in terms of its ratification, characteristics and goals. This part also describes the advantages and disadvantages of Vision Zero that are mentioned in the available literature. In addition, in this chapter I review the past articles that are about the policy or traffic safety in general and I examine their ties to my research.

### *2.1. More details about Vision Zero*

The policy was authorized in October 1997 by the Swedish Parliament, but the idea for Vision Zero originated from the National Road Administration's idea that started to be constructed already during spring 1995. Sweden's traffic mortality number was already one of the lowest in the world even long before the policy. According to one of pre-policy goals, as it was established in 1990, the number of traffic fatalities ought to be decreased below 600 by year 2000. "This original target of 600 fatalities was achieved already in 1994." (Andersson and Pettersson 2008, p. 6). Belin et al. (2011, p. 3) add that the policy is seen as ambitious as in the year prior to its establishment there were about 488 reported traffic fatalities and 3,048 serious injuries. The main goal of Vision Zero aims to revolutionize the traffic safety even further by gradually trying to eliminate all of the traffic deaths and serious injuries that occur in the country.

Vision Zero works as cooperation between the Government and the National Road Administration (NRA), but the introductory ideas came strictly from the NRA. On the whole, the whole national government was quite content with the views and goals of the policy. "Basically, all parties were for Vision Zero, but the Green Party wanted a general goal with sub-goals to be specified." (Belin et al. 2011, p. 3). That is why the policy consists of a

number of measures used to reach its main as well as interim goals. These measures, in short, include rebuilding and broadening of the roads, creating safer vehicles and isolating each traffic type group from one another. The latter is done so that, for example, pedestrians do not 'interact' with cars and that their access to car lanes is thoroughly limited. "(...) strategy from Vision Zero is to manage kinetic energy in crashes and collisions. It is kinetic energy that kills and injures road users – not the accident." (Johansson 2009, p. 828). Accordingly, the policy contains the guidelines about the speed limits and the likelihood of a traffic victim's survival if he or she is involved in a car accident where the vehicle is traveling at a particular speed. Elvebakk (2007, p. 429) mentions that drivers ought to survive, with no permanent harm, the head-on collision with a vehicle traveling at the speed lesser than 70 km/h and a side collision if the said speed does not exceed 50 km/h. In addition, pedestrians are said to survive being hit by a car traveling no faster than 30 km/h.

Therefore, roads should be designed and rebuilt to account for those speed limits. As such, residential areas are to have roads where the maximum speed is 30 km/h, whereas express roads and highways where the speeds are naturally much higher should be equipped with guardrails between the lanes as well as broader roadsides to prevent the vehicles from going off the road and into hazardous ditches. This means that there is a responsibility shift from the drivers towards the road system designers. In theory, both sides have their own responsibilities to abide to and fulfill, which means that drivers should follow the fixed speed limits, wear seatbelts and use the safety features of their cars accordingly, e.g. brakes, airbags, wipers, etc. However, in practice, the policy states that humans are prone to make errors. Therefore, the road designers take all the blame, even for the bad judgment on the drivers' side or their lack of abilities, and must take additional measures to further prevent the similar accidents from happening in the future. "Whereas individuals may be said to trigger accidents through their behavior, system designers are causally responsible in terms of underlying systemic conditions." (Fahlquist 2006, p. 1116).

The main goal of the policy which is no deaths and serious injuries is seen by many as utopian or unattainable. Vision Zero has and still is stirring a number of complaints and controversies. The complaints occur mostly due to the fact that the results cannot be seen in an ad hoc manner. People also get upset about decreased speed limits, more police controls and more expensive speeding tickets. In addition, the complaints are about diminishing the freedom of the members in traffic by making them wear seatbelts and helmets. "Forcing people to be more cautious than they actually want to be is paternalistic, or even dictatorial." (Rosencrantz et al. 2007, p. 561). On the other hand, the controversies around Vision Zero come from its main long-term target of decreasing mortality. People mention that putting a lot of effort and financial resources into decreasing this one particular type of deaths and injuries, might indirectly impact an increase in another type and thus being counterproductive in terms of the bespoke goal. This invokes a moral dilemma that the people in charge of the Vision must handle, which is about how to adjust and improve the Vision without risking more lives and the freedom and consent of the citizens. Moreover, the policy focuses on both deaths and severe harms, but both clearly cannot be dealt with at the same time. What happens if the decrease in one results in an increase of the other? The authors of one of the papers also

question that by asking: “When such a mixed result should be interpreted as an advance in the direction of Vision Zero?” (Rosencrantz et al. 2007, p. 563).

In addition, the policy is not only interesting from the point of view of traffic and infrastructure design, but is also tries to contribute to improvements in demography and economy. If the person who is the victim of the car accident is in the prime working age, then obviously there is some negative impact on the country’s economy, not to mention the suffering and issues of the families of the said victim. Another obvious point here is that wrecked cars can also be quite costly for the family members of the people involved in the traffic collisions. It is a well-known fact, that it is the young and inexperienced drivers that cause a large proportion of the traffic accidents worldwide and this negatively affects the age structures within the countries.

On the whole the policy is seen as a Vision more than as a safety guidelines and objectives since its main goal is long-term and therefore quite difficult to evaluate. Some say, as such, that the goal of zero deaths and serious injuries is purely fictional. This is due to the fact that: “(...) the combination of over-arching idealistic and possibly unrealistic goals that no-one can be opposed to, insufficient resources for investments and lack of approval for the policy from actors within the sector, can create lock-in effects and actually prevent effective policies from being implemented.” (Andersson and Pettersson 2008, p. 15). The authors add that this fact and their conclusion that Vision Zero goes clearly in line with the Swedish tradition might be the major reasons behind the ineffectiveness of the policy. Nevertheless, the policy clearly had already made some changes through its measures of redesigning roads, vehicles and human behavioral patterns when in traffic. The final goal may not be realized in a foreseeable future, or at all, but one cannot argue that the time since 1997 has not been completely wasted.

What is interesting is that despite the fact that many are negative towards the Vision and criticize it due to the fact that the results were not immediate, the idea of a complete elimination of the negative results made its way to other industries. A good example is the safety in the workplace environment especially in the factories that take advantage of big machinery or on the construction sites where people are working on great heights and in a hazard of being hit by falling objects. In such places even a minor human error may have severe physical consequences. By creating and modernizing the safety measures and by educating workers on proper behavior, factories and construction sites are trying to diminish their accident count. Another industry where the idea of Vision Zero is making its progress is the medical one. Lingfors et al. (2002) wrote a research paper examining the possibility of eradicating all incidents of premature death caused by ischemic heart disease (cardiovascular disease which risk is heightened by obesity and various habits caused by, as the authors put it, the “civilization syndrome”) in Sweden. The authors conclude that: “(...) a vision zero for premature death from IHD is not completely unrealistic.” (Lingfors et al. 2002, p. 31).

The above examples of how the ideology was transferred to other areas are not very uncanny and actually the reasoning behind using the main idea of Vision Zero in medicine or technical

industries seems quite natural. Eva Kraepelien-Strid who works at The Swedish School of Sport and Health Sciences in her interview from 2004 presented an idea of using Vision Zero to prevent people from drowning by putting more resources and time into swimming classes among the Swedish primary school pupils. Therefore, since the idea of removing all lethal and severe traffic collisions and the fact that the philosophy of reaching the Vision Zero finds its way into other industries and parts of life are so deeply rooted in the Swedish society, then a more detailed and different examination of the functioning of the said policy can be really helpful. As such, this paper can aid, not only the current state of the research on Vision Zero, but also the policy-makers in helping them to upgrade and update this particular traffic policy.

Some may be unhappy with or dubious about the functioning and the results of the policy, but the governments of other countries (mostly Scandinavian and Western European ones) are trying to bring similar policies into their own traffic conditions. In addition, even countries which are farther off in terms of the distance, culture and even economic situation are taking the introduction of the Vision into account. Davoud Khosarani-Zavareh from the Iranian Medical University mentions in his editorial from 2011 that: “the ‘Vision Zero’ is not just applicable to high-income countries and it could be transferred to low- and middle-income countries.” (Khosarani-Zavareh 2011, p. 61). The author later adds that the principles of the policy can be used in any type of road transport system which, in turn, can be at any given development stage. Everything mentioned above is what makes Vision Zero an interesting research topic, but also a difficult one due to its complexity and the likelihood of many different factors impacting one another.

## *2.2. Previous research*

The previous articles about Vision Zero that are used as references in my paper are also questioning the functioning of the policy from various standpoints. These standpoints vary from philosophical to political, but they are not very scientific as most of the articles summarized below are presented in the form of the reports or discussions. This means that the majority of the previous research on this topic is purely theoretical, but it is also quite understandable since Vision Zero is a governmental method of increasing road safety by a set of various measures. Therefore, the articles presented in the section below are either concerned with traffic safety itself as well as injury prevention on the roads or are dealing explicitly with either evaluation or criticism of the national policy. On the whole, however, the fact that the articles presented below lack a scientific side is a serious drawback as they only present the already existing facts and if any discussion or evaluation is made, then very often little or no data analysis is involved in the process. This, in turn, makes it harder for me to follow up on and build up from already existing ideas.

The article by Elvik from 1999 is a bit philosophical as it tries to list the pros and cons of the policy only a short time after its introduction. The paper, therefore, tries to examine the possible outcomes of the policy and its costs by creating a similar, albeit hypothetical, Vision Zero in Norway. The author states that the costs and effects of this hypothetical Vision Zero program are biased in favor of the policy. This is due to the fact that only focusing on traffic fatalities might negatively affect the finances for controlling other types of deaths. As such,



mortality rates in the population are increasing, which is counterproductive to the main goal of the said policy. However, the author also puts forward that: "(...) a program that reduces traffic deaths may increase overall life expectancy even if the program causes an increase in general mortality." (Elvik 1999, p. 278). It is stated in the article that the mean life expectancy loss in Norway in any accident is 14 years, but it goes up to 38 years when the traffic accidents are regarded.

Fahlquist's research from 2006 mentions an interesting aspect where the creation and progress of the Vision Zero makes its proponents confront a moral dilemma. The said dilemma is created by the shift in the responsibility from the driver to the infrastructure designers. Since humans are said to be fallible, so we can only blame the road designers for the lethal and severe car accidents. "(...) the difference between the old and the new approach is that we used to say that 90% of all road accidents are caused by the individual, whereas we now say that 90% of the injuries can be affected by the system designers." (Fahlquist 2006, p. 1116). This scientific paper goes in detail into explaining the causality and responsibility ascriptions of both the accidents and the Vision Zero. The author concludes that for the goals to actually work and for the long-lasting effects to be attained, the industry needs to play its part as well as every side needs to cope equally well with the issues of moral responsibility attached to the goals of the policy.

The paper by Rosencrantz et al. written in 2007, mentions that the goals of the policy are far from being reached, especially in terms of decreasing the amount of drivers driving under the influence of alcohol and/or not wearing seatbelts. "The point here is that since the goal is not perceived as a genuine goal, and since it is not always taken seriously, it could just as well be abolished." (Rosencrantz et al. 2007, p. 561). This is due to the fact that the measures within the policy are often deemed as controversial or as ones that diminish the freedom of the individuals in traffic. The authors go into detail about whether or not Vision Zero can be perceived as rational in terms of its precision, evaluability, approachability and motivity and conclude that it more or less fulfills all of the categories and can, thus, be perceived as rational. They also mention the bespoke responsibility shift and conclude that in spite of all of the measures and sub-goals the Vision has a long way to go. The main problem, according to the authors, is that the aforementioned road designers cannot do their tasks properly if the drivers are not fulfilling their own set of responsibilities.

In Elvebakk's article from 2007 everything concerning our new way of looking at the traffic and the spatial dynamics of the roads after the introduction of Vision Zero is described. "Vision Zero was presented as at least four things: a new ambition for road safety, a new ethical line in road safety management, a new 'scientific' approach to human toleration for physical trauma in traffic, and a new, integrated way of understanding the traffic system." (Elvebakk 2007, p. 430). The author states that the policy and its measures has and still are reshaping our mindsets about the various agents in traffic and their roles in it. The conclusion of this article is that so far Vision Zero has mostly delivered quite mixed results due to the fact that the fall in the number of serious car crashes was not as big as expected. The article also mentions, however, that our earlier view was on shifting from the unsafe driver to the

unsafe car, whereas the policy takes it even further by, namely, focusing on the unsafe road and trying to make it safer through the work of road designer.

The paper by Andersson and Pettersson from 2008, discusses the political and governmental side of this policy. The authors describe in detail the politics behind the policy. "In most European countries, and especially Scandinavia, welfare policies have also been integrated into traffic policy and regulation, so that explicit social concerns were considered in the policy making." (Andersson and Pettersson 2008, p. 4). What is interesting to mention is that the article clearly states that the policy is very explicit about its long- and short-term goals along with the different measures and procedures, yet is it admitting that the costs of each of these cannot be possibly estimated. Their conclusion is that since the policy goes well in line with the Swedish tradition of creating visionary national goals, this might be the cause of its ineffectiveness. They also mention that the strong ideology of Vision Zero leads to a lack of opposition to its goals and measures. This, in turn, may cause less effective utilization of resources and lock-in effects.

Johansson (2009) also mentions that Vision Zero shifts the blame to infrastructure designers in order to eliminate the, so called, "blame the victim" factor. He states that the idea behind the Vision was to: "(...) build a "safe system" where all predicted crashes and collisions had tolerable health losses." (Johansson 2009, p. 827). The article mentions shortly, but in a quite detailed manner, the road design principles that are in the policy and that strive to minimize the kinetic energy released onto human beings that are involved in the road accidents. It also touches upon the spatial dynamics of the traffic and the need to isolate each road member, if possible. He concludes that the decrease in serious car crashes is clearly visible across time, but its distribution is not homogenous. It is worth mentioning that the author states that the changes are needed in road building standards to adapt them, not only to long-term goals of the policy, but also to local standards, demands and cultural customs.

Finally, a research paper by Belin et al. from 2011, also treats the policy from its political side and even describes the backstage politics behind the making of the Vision by stating which political parties were for and which were against the policy. They state that Vision Zero came to be as a mutual understanding between the Government and the National Road Administration in regards to the costs of human lives. The paper mentions that behind the guidelines of the policy: "(...) lies a long tradition of systematic road safety work that has involved the taking of key political decisions by the Government and Parliament." (Belin et al. 2011, p. 7). The authors also add that Vision Zero is mainly a long-term goal, but as its side-effect it is also a driving force for the development of new and upgraded measures and procedures that are both cheaper and more effective than the ones available at present.

There are also two articles not directly connected to Vision Zero, but which deal with Swedish traffic safety in general. The findings of the paper by Lindgren and Stuart from 1980 contain the fact since 1965 Sweden has been better and way stricter than USA in terms of motor vehicle safety. They state that changes in mandated improvements in physical safety of the motor vehicles, which entail more costs and controls, did not impact Swedish drivers as it

did the American ones. This means that the response of the Swedes was far more positive and did not impact their driving intensity at all. Elvik et al. (2009), an article that was published 29 years later, follows up on that idea in terms of decline in road fatalities and states that none of the other Scandinavian countries, nor USA or UK had been as successful in that regard as Sweden had been. However, Netherlands is a country comparable to Sweden in terms of a number of traffic-related factors, but it was more successful than Sweden in decreasing the percentage of road deaths since 1970s. The authors also mention the magnitude of changes in terms of lowering the amount of severe car crashes in respect to each of the safety measures (seatbelts, guardrails, speed limits, etc.).

As can be seen from the above, in the current state of the research on Vision Zero it is mentioned that the policy is not necessarily faulty, but one can clearly see that people are not satisfied with its results so far. Most of the researchers voice their complaints or criticisms about the policy due to the fact that its goals are mostly long-term ones. This means that the majority of the effects are yet to be seen and experienced, given that the policy is indeed correct and that further updates will only make it better. Another problem that I foresee here is the latency effect. People can buy motor vehicles that are built in accordance to the policy's rules, but it takes them time to learn to drive them in a safer manner. Here this aforementioned responsibility shift from person on the road to a person who designs and builds it also plays a big role. Clearly, both sides have to fulfill their duties and responsibilities for the system to work.

On the other hand, all of the above papers, with the exception of a couple of sentences mentioned in the passing in the article by Johansson (2009), look at the functioning of the policy along with its successes and failures from a nation-wide point of view. Elvik et al. (2009) state that traffic safety betterment was more successful in the Netherlands, but it is a smaller and more geographically compact nation in comparison to Sweden. My opinion is that since all three regions of Sweden (North, Center and South) are quite different from one another, then maybe Vision Zero works better or worse due to certain factors or conditions that are characteristic solely in one particular region.

### **3. Theoretical considerations**

In this chapter I am analyzing and discussing different factors and notions that I deem as the most important for my research and its results. All of the following sections show the theory behind the hypotheses that are addressed and examined in this paper. These hypotheses along with the main aim of the paper, in turn, are presented in the final section of this chapter.

#### *3.1. Humans in traffic*

The aim of Vision Zero is quite clear and straightforward as it strives to minimize, and gradually eliminate, all traffic accidents where the victims either pass away or are subjected to severe physical injuries. As many of the previously presented articles mention, there is a responsibility shift from the driver to the infrastructure designer. This occurs because the

humans are prone to make errors and mistakes. On the other hand, the goals of Vision Zero can only be reached if both sides (designers and drivers) fulfill their responsibilities correctly. It is therefore interesting to examine how all traffic members, and drivers in particular, react to safety measures.

If you know that a new measure or method is being applied and that it has a significant impact on your life and your daily activities, then your reaction can only be straightforward and two-fold: you comply and adjust to the rules or you ignore and rebel against them. The earlier mentioned article by Lindgren and Stuart (1980) examines the impact of traffic regulations that took place in Sweden between 1965 and 1973. The authors state that the reaction of Swedish drivers was not as strong as they have expected in comparison to the one of the drivers in the United States of America. "(...) there is nothing in the Swedish experience which suggests that drivers responded to mandated improvements in physical by increasing their driving intensity (...)." (Lindgren and Stuart 1980, p. 426).

Vision Zero being a newer policy that encompasses more radical changes and safety measures could not have been as easily tolerated by drivers as the previous traffic regulations had been. There are three articles that specifically examine this issue; the first one was written by Eriksson and Bjørnskau (2012), the second is by Johnston from 2010, while the third one was published in 2008 by Hokstad and Vatn. "Results have shown that being older and driving shorter distances, as well as holding various beliefs, such as awareness that driving fast causes accidents, a strong moral obligation to keep speed limits (i.e. personal norm) (...) are all linked to a higher level of acceptability." (Eriksson and Bjørnskau 2012, p. 336). This article also mentions that the acceptability may be significantly increased among the public by a simple act of raising awareness, in this case about speed being a risk factor. From this paper, it can be gathered that most people adjust and adapt quite easily to new regulations and conditions, but they have to be persuaded first that these new measures are introduced for their safety and will not unnecessarily threaten their personal privacy.

On the other hand, Vision Zero also has its darker side. Because of the fact that the policy tries to take care of all of the factors, including the human error, therefore the drivers may feel more secure to act and drive more reckless. The blame for their mistakes is, after all, put on the road designers due to the bespoke responsibility shift that includes the elimination of the "driver's error". It, consequently, means that different people will react differently to this shift. Some will act more inattentively due to the fact that they cannot really be punished for their actions. Others will act in accordance with the new safety measures by driving slower and more correct. Which types of people belong to each of these groups?

Johnston in his article from 2010 states that drivers: "(...) perceive a personal benefit from setting their own travel speed, do not regard low level speeding as dangerous and seem not to accept that if everyone moderated their speed by a small margin there would be significant safety gains for the community." (Johnston 2010, p. 1180). People, normally, do not like to have their freedom suppressed by new rules and controls. Luckily, there exist certain groups of people that are prone to adjust easier to the new regulations. As one of the conclusions of

the paper by Hokstad and Vatn it is stated that people with higher incomes are more willing to pay for the additional safety measures. “An increase in wealth from 20 to 25 is ‘more worth’ (...), than an increase from 100 to 105. So the person with wealth 100 can more easily spend an amount 5 to achieve risk-reducing measures.” (Hokstad and Vatn 2008, p. 1441). This, in turn, may partially mean that people who earn more have a bigger likelihood of purchasing vehicles that have the necessary equipment mentioned in the Vision Zero measures – stronger seatbelts, more airbags and better brakes. Therefore, it may be gathered that such people are more likely to comply with the new rules.

It is also in the Swedish mentality to trust the government and not to instantly try to rebel against the new policies and rules that are being introduced. “(...) car owners in general exhibit more positive views on safety measures with possible privacy implications than what is often thought by politicians and others.” (Eriksson and Bjørnskau 2012, p. 345). That is why even if the speed limit in the urban areas is decreased to 30 km/h, there is no need for heavy police supervision as the drivers will mostly try to comply with this new regulation. Another such factor was mentioned in the article by Lindgren and Stuart (1980, p. 421), where the authors state that the increased alcohol consumption in Sweden did not lead to increased driving under the influence of the alcohol. Instead Swedish people turned to calling for taxi services or simply walked back home after consuming their alcoholic beverages.

According to the annual reports on traffic accidents published by SIKÅ (Statens Institut för KommunikationsAnalys or Swedish Association for Transport and Communication Analysis), in 1998 there occurred 781 accidents because of alcohol. In the previous year driving under the influence accounted for 753 accidents. For comparison purposes, traffic crashes caused by alcohol influence in 2003 amounted to 421 cases; whereas in 2004 it was 381 (data is coming from SIKÅ report for 2004). Alcohol consumption and driving may, therefore, be the area where intelligence and sensibility are of more importance since it entails the thinking that your own actions can be harmful not only to yourself but also to others. What is also of interest is that men in 1998 were in a 2.7 greater risk of being a victim in a lethal or severe car accident than females. The corresponding number for 2004 is 2.0, which means that men are still in a bigger risk, but that said risk is smaller than in the beginning of the Vision Zero period.<sup>1</sup>

It can be, consequently, interesting to see if people with higher education who, therefore, probably have better-paid occupations are indeed causing less traffic accidents. This is followed by the assumption that such group of drivers is more eager to follow the rules and less likely to drunk drive or not wear a seatbelt in addition to also being more receptive to all of the actions on the road and, thus, being more considerate of other traffic members. People with higher education are also more likely to be more careful and behave in a better manner in

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<sup>1</sup> The years of these bespoken reports were chosen due to the fact that 1998 is the year that the first such report was published as well as it being the first full year of the existence of Vision Zero. Consequently, the reason behind choosing the 2004 report is because it is the last year examined in this research paper.

addition to being the ones who try to contribute to population's safety by buying better and safer vehicles and by donating money to improve the road conditions in the country. With the help of the gender stratification, the type of people which are, to a larger degree, responsible for the majority of the traffic collisions will be pinpointed more in detail.

### *3.2. Traffic density*

It is also worth mentioning, that even though national public transport is well developed and is of high quality in Sweden, people still tend to drive quite a lot in their own personal cars. Due to greater traffic congestion, more car crashes are prone to happen. "Higher motorization results in higher exposure to risk for most classes of road users (...)." (Johnston 2010, p. 1175). In the 1998 edition of the earlier mentioned traffic accident report it is mentioned that: "During 1998, 19,132 passenger cars were involved in the 12,948 traffic accidents where a person was injured. Through the analysis of the registry, more than 20,700 of these vehicles were found." (SIKA 1999, p. 15). Similarly, the data from the report from 2004 mentions 3,820 cars that were involved in 2,842 traffic crashes where the involved parties died or were severely harmed. "Out of these, with the help of the car registry 3,131 vehicles were found by the means of analyzing their license plates." (SIKA 2005, p. 29). It is also true, that higher traffic density makes drivers more nervous since they need to constantly be attentive and have much smaller margin for any errors. This also impacts the amount and frequency of car collisions. Therefore the inclusion of the number of registered personal cars in each county across time can really aid my analysis.

### *3.3. Regions*

Finally, we turn to the issue of the aforementioned regional division. Vision Zero, as mentioned before, was created as a policy to govern and control the traffic safety in Sweden as a whole. The country however is rather oblong as it stretches itself quite far from south to north. The longest distance between the southern- and northern-most point reaches up to 1574 kilometers. Therefore, it can be easily assumed that there are some considerable differences between various regions in Sweden.

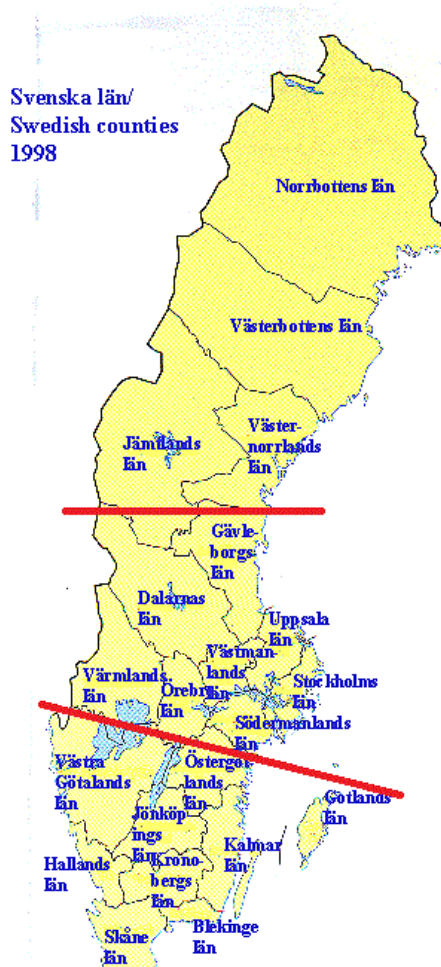
The division of the country into these three regions follows roughly the similar division that already exists in Sweden and its culture. The region called North in this paper is referred to as Norrland in the Swedish culture. Central Sweden is named as Svealand, whereas South is usually called as Götaland. The choices of Swedish counties that fall into one of these three regions, clearly, follow the same rules. All of this is presented and summarized below in Table 3.1. The graphical representation is shown in Figure 3.1.

**Table 3.1.** The division of the 21 counties into 3 regions

Region	Counties
North (Norrland)	Norrbottnen, Västerbottnen, Jämtland, Västernorrland
Center (Sveland)	Dalarna, Gävleborg, Värmland, Örebro, Västmanland, Uppsala, Södermanland, Stockholm
South (Götaland)	Västra Götaland, Östergötland, Gotland, Kalmar, Jönköping, Halland, Kronoberg, Blekinge, Skåne

The number of counties in each of the regions is not equal and same can be said about the amount of inhabitants and even the number of cars in each region, but the application of such geographical division is done because of the aforementioned culture as well as for the simplicity reasons. It is also worth mentioning, that some of the counties changed their names or were created by splitting one county into two separate ones; this further confirms that the analysis performed on the regional division is a more sound solution than on the county division.

**Figure 3.1.** The division of the 21 counties into 3 regions – rough graphical representation  
(Source: [http://www.algonet.se/~hogman/swe\\_counties\\_map\\_eng.htm](http://www.algonet.se/~hogman/swe_counties_map_eng.htm))



Another reason for using this division falls well in line with my research. There are certain differences between each of these three regions that may impact the functioning of the Vision Zero in quite dramatic ways. The northern parts of the country have weather conditions that are more harsh and unpredictable than in the south or in the middle of the nation. There are also fewer cities in that part of Sweden and a bigger number of roads tend to be less maintained. In addition, the far north has more forests and wildlife. The middle of Sweden is densely populated as there are quite a lot of urban areas located in the central parts of the nation (i.e. Stockholm area). In addition, this region has more motorways and is quite attractive to tourists. Finally, the south of Sweden has a big proportion of rural areas in the addition to urban ones (Malmö and Göteborg), which means that there is a bigger likelihood of experiencing the presence of heavy farmyard vehicles on the roads in that region. This region also includes a number of smaller and tighter roads, even with a presence of dirt ones.

Unluckily, due to the nature and length of this research along with the scarcity of data, not all of the above factors can be controlled for. This, however, is mostly common knowledge about Sweden and the differences within the borders of this country. On the whole, the results that point out the differences between the functioning of Vision Zero in each of the regions might be severely impacted by the bespoke regional factors. In addition, the differences in the results can also point out to the fact that these factors are causing an issue when one of the regions gets better or worse traffic safety outcomes because of the lack or presence of some factors that other regions possess.

On the other hand, the data gathered in to the aforementioned traffic accident reports makes the division seem quite plausible in the light of the facts presented in this section. In 1998 the majority of traffic collisions occurred in the rural areas. “(...) seven out ten of all car accidents and about six out of ten that were lethal took place in the non-densely populated areas.” (SIKA 1999, p. 8). The figures for this year were 1,039 and 2,540 accidents in urban and respectively rural areas of the country. It is worth mentioning that the corresponding numbers for the year 1997 are 969 and 2,619 car accidents. “Out of these 3,579 car accidents, which took place during 1998, 156 have resulted in a death of the involved people.” (SIKA 1999, p. 8). From the 2004 report it can be gathered that: “(...) 75% of all single accidents took place in the rural areas.” (SIKA 2005, p. 25). The figure describing the amount of single accidents with the involvement of a motor vehicle in the urban areas adds up to 278 cases for the year 2004 and 314 for the previous year. In terms of the accidents in the rural areas the numbers are 848 and 984 for each respective year.

### *3.4. Problems*

Ideally, such research demands a large amount of data that represents all of the counties in Sweden throughout all of the years. Unluckily, a lot of the potential variables had to be removed from the analysis since they did not fulfill this requirement. Even some of those that are kept in the dataset suffer from certain problems, as it will be mentioned in the “Data” chapter of this paper. In addition, the examined time period had to be significantly shortened to adjust it to the existing data figures. As I have mentioned before, other good variables that would have surely enriched the analysis would have been the years of driving experience of



the traffic victims, the distance driven within certain time interval or even the earnings of the drivers.

I am also aware that the data may suffer from the lack of causality or the presence of endogeneity. However, due to the type of the research and the aforementioned problems with the data, no sound solutions can be found to get rid of these issues. It is, for example, quite hard to think of a proper instrumental variable to account for the lack of controlled experiments. An IV or any of the missing variables mentioned above may significantly impact and change the results and may act as the real driving force behind the change of lack thereof in Vision Zero's functioning in three regions, but due to the bespoke factors and limitations such variable cannot be included in the analysis. On the other hand, it may also be the case that if such a variable is actually found and used, it will downplay the effects that other variables have on the dependent one and will make their relationships much less clear and significant.

### *3.5. Aim and hypotheses*

My main aim in this research paper is, consequently, to examine whether or not Vision Zero is working equally well independent of the region in Sweden. I take three different Swedish regions into consideration: North, Center and South. These three regions, as described above, vary from one another in a number of factors. It can, thus, be easily assumed that one policy cannot take all of that into account. One of the regions might be, as a result, favored more than the other two by the Vision.

This aim will be addressed, with the consideration of the discussion presented above, by testing the following hypotheses:

*Hypothesis 1: Greater consumption of alcohol in each of the examined regions results in more lethal and heavy traffic injuries; this, thus, negatively impacts the functioning of Vision Zero.*

*Hypothesis 2: Heavier traffic congestion created by the presence of more cars on the roads in the analyzed regions results in a bigger number of car accidents ending with the death or severe harm of at least one of the involved individuals; this is seen as negatively impacting the functioning of Vision Zero.*

*Hypothesis 3: Bigger proportion of highly educated people in traffic that inhabit the studied regions, results in a decrease in fatal and heavy car crashes; this positively affects the goals of Vision Zero. Consequently, the bigger proportion of people with lower education negatively impacts the Vision Zero by increasing the number of traffic collisions.*

The next section describes the data that is used in the analysis. It will also go into details about the examined variables as well as their shortcomings and possible problems that may occur.

## 4. Data and variables

The main and final goal of Vision Zero, as mentioned before, is to eliminate all traffic accidents that result in death or severe injuries of at least one of the involved individuals. I, therefore, create four separate models. The first two models are using the amount of male deaths and severe injuries because of traffic accidents, respectively. In the second model the variable describing the quantity of women being killed or heavily hurt in traffic accidents is being used. Such separation is intended in order to see if the Vision Zero works equally well in decreasing the annual figures for both accident outcomes for both genders or if the decrease in one leads to an increase in the other.

Gender of the traffic victims is included in the dataset to examine whether or not Vision Zero is impacting traffic members of one gender more than the ones of the other. In addition, it can be interesting to see if the impact changes over time and which gender is favored to a larger degree by the measures of the policy. Finally, the annual number of inhabitants in each county during those 14 years is also being included. Its purpose is to serve as a so called “risk group”. This means all of the people in the Swedish counties that are annually at risk of being involved in a car crash. This part of the dataset is also stratified with respect to gender in each county to avoid unnecessary biases. The dependent variable in each of these models is, consequently, a ratio of the number of men and women who are either killed or severely injured in car crashes to the number of inhabitants of each respective gender.

In accordance to the research question, regional division is also to be included in the said models. This variable is created by collecting annual observations for each Swedish county and putting them into three separate regions with regard to the two separate traffic collision outcomes, which are represented through the bespoke models. The separation of the counties into geographical regions, which named as South, North and Center, and the reasons behind such division, are both described in the previous section of this paper. Each region makes up a separate panel.

I intend on examining the changes in the aforementioned numbers across time. My interest, as such, is to address a time span of fourteen years and divide this interval into two smaller time periods. These periods are each seven years long and they respectively represent the time phase before and after the policy. The introduction of Vision Zero occurred in late 1997 (in October, to be exact) and therefore, for simplicity reasons, this year is included in the pre-policy time period. Therefore, to account for these two time periods I create an additional variable, which is made by interacting each of the bespoke dependent variables with the dummy variable representing the Vision Zero to account for the pre- and post-policy periods. This dummy variable has zero-values for the period 1991 to 1997 and one-values for the period 1998 to 2004. Consequently, these four interactions are used as the independent variables in their respective models.

In order for me to control for the additional factors and to avoid overestimations of the results, I include a set of control variables. These control variables are mentioned among the

guidelines and measures of the policy. The first variable describes the alcohol availability in each county across time by using the serving of alcohol per 10,000 inhabitants of ages 15 and above. The motivation for using this control variable is that alcohol very often causes serious traffic accidents due to the fact that a person under the influence has slower reactions and worse off judgment of the situation on the road. In addition, if alcohol is more easily available to the potential buyers, then there is a bigger chance of having people driving after drinking. As such, I use this variable as the proxy for alcohol consumption in the society.

The second control variable describes the amount of registered personal passenger cars in each county throughout the examined time period. The figures for this variable come from the registry index and are gathered at the end of each calendar year. The logic behind using this variable is quite clear: if more cars that are potentially on the road at the same time then this results in higher traffic congestion. This, in turn, leads to reasoning with denser traffic on the roads there is a higher probability of car crashes. I use this variable as a proxy for traffic congestion.

The third control variable used here is the level of education of the people in each Swedish county across time for ages between 16 and 74. The reasoning behind using this control, as mentioned before, is the fact that people with higher education might be more prone to comply with traffic safety rules by not speeding, obeying the traffic signs and wearing seatbelts. In addition, since better educated people are more likely to earn more, therefore they can afford cars that are adjusted to the measures of the Vision Zero. As such, the assumption is made here that the bigger density of highly educated inhabiting a certain region, the smaller the likelihood of dangerous car collisions. In turn, the bigger amount of people with lower education is assumed to result in a greater number of traffic accidents. This variable is also divided by gender. I use the following dummy-like structure here: no higher education (up to 12 years of education), higher education (over 12 years in school).

#### *4.1. Data sources*

The data and numbers used to create the final dataset are coming from various sources. This leads to certain problems and disparities which are explained in the next section. The main part of the dataset, which is the number of people in different Swedish counties that had passed away or were severely injured in traffic accidents across time and with regard to the gender of the victims, comes from the website of the Trafikverket (Swedish Traffic Administration). This data covers the time period from 1985 to 2008. It has to be mentioned that this part of the dataset is openly available, but without the inclusion of the gender stratification. This data was created and merged to include the gender of the traffic victims specifically to help me with my research.<sup>2</sup>

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<sup>2</sup> I would like to hereby thank my research supervisor, Maria Stanfors (Associate Professor at the Department of Economic History at Lund University), for helping me to get this part of the dataset from the people responsible for the official statistical databases created and published by the National Traffic Administration (Trafikverket).

The other parts of the final dataset are openly available on the respective websites and links are given in references. The data describing the “risk group” covers the time period between 1968 and 2010 and comes from the website of Statistiska Centralbyrån (Statistics Sweden). The values of the first control variable, which is the alcohol availability in each county throughout time, come from the Statens Folkhälsoinstitut website (Swedish National Institute of Public Health). The time interval for this variable covers the yearly observations between 1995 and 2010. The figures of the second control variable, the annual amount of registered passenger cars per county, come from the Trafikanalys (Transport Analysis Agency) website. The time covered in this part of the dataset stretches itself between 1998 and 2004. Finally, the third control variable, which describes the education levels of Swedish citizens, comes also from Statistiska Centralbyrån and it covers the period from 1985 until 2011.

#### *4.2. Data discrepancies*

The time span covered in this research paper is not extensively long, but it covers the period where many geographical changes were made to the county structure of Sweden. A majority of these changes occurred in 1997 and 1998. Some counties were created by gathering several smaller ones into one big county, some counties just changed their names, while in some cases several municipalities from one county were moved to the other one. This does not create bigger problems when the three examined geographical regions are regarded, but one has to bear in mind that sometimes the numbers may not fully reflect either the amount of traffic victims or the population at risk in each of the counties.

The biased results can also come from the fact that two of my control variables are not a subject to gender division (alcohol availability and number of registered cars). This is because the construction and structure of the said variables disallows the use of any gender groupings. Therefore, there are no sound solutions to this discrepancy.

The other issue is connected with the fact that not all separate parts of the dataset cover the whole period in question in this research paper (1991-2004). This is, again, an issue with the aforementioned two control variables. The second control variable (number of cars) is the most problematic due to the fact that it only covers the time interval after the introduction of the policy (1998-2004). This leaves out seven yearly observations. The obstacle with the first control (alcohol sales) is slightly less significant as its annual observations start from 1995. It means that there are four missing observations. In addition, this variable only takes restaurant sales of alcoholic beverages into account and leaves out the sales coming from liquor stores. The solution to the issue of missing data in these two cases is processed by linear extrapolation. This method ensures that there are no missing observations in the dataset. On the other hand, it also has an extensive drawback that comes from the fact that these newly created observations are somewhat less meaningful. Therefore, they should be treated with a greater level of uncertainty. The extrapolation is performed with the help of statistical software called Minitab, whereas the rest of the analysis is done in STATA.

## 5. Methods

I intend on using the panel data analysis method which seems most applicable to the bespoken dataset given the stated hypotheses. On the whole, the panel data approach does not vary much from the regular time series analysis one, since in both cases one should make tests for both the unit root and cointegration. My plan is to apply the panel data method, however, as the dataset does not only have time-dependent variables, but also the effects that vary in the individual terms. In this case it is the variation across the geographical regions. “Having data over time for the same cross section units is useful for several reasons. For one, it allows us to look at dynamic relationships, something we cannot do with a single cross section.” (Wooldridge 2002, p. 169).

The advantage of using panel data is that heterogeneity across individuals is allowed, which is absent when one is just using time series approach with aggregated data. “They also give more variability, which often leads to less collinearity among variables (...).” (Harris and Sollis 2003, p. 189). In this case, the individuals/entities, as mentioned before, are the three geographical regions in Sweden. Each of these regions can be affected differently by certain factors and conditions and, thus, traffic accidents and the likelihood of their occurrence as well as their outcomes may also be affected differently across these regions. On the other hand, the panel data method also has some drawbacks which mostly come from the design and collection of data. These disadvantages can be due to missing observations, sampling mistakes or measurement errors.

There are two main types of panel data models – fixed and random effects. The main difference between these types is how the individual effects are treated. The fixed effects type seems to be a good choice due to the fact that the geographical division (regions) is not impacted by the time aspect, which would be the case in the random effects approach. “Fixed effects explore the relationship between predictor and outcome variables within an entity (...). Each entity has its own individual characteristics that may or may not influence the predictor variables (...).” (Torres-Reyna, p. 9). This is further confirmed by the results of the Hausman specification test, which is fully presented in the Appendix in the Table A.5.1. It has to be noted here that fixed effects are to be used if the p-value of the Hausman test is below 0.05 as this test has the null hypothesis that random effects are to be used. The null hypothesis is rejected in all of the models and therefore it is confirmed that fixed effects are to be used in all of these four cases.

The final equation representing the regression of data using a panel method can look like the one shown below in (1). In this equation, letter  $y$  represents the dependent variable, while  $X$  is the vector of the explanatory/control variables. The parameter  $\beta$  clearly signifies the coefficient of each of these variables, while  $\alpha$  is the constant in the model. Error term is represented by  $e$ , as it has been mentioned above. The subscripts  $r$  and  $t$ , throughout this equation, stand for region and time, respectively. These subscripts account for the fact that each of factors within that equation can be either only entity-specific (e.g. the intercept) or entity-specific and time-dependent at the same time (the rest of the parameters).

$$y_{it} = \alpha_r + X_{it}\beta + e_{it} \quad (1)$$

In the fixed effects model the error term is divided into two parts, see (2). This takes place in the following manner:

a) part  $\varepsilon$  – this part represents the portion of the error term which is not correlated with the regressors and which varies across time;

b) part  $\nu$  – this part stands for the part of the disturbance that is correlated with the  $x$  and which is fixed for each individual (region in this case).

$$e_{it} = \varepsilon_{it} + \nu_{it} \quad (2)$$

The above equation can be also viewed as the one that shows all of the included variables and used parameters. This is shown in (3) :

$$\begin{aligned} (AccidentOutcome)_{it} = & \alpha_r + (AccidentOutcome * Dummy)_{it} \beta_1 + \\ & + (AlcoholConsumption)_{it} \beta_2 + (CarAmount)_{it} \beta_3 + \\ & + (HigherEducation)_{it} \beta_4 + (LowerEducation)_{it} \beta_5 + e_{it} \end{aligned} \quad (3)$$

One, however, needs to remember that there are actually four models that are examined in this research paper – two of them are taking into account male traffic accident outcomes (lethal and severe injury, respectively), while the other two are analyzing the female traffic accident results (lethal and severe injury, correspondingly). Therefore, each of the models will be tested not only with the full set of the independent and control variables, but also with variety of different combinations to account for all of the effects and relationships between the variables.

### 5.1. Unit root testing and diagnostics

As I have mentioned before panel data method also demands that one tests the data for stationarity of the included variables. The difference between panel data and time series is that there are a greater number of tests that can be used for this purpose. These tests vary from one another in terms of their testing power, hypotheses treatment and even in how detailed and well-specified these tests are. To ensure that there are no misspecifications and that the risk of running into a spurious regression is thoroughly minimized, I perform two separate unit root tests on all of the variables.

My choice of tests here is LLC (Levin-Lin-Chu) and IPS (Im-Peseran-Shin). The first test was created in 2002, while the other was designed in 2003. Both tests have unit root in the panels as their null hypotheses. In addition, LLC test examines the existence of the common unit root among the panels, whereas IPS analyzes whether or not there are any panels that are non-stationary. After the initial testing some of the variables turned out to have unit roots and

therefore their first differences had to be taken. In some cases, certain variables had to be differenced at least once again as they turned out to be of the higher order than I(1). Then the same unit root tests were done again on these transformed variables to test for the stationarity. The complete results and variable specifications are shown in the Table 5.1.

**Table 5.1.** The results of the testing for the presence of unit roots – p-values in parentheses.

Variable	LLC	Stationary?	IPS	Stationary?	Order
Lethal accidents for males	-8.3067 (0.0028)	Yes	-7.5457 (0.0001)	Yes	I(2)
Lethal accidents for females	-5.8519 (0.0010)	Yes	-4.5793 (0.0010)	Yes	I(1)
Severe accidents for males	-8.6167 (0.0001)	Yes	-7.0183 (0.0003)	Yes	I(3)
Severe accidents for females	-6.1321 (0.0069)	Yes	-3.3482 (0.0058)	Yes	I(1)
Lethal accidents for males (with a Vision Zero dummy)	-4.3626 (0.0376)	Yes	-3.5795 (0.0035)	Yes	I(1)
Lethal accidents for females (with a Vision Zero dummy)	-5.6338 (0.0023)	Yes	-5.0428 (0.0004)	Yes	I(2)
Severe accidents for males (with a Vision Zero dummy)	-4.7196 (0.0203)	Yes	-3.0886 (0.0100)	Yes	I(1)
Severe accidents for females (with a Vision Zero dummy)	-4.8230 (0.0104)	Yes	-3.4378 (0.0045)	Yes	I(1)
Alcohol consumption	-6.5528 (0.0001)	Yes	-4.7604 (0.0005)	Yes	I(1)
Number of cars	-7.6998 (0.0000)	Yes	-3.2648 (0.0067)	Yes	I(1)
Higher educated males	-4.6113 (0.0045)	Yes	-3.2263 (0.0076)	Yes	I(1)
Higher educated females	-4.4118 (0.0087)	Yes	-3.4730 (0.0053)	Yes	I(1)
Lower educated males	-7.8416 (0.0000)	Yes	-4.6540 (0.0008)	Yes	I(2)
Lower educated females	-5.0593 (0.0030)	Yes	-2.7373 (0.0294)	Yes	I(1)

As can be seen from the table above the dependent variable describing the number of lethal male accident, the independent variable representing the number of males with lower education along with the interaction describing the number of deadly female accidents are of order I(2). In turn, the dependent variable responsible for the number of severe injured men in traffic is of order I(3). It has to be noted that all of the p-values are fully significant at the 5%-level.

The data is also examined for heteroskedasticity. The null hypothesis here is that there is a constant variance across the observations, which means that the homoskedasticity exists. The test performed here is called as a modified Wald test for groupwise heteroskedasticity in fixed effects with the significance level of 5%. I am performing this test on the models in their full form, which means with the presence of all of the variables and controls in the regression. As

it turns out, all four of my models suffer from the issue of non-constant variances. The table with the full results of these tests is shown in the Table A.5.2 in the Appendix. The p-value for the model representing severe male traffic accidents barely surpasses the 5%-level limit (0.0561), but for simplicity and safety even this model will be treated as heteroskedastic; all other p-values turn out to be fully significant. The problem of having heteroskedasticity among the variances is quite common in the fixed effects panel data models and can be easily solved by using the robust standard errors.

## 6. Results

Firstly, I provide a short summary of the descriptive statistics of the included variables. Note that these variables are in their main form, which means that they are not made stationary. They are, however, standardized, if necessary. This entails that the values of these variables differ from the values of the final and changed variables. The factors presented in the Table 6.1 below consist of the mean of the variable ( $\mu$ ), its standard deviation ( $\sigma$ ) along with the variables lowest and highest values. Although, the contents of the table are quite clear, it has to be mentioned that the somewhat uncanny numbers for all the variables marked as the interactions are caused by the very fact of using a dummy variable in the interaction process. That is why their minimal values are all equal to zero in addition to their means being equal to their standard deviations. Note that, no regional division is carried out for these values.

**Table 6.1.** Descriptive statistics

Variable	$\mu$	$\sigma$	Min. Max.	Variable	$\mu$	$\sigma$	Min. Max.
Lethal accidents for males	0.0001	0.00002	0.00007 0.0002	Severe accidents for females (interaction)	0.0002	0.0002	0 0.0006
Lethal accidents for females	0.00004	0.00001	0.00002 0.00007	Alcohol consumption	99.8	32.2	45.7 152.4
Severe accidents for males	0.0007	0.0001	0.0005 0.001	Number of cars	1272,362	627,538	415,287 2001,124
Severe accidents for females	0.0004	0.0001	0.0003 0.0006	Higher educated males	238,949.2	129,047.2	54,201 395,154
Lethal accidents for males (interaction)	0.00005	0.00005	0 0.0002	Higher educated females	261,363.5	143,477.7	55,524 460,042
Lethal accidents for females (interaction)	0.00002	0.00002	0 0.00007	Lower educated males	805,082.4	397,628.1	247363 1216409
Severe accidents for males (interaction)	0.0003	0.0003	0 0.001	Lower educated females	773,459.2	390,213	216,102 1207,728

Next, I provide a short overview of the percent-wise change for each of the examined variables between the specific time-points for the three geographical regions. These time-points are: 1991 and 1997 as well as 1998 and 2004. This makes up for the beginning and,



respectively, the ending of the pre- and post-policy periods that are limited by the time-span used in this research paper. These figures are presented in the Table 6.2 below.

**Table 6.2.** The summary of the over-time change between the variables

	NORTH			
	1991-1997		1998-2004	
Male Lethal Accidents	74	<b>-18.9%</b>	57	<b>-19.3%</b>
	60		46	
Female Lethal Accidents	30	<b>-36.7%</b>	20	<b>-25.0%</b>
	19		15	
Male Severe Accidents	423	<b>-26.5%</b>	333	<b>-3.9%</b>
	311		320	
Female Severe Accidents	268	<b>-20.9%</b>	241	<b>-7.0%</b>
	212		224	
Alcohol Consumption	73.6	<b>-15.2%</b>	60.8	<b>-24.8%</b>
	62.4		45.7	
Number of Cars	415,287	<b>2.2%</b>	42,2597	<b>2.9%</b>
	424277		43,5033	
Higher Education - Men	54,201	<b>19.5%</b>	65,619	<b>15.1%</b>
	64,757		75,529	
Higher Education - Female	55,524	<b>30.8%</b>	75,049	<b>24.0%</b>
	72,628		93,054	
Lower Education - Male	278,808	<b>-5.1%</b>	261,101	<b>-5.3%</b>
	264,522		247,363	
Lower Education - Female	266,457	<b>-8.2%</b>	239,633	<b>-9.8%</b>
	244,621		216,102	

**Table 6.2. (cont.)** The summary of the over-time change between the variables

	CENTER			
	1991-1997		1998-2004	
Male Lethal Accidents	206	<b>-34.0%</b>	152	<b>-17.8%</b>
	136		125	
Female Lethal Accidents	85	<b>-44.7%</b>	40	<b>17.5%</b>
	47		47	
Male Severe Accidents	1,026	<b>-14.0%</b>	875	<b>29.7%</b>
	882		1,335	
Female Severe Accidents	591	<b>-5.2%</b>	592	<b>17.6%</b>
	560		696	
Alcohol Consumption	124.5	<b>-12.9%</b>	105.5	<b>-21.7%</b>
	108.4		82.6	
Number of Cars	1358,829	<b>11.4%</b>	1512,675	<b>10.9%</b>
	1514,101		1677,262	
Higher Education - Men	264,019	<b>23.0%</b>	331,618	<b>19.0%</b>
	324,708		394,531	
Higher Education - Female	268,111	<b>30.6%</b>	362,699	<b>26.8%</b>
	350,214		460,042	
Lower Education - Male	1009,238	<b>-3.2%</b>	972,023	<b>-1.2%</b>
	976,428		960,083	
Lower Education - Female	1018,449	<b>-6.4%</b>	942,618	<b>-5.9%</b>
	953,267		887,084	

	SOUTH			
	1991-1997		1998-2004	
Male Lethal Accidents	250	<b>-29.6%</b>	209	<b>-7.7%</b>
	176		193	
Female Lethal Accidents	100	<b>-29.0%</b>	70	<b>-22.9%</b>
	71		54	
Male Severe Accidents	1615	<b>-30.3%</b>	1217	<b>-15.4%</b>
	1125		1030	
Female Severe Accidents	909	<b>-12.5%</b>	735	<b>-16.0%</b>
	795		619	
Alcohol Consumption	152.4	<b>-7.8%</b>	135	<b>-14.9%</b>
	140.5		114.8	
Number of Cars	1721,945	<b>6.4%</b>	1854,060	<b>7.9%</b>
	1832,041		2001,124	
Higher Education - Men	254818	<b>19.7%</b>	311,469	<b>26.9%</b>
	304975		395,154	
Higher Education - Female	254,378	<b>26.0%</b>	333,017	<b>37.6%</b>
	320,637		458,273	
Lower Education - Male	1216,409	<b>-2.6%</b>	1180,434	<b>-2.5%</b>
	1184,398		1151,285	
Lower Education - Female	1207,728	<b>-4.5%</b>	1139,977	<b>-7.0%</b>
	1152,797		1060,488	

As can be seen from the three tables above, the values do not follow the same trends across the regions when these two time periods are regarded. The alcohol consumption has decreased over the year with the value for the post-policy period being always significantly bigger than its pre-policy counterpart. The amount of cars grew slightly between the periods for the Northern and Southern regions, whereas in middle Sweden the value has gone down in the period 1998-2004. The amount of people of both genders with higher education grew in the second period only in the south, but the numbers for the ones with lower education fell visibly between the periods in all three regions. However, the number of lower educated males in the second period in the Center and South is lower than the value for the pre-policy period; this also takes place for females with lower education from the Central Sweden.

The figures of the deadly and heavy traffic accidents tell us that Vision Zero indeed seems to be working, because the numbers for the second period are still in their negative terms, even if their values are slightly smaller than of the ones for the pre-policy period. It is interesting to see that this does not hold true for severe and lethal female accidents along with severe male accidents only in the Central Sweden. The numbers are actually positive for those variables in the second time period. This points out that some further changes and updates to Vision Zero may be needed in that region.

Now, let us turn to the results of the panel data models. This section is presented in the following manner by the means of two sub-points:

a) Each model is analyzed in its own section and this is done through a number of different panel data regressions, all of which are done with the fixed effects method. There are seven regressions, for which the equations are shown in the Table 6.3 below. These regressions go in accordance to the paper's hypotheses with some additional regressions being used to better analyze the data and the connections between the variables. The first regression only includes the aforementioned interaction between the dependent variable and the dummy for Vision Zero to account for the changes in traffic accident numbers due to the introduction of the policy. This is referred to simply as "Interaction" in the table below. Later equations include the said interaction term along with other variables that aim at testing the paper's hypotheses (alcohol consumption, traffic congestion, higher and, respectively, lower education). The final equation includes all of the paper's variables. All of the significant results are marked in bold font. One has to remember that since the dependent variable itself is a ratio, then a many coefficients are, in consequence, quite small in their values.

This part allows me to check which explanatory or control variables have the biggest impact on the dependent variable across all three panels and what the direction of that impact is. The latter is addressed by examining the sign of all of the significant coefficients in the panel data regressions. The more detailed analysis where each single region is regarded is carried out by pooled OLS in the next sub-point.

**Table 6.3.** The overview of the used regressions

#	Variables	Equation
(1)	Interaction	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + e_{rt}$
(2)	Interaction and Alcohol Consumption	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (AlcoholConsumption)_{rt} \beta_2 + e_{rt}$
(3)	Interaction and Number of Cars	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (CarAmount)_{rt} \beta_2 + e_{rt}$
(4)	Interaction, Alcohol Consumption and Number of Cars	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (AlcoholConsumption)_{rt} \beta_2 + (CarAmount)_{rt} \beta_3 + e_{rt}$
(5)	Interaction and People with Higher Education	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (HigherEducation)_{rt} \beta_2 + e_{rt}$
(6)	Interaction and People with Lower Education	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (LowerEducation)_{rt} \beta_2 + e_{rt}$
(7)	Interaction, Alcohol Consumption, Number of Cars, People with Higher Education and People with Lower Education	$(AccidentOutcome)_{rt} = \alpha_r + (AccidentOutcome * Dummy)_{rt} \beta_1 + (AlcoholConsumption)_{rt} \beta_2 + (CarAmount)_{rt} \beta_3 + (HigherEducation)_{rt} \beta_4 + (LowerEducation)_{rt} \beta_5 + e_{rt}$

b) If the fixed effects regression shows significant results in any of the included variables (except the constant), then a pooled OLS regression is done on the same set of the regressors with respect to the three regions in Sweden. These regressions are also done with robust standard errors to account for the heteroskedasticity in the models. To preserve space only the significant results are mentioned in the text, whereas the full tables from this sub-point are located in the Appendix (Tables A.6.1 – A.6.4).

This part is done to see which of the factors is the most prominent one to impact the panel results and for which region does that occur. In this part I also check if any viable explanation and connection between the significant result of the panel data regression and the OLS one can be found.

### 6.1. Model I – lethal accidents among men

The second regression shows a significant, but negative result for the alcohol consumption variable. The interpretation of this result is that with one unit rise in alcohol usage, the deathly accidents among men actually decrease by a small amount (circa -0.0032). The p-value of this coefficient is 0.076. This result is picked up in the OLS by the interaction term in the Central Sweden. The value is 0.226 with a p-value of 0.008. This may mean that even though the Vision Zero may not be working as intended and that men in Central Sweden are still quite likely to be killed in a traffic accident, but these accidents are unlikely to be caused by drunk drivers.

The fourth regression also shows a significant result for the alcohol consumption variable as the reason of the occurrence of deadly traffic collisions among men. The p-value is equal to 0.085, whereas the coefficient is almost equal to the one mentioned above (circa -0.0031). Consequently, this result is also picked up by the interaction term for Central Sweden. The p-value is somewhat bigger (0.072), while the coefficient is a bit smaller (0.210). The conclusion, however, can be the same here and the reason for the differences in values is purely due to the fact that there are more regressors included in the regression (4) than in (2).

**Table 6.4.** The results of the panel data FE testing for the **first** model – p-values in parentheses

<b>Lethal car accidents for men</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.179 (0.248)	0.175 (0.293)	0.198 (0.194)	0.195 (0.231)	0.193 (0.211)	0.200 (0.186)	0.238 (0.124)
Alcohol Consumption		<b>-1.26e<sup>-06</sup></b> <b>(0.076)</b>		<b>-1.27e<sup>-06</sup></b> <b>(0.085)</b>			<b>-1.69e<sup>-06</sup></b> <b>(0.038)</b>
Number of Cars			1.71e <sup>-10</sup> (0.492)	1.47e <sup>-10</sup> (0.512)			3.66e <sup>-10</sup> (0.409)
Higher Education					6.40e <sup>-10</sup> (0.272)		-2.82e <sup>-10</sup> (0.167)
Lower Education						<b>9.04e<sup>-10</sup></b> <b>(0.092)</b>	<b>1.27e<sup>-09</sup></b> <b>(0.082)</b>
Constant	<b>-2.79e<sup>-06</sup></b> <b>(0.074)</b>	<b>-6.23e<sup>-06</sup></b> <b>(0.004)</b>	-5.62e <sup>-06</sup> (0.231)	-9.14e <sup>-06</sup> (0.114)	-7.74e <sup>-06</sup> (0.158)	<b>-3.57e<sup>-06</sup></b> <b>(0.045)</b>	-1.24e <sup>-05</sup> (0.179)
N	36	36	36	36	36	36	36
R <sup>2</sup> -between	0.4376	0.9091	0.9507	0.9105	0.9972	0.5561	0.8824

In the case of regression (6) the significant result is for the variable for men with lower education. The p-value is 0.092 and the interpretation is that with one unit rise in the amount of lower educated males, the number of lethal traffic accidents among this gender increases by about 0.0004. This is understandable and actually goes in line with my hypothesis 4 that the more people with lower education that inhabit a certain region, the bigger the likelihood of an accident due to their recklessness and disregard for traffic rules. This result is picked up by the interaction term for Central Sweden. The coefficient is 0.214 with a p-value of 0.015. It may mean that due to bigger population density in that region, people who are less careful and more rebellious have smaller error margin while participating in traffic.

For the last equation, the significant results are, understandably, for the variables responsible for the alcohol consumption and lower education. The prior coefficient is equal to about -0.004 (p-value is 0.038), whereas the latter is circa 0.0001 with a p-value of 0.082. This means that a one-unit increase in alcohol consumption results in a decrease of lethal traffic accidents by 0.004 units, whereas simultaneously an increase in the amount of men with lower education results in an increase of the said traffic accident outcomes by about 0.0001 units. The result is picked up by the variable for lower educated males in Southern Sweden

with a p-value of 0.076 and the coefficient that is circa 0.0002. The result for the variable for lower educated males is quite clear as both analysis types (FE and OLS) have significant results for that particular variable. In the case of the OLS result and the second significant variable (alcohol) from the panel data, the interpretation may be as follows: even though people with lower education in that region of Sweden are more likely to cause lethal traffic accidents, but the cause of such collisions is not due to driving under the influence of alcohol.

### *6.2. Model II – lethal accidents among women*

The first equation shows a significant result for the interaction term (coefficient is 0.056 with a p-value of 0.037). This may mean that Vision Zero is not working as intended for women in regard to this traffic outcome since the coefficient has a positive sign. The result is not picked up in any of the OLS regression, which may mean that it occurs due to the mixture of the analyzed factors.

In the equation (3) it is again the interaction term that is significant (value of 0.126 and significance of 0.087), but it also holds true for the variable for the amount of cars. In the latter case the p-value is 0.009, whereas the coefficient amounts to about 0.00009. Therefore, it is again the case that Vision Zero may not be working as planned, but also the fact that there are more cars on the roads causes more stress and less room for any errors for women and, in turn, results in a small rise in their lethal car accidents. This is, understandably, picked up by the car amount variable in the case of Central Sweden and the interaction term in the Southern region. In the prior case the coefficient is about 0.00009 (0.010), while the second case has the coefficient 0.217 with a p-value of 0.033. The interpretation of the result for the Central Sweden is quite clear as in both the OLS and panel data the significant result is for the same variable. The interpretation for the Southern Sweden, however, can be as follows: the Vision Zero does not seem to be working correctly for this group of people due to increased traffic congestion in the region that they inhabit.

In the case of the equation (4), it is again the number of cars variable that shows significant results. It is worth noting that the coefficient is exactly the same as in the equation (3), but the p-value is slightly bigger. This may be due to the fact that this equation uses an additional variable. The result is picked up by the interaction term and the alcohol consumption variable. Both are for the Southern part of the country. The interaction has a coefficient 0.181 and a p-value 0.003. The alcohol consumption has a p-value of 0.046 with a coefficient amounting to 0.0055. In the case of the interaction term, the interpretation of this result is the same as in the case of the equation (3). The conclusion for the variable for alcohol consumption, however, can be carried out in the following manner: the higher the consumption of alcohol, the bigger the chances of causing or being involved in a lethal traffic accident for Southern women especially due to the fact that there is an increase in the amount of motor vehicles that are present on the roads in that geographical region.

**Table 6.5.** The results of the panel data FE testing for the **second** model – p-values in parentheses

<b>Lethal car accidents for women</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	<b>0.056</b> <b>(0.037)</b>	0.055 (0.209)	<b>0.126</b> <b>(0.087)</b>	0.126 (0.155)	<b>0.062</b> <b>(0.006)</b>	<b>0.056</b> <b>(0.037)</b>	0.133 (0.180)
Alcohol Consumption		-2.61e <sup>-08</sup> (0.982)		1.69e <sup>-06</sup> (0.988)			-6.81e <sup>-08</sup> (0.952)
Number of Cars			<b>2.00e<sup>-10</sup></b> <b>(0.009)</b>	<b>2.00e<sup>-10</sup></b> <b>(0.011)</b>			<b>2.54e<sup>-10</sup></b> <b>(0.004)</b>
Higher Education					1.19e <sup>-10</sup> (0.623)		-1.93e <sup>-10</sup> (0.141)
Lower Education						-1.07e <sup>-10</sup> (0.717)	2.31e <sup>-10</sup> (0.549)
Constant	<b>-2.30e<sup>-06</sup></b> <b>(0.000)</b>	-2.37e <sup>-06</sup> (0.496)	<b>-5.41e<sup>-06</sup></b> <b>(0.004)</b>	-5.37e <sup>-06</sup> (0.171)	-3.63e <sup>-06</sup> (0.258)	-3.18e <sup>-06</sup> (0.269)	-2.38e <sup>-06</sup> (0.427)
N	36	36	36	36	36	36	36
R <sup>2</sup> -between	0.9731	0.9777	0.9047	0.9043	0.7823	0.7071	0.9812

The interaction term is significant in equation (5) (coefficient amounts to 0.062 with a p-value of 0.006). It means that the policy is not working properly in decreasing the amount of women who are killed in traffic accidents. This is not picked up by any of the OLS coefficients which may be due the fact that this result occurs as a consequence of a mixture of the included variables.

In the case of the equation (6), it is the interaction term that is significant (p-value of 0.037 and the coefficient of 0.056). The interpretation of this result is the same as in the above case. However, in this case the result is picked up by the variable for lower educated females in the Northern region. The p-value is 0.060 and the coefficient is actually negative and equal to -0.0005. The interpretation is then a bit uncanny as it states that higher density of people with lower education is not causing an increase in the number of lethal traffic accidents among women. This may be, however, only limited to the Northern Sweden.

Finally, the last equation has a significant result for the variable responsible for the number of cars. The coefficient is equal to circa 0.00011 and its p-value is 0.004. Again, the interpretation here is that the more cars are present on the roads, the bigger the likelihood for a female to cause or be involved in a serious car crash. This result is picked up by the amount of cars in the Central part of the country (coefficient of about 0.00014 and a p-value of 0.085) and the interpretation here is obvious due to the fact that the same variable shows significance in two different testing methods. On the other hand, this result is also picked up by the interaction term for Southern Sweden. The p-value of that result is 0.031 and its coefficient is 0.199. The explanation here may be that Vision Zero is not working properly for females in the South in regard to lethal car accidents which may be due to the actual traffic congestion on the roads in that part of the country.

### 6.3. Model III – severe accidents among men

In the third model, the first significant result takes place in the second equation. The variable for alcohol consumption has the coefficient of about 0.015 and the p-value that amounts to 0.050. This means that due to an increase in alcohol consumption, more males are seriously injured in traffic collisions; a one unit rise in alcohol intake results in 0.015 increase in heavy traffic injuries for this group. This is picked up by the interaction term for Southern Sweden, where the coefficient is negative and equal to -0.104 with a p-value of 0.013. The conclusion here is Vision Zero is actually working in eliminating the heavy car crashes among Southern men, but if these accidents take place they are mostly due to men consuming greater amounts of alcoholic beverages.

In equation (3), the significant result is for the variable for the congestion of the passenger cars on the roads. The coefficient here is about 0.0003 (p-value is 0.010). Therefore a one unit increase in the amount of cars results in 0.0003 more severely harmed males in traffic. This significance is not picked up by any of the OLS results which may be due to the fact that a mixture of all of the variables may be affecting this.

**Table 6.6.** The results of the panel data FE testing for the **third** model – p-values in parentheses

Severe car accidents for men							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.246 (0.531)	0.226 (0.509)	0.293 (0.427)	0.270 (0.398)	0.280 (0.477)	0.295 (0.460)	0.364 (0.124)
Alcohol Consumption		<b>2.23e<sup>-05</sup></b> <b>(0.050)</b>		<b>2.18e<sup>-05</sup></b> <b>(0.063)</b>			<b>1.87e<sup>-05</sup></b> <b>(0.062)</b>
Number of Cars			<b>2.24e<sup>-09</sup></b> <b>(0.010)</b>	<b>2.02e<sup>-09</sup></b> <b>(0.033)</b>			-3.14e <sup>-09</sup> (0.273)
Higher Education					7.78e <sup>-09</sup> (0.524)		-3.62e <sup>-09</sup> (0.788)
Lower Education						1.15e <sup>-08</sup> (0.285)	<b>1.23e<sup>-08</sup></b> <b>(0.092)</b>
Constant	-2.56e <sup>-05</sup> (0.290)	<b>3.76e<sup>-05</sup></b> <b>(0.071)</b>	<b>-6.33e<sup>-05</sup></b> <b>(0.040)</b>	-2.04e <sup>-06</sup> (0.846)	-8.68e <sup>-05</sup> (0.158)	-3.77e <sup>-05</sup> (0.244)	6.70e <sup>-05</sup> (0.306)
N	33	33	33	33	33	33	33
R <sup>2</sup> -between	0.5328	1.0000	0.9997	0.9655	0.9480	0.9746	0.9583

In the next equation, it is the alcohol consumption and the motor vehicle amount that are significant. The first coefficient is equal to about 0.015 (0.063), whereas the second one is circa 0.00025 (0.033). This states that a one unit rise in any of these factors results in a 0.015 and, respectively, in 0.00025 rise in traffic accidents that end up in men being heavily harmed. The OLS, however, shows no significant results in any of the three regions for this particular equation. The conclusion here is the same as in any of the other similar cases above.

In the final equation there are two significant results. The first one is for alcohol consumption; its coefficient is about 0.013 with a p-value of 0.062. It tells us that the rise by one unit in



alcohol consumption results in a circa 0.013 increase in heavily injured males in traffic. The second significant result is for the lower educated males. The coefficient here is about 0.0004, whereas its p-value is quite high as it amounts to 0.092. The interpretation here is that an increase in the amount of lower educated Swedish males results in a 0.0004 increase in them being severely hurt in traffic accidents. This result is picked up in Southern Sweden by the variable for lower educated males (coefficient is about 0.00036 with a p-value of 0.080). Therefore, this relationship does not need any further explanations for this factor, but it is needed when the other significant result from FE is regarded.

#### *6.4. Model IV – severe accidents among women*

The final model takes severely harmed women into account and the significant result for the first equation is clearly the interaction term. Its p-value is equal to 0.063, while the coefficient is equal to 0.163. The analysis here is that the policy is clearly not working as intended for this gender. This result is picked up by interaction terms for Northern and Southern Sweden. Since the significant results are for the same variable irrespective of the used testing method, then no additional explanation is needed. In the North the coefficient is 0.207 (0.007), in the South it is 0.059 (0.061).

In equation (2) it is also the interaction term that is significant. Its coefficient amounts to 0.164 with a p-value of 0.050. The explanation for this result is the same as above; the difference in values is the effect of using an additional parameter in the second equation. This result is picked up by the interaction term for the Northern part of Sweden (coefficient is 0.194; p-value is 0.011). No further explanation is, thus, needed in this case.

Similar interpretations and actions had to be taken for the results of the third equation. Again, only the interaction term is significant for heavily harmed women. The p-value of this result is 0.050 and the coefficient is equal to 0.178. Additionally, only the interaction term for the Northern region picks up this result. Its coefficient is 0.231 and its p-value is 0.004.

In the equation (4) it is, again, only the interaction term that shows significant results. The p-value here is 0.040 and the coefficient is equal to 0.179. Nevertheless, this result is picked up by the variable for the amount of cars in the North in addition to the interaction term in the same region. The prior variable has the coefficient of 0.219 (0.005), whereas the latter is equal to 0.000087 (0.039). The explanation for the interaction terms in both tests is quite straightforward. On the other hand, the conclusion for the other significant variable from OLS in connection to FE may be stated as follows: the larger the traffic congestion, the more heavy traffic collisions occur to females and therefore Vision Zero needs to be upgraded to take that into account.

**Figure 6.7.** The results of the panel data FE testing for the **fourth** model – p-values in parentheses

<b>Severe car accidents for women</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	<b>0.163</b> <b>(0.063)</b>	<b>0.164</b> <b>(0.050)</b>	<b>0.178</b> <b>(0.050)</b>	<b>0.179</b> <b>(0.040)</b>	<b>0.167</b> <b>(0.047)</b>	<b>0.161</b> <b>(0.068)</b>	<b>0.176</b> <b>(0.045)</b>
Alcohol Consumption		2.17e <sup>-06</sup> (0.339)		2.13e <sup>-06</sup> (0.324)			2.73e <sup>-06</sup> (0.231)
Number of Cars			4.52e <sup>-10</sup> (0.160)	4.43e <sup>-10</sup> (0.167)			1.89e <sup>-10</sup> (0.615)
Higher Education					<b>1.40e<sup>-09</sup></b> <b>(0.009)</b>		<b>1.55e<sup>-09</sup></b> <b>(0.051)</b>
Lower Education						-5.01e <sup>-10</sup> (0.425)	-4.02e <sup>-10</sup> (0.612)
Constant	<b>-9.72e<sup>-06</sup></b> <b>(0.017)</b>	-3.76e <sup>-06</sup> (0.477)	<b>-1.73e<sup>-05</sup></b> <b>(0.060)</b>	-1.13e <sup>-05</sup> (0.131)	<b>-2.55e<sup>-05</sup></b> <b>(0.003)</b>	<b>-1.39e<sup>-05</sup></b> <b>(0.084)</b>	<b>-2.62e<sup>-05</sup></b> <b>(0.062)</b>
N	39	39	39	39	39	39	39
R <sup>2</sup> -between	0.0503	0.0048	0.1622	0.1629	0.0121	0.1588	0.0058

The equation (5) has two significant variables. The first one is the interaction term. The coefficient here is 0.167 with a p-value of 0.047. The second variable is for higher educated women. Its coefficient is equal to about 0.0002 (0.009). In the second case, the one unit rise in the amount of higher educated females, results in an actual increase of severe car crashes where women are involved. These two results are only picked up by the interaction term in both Northern and Southern Sweden. In the prior case the coefficient equals 0.199 (0.014). In the latter case the p-value is equal to 0.053, while the coefficient amounts to 0.074. The interpretation of the case where the interaction term is significant in both tests does not need to be included. On the other, the other significant combination has the following, albeit a bit uncanny, explanation: Vision Zero does not seem to be working well for females in those two regions and it may be caused by the fact that there a high density of well-educated females that are living in those parts of the country.

The interaction term is again the only significant value in the equation (6). In this case the coefficient is equal to 0.161, while its p-value amounts to 0.068. Consequently, only the interaction terms for the North and for the South pick up that result. In the first case the coefficient is 0.213 (0.008) and in the second case it is equal to 0.056 (0.076). Nor further explanation is needed as the significant results in both tests come from the same variable.

Finally, in the last equation for this model it is the interaction term along with the variable for the number of higher educated females that are the significant results. In the first case, the p-value is equal to 0.045 and the coefficient is 0.176. The second result has the coefficient of about 0.0002 and the p-value of 0.051. This result is only picked up by the interaction term for the Northern region, which has the coefficient of 0.236 (0.022). Similarly as in the other comparable cases where the significant results from two tests are for the same variable, no additional analysis of this result is needed. On the other hand, in the case of the interaction

from the OLS and its connection to the other significant result from FE, the peculiar explanation may be as follows: females with higher education living in the Northern part of the country may be more prone to cause or be involved in accidents that result in these females being severely injured.

### 6.5. Conclusion of the results

To conclude this section, I analyze which hypotheses were supported and in which cases (models and regions) the support took place. In some cases not all traffic outcomes, when two genders are regarded, support the given hypothesis at all (and therefore they are not mentioned below), whereas in the other cases the results will lean towards the alternative hypothesis. The summary of the results of both the panel data and pooled OLS regressions for all three hypotheses (with the final one being split into two) are presented in Table 6.8.

**Table 6.8.** The summary of the results

Hypothesis	Traffic victim group	Variable sign from FE	OLS result	Sign	Region
1 (Alcohol Consumption)	Lethal accidents for males	Negative	Interaction	Positive	Center
			Lower Education	Positive	South
	Severe accidents for males	Positive	Interaction	Negative	South
			Lower Education	Positive	South
2 (Number of Cars)	Lethal accidents for females	Positive	Interaction	Positive	Center
			Interaction	Positive	South
			Alcohol Consumption	Positive	South
	Severe accidents for males	Positive	No OLS result	-	-
3.1 (Higher Education)	Severe accidents for females	Positive	Interaction	Positive	North
			Interaction	Positive	South
3.2 (Lower Education)	Lethal accidents for males	Positive	Interaction	Positive	Center
			Lower Education	Positive	South
	Severe accidents for males	Positive	Lower Education	Positive	South

The first hypothesis questions whether increased alcohol consumption, in regard to two genders and three regions, indeed does negatively impact the goals of Vision Zero, which means that the number of deadly and severe car crashes actually increases. The hypothesis is supported for severe car crashes for males. This variable also had significant results for lethal traffic accidents among men. However, these results are all negative, which means that the alternative hypothesis is supported in this case.

The second hypothesis analyzes the impact of the amount of passenger cars on the roads on the likelihood of the deadly and heavy traffic accidents taking place. There are two traffic victim groups that fully support this hypothesis: killed females and heavily harmed males.

The third and final hypothesis takes higher education of traffic members into account and analyzes whether people with better education are more careful, attentive and tend to follow the traffic rules. This means that they ought to cause less traffic accidents of both researched types. Since the variable in question should have a negative direction, but the above results show a positive one, then the support is for the alternative hypothesis in this case. This takes place for severely injured females. This hypothesis is, however, fully supported by the amount of lethal male accidents occurring in Sweden.

In most of the above cases the results their results are picked up by the interaction term, which analyzes the change in traffic accident outcomes for both genders in regard to the pre- and post-policy periods. It, therefore, examines if the Vision Zero is indeed working towards its goals. In almost of such cases the sign of these interaction terms is positive, which means that the effects of the aforementioned variables are, among others, what hinders the proper functioning of the policy.

## **7. Discussion**

To evaluate Vision Zero in general and to examine its effects on national traffic safety issues is not an easy task. However, to simply state that the policy is not working correctly and that its goals are unattainable and even sort of utopian does not validate the magnitude of positive changes, because the policy in itself is quite intricate in addition to the variety of complicated tasks and goals that it is supposed to deal with. There have been a lot of positive changes in the safety on the roads and the number of accidents is indeed going down, even if somewhat slower than people had anticipated it to in 1997.

Although the results are fairly firm in telling their story not only about the performance of Vision Zero, but also about the equality of it when different geographical regions are regarded, they are, nevertheless, far from being undisputable. There are a great number of other factors that ought to be taken into account when judging the policy in the light of this research paper. First and foremost, both the distance driven per a certain period of time as well as the years of experience is going to have a major impact on an individual's likelihood to cause or be involved in a traffic accident. Therefore, if you drive more frequently because you commute or if your work requires you to drive a lot, then that means that you are putting yourself and others in the danger of being in a traffic collision much more often. Especially the latter factor is of importance. Drivers need to be attentive, act quickly and responsibly and they need to have the skills to predict the activities of others on the road. However, the longer you drive, the more tired you get and you start to lose focus and you react slower to the ever-changing traffic conditions.

On the other hand, those who drive seldom can also be perceived as a dangerous group due to their lack of experience and worse off abilities to perform certain road and safety maneuvers. Such people also tend to be more afraid and getting easily stressed and startled can lead to hazardous errors, while there is no room for those in traffic. In addition, non-experienced drivers tend to also be slower, both in terms of their actions and their driving speed. Depending on the traffic congestion and its quality, these factors can cause a fair amount of chaos and can lead to harm among other traffic members.

Two of the economic-related factors, working as driving and commuting to work by driving, have been mentioned above. Another one is the earnings of the potential drivers. I am not stating here that rich drivers are more careful and responsible than those with smaller incomes, because the financial matters come into the picture through a different reasoning. Namely, as mentioned before, people who earn more have the bigger ability and possibility to purchase newer and safer motor vehicles that are equipped with features that go in line with the measures of Vision Zero. In addition, they are able to keep their cars in better conditions as they can afford the maintenance and servicing.

On the other hand, however, due to the complexity of the economy, it is mostly those that do not have any good education that end up not being financially well-endowed. Even though, alcohol in Sweden is quite expensive and its sales are mostly restricted to special liquor stores (Systembolaget), but living in poverty and unemployment or being stuck in a job with very small wages can cause excessive drinking. Some find it actually cheaper to purchase their large quantities of alcoholic drinks just across the border in Denmark. From the results of my research we see that alcohol indeed is one of the reasons of severe car accidents among males, especially in the Southern Sweden. There seems to be a connection since people from Skåne and Hallands live relatively close to the Danish borders.

Financially instable people that also have drinking problems are very dangerous drivers due to them being frequently intoxicated but also unable to focus on the road as they are constantly worried about their future and economic situations in addition to being angry and depressed. Moreover, alcohol consumption for many Swedish people seems to be highly correlated with them having attained only lower education levels. For men the correlation between the two reaches up to 0.9362. For women it is even higher as the value equals to 0.9486, which can be perceived as an uncanny result in the light of this thesis. Consequently, the numbers are somewhat lower for these two genders with higher education: 0.7378 and 0.6798, respectively. It can be seen that, even though lower educated males have lower correlation to alcohol consumption than equally educated women, but the situation is diametrically different when it comes to higher educated individuals from each gender where the male correlation is significantly greater than that of females.

**Table 7.1.** The correlation results between alcohol consumption and two education levels for both genders

	Alcohol
Higher educated males	0.7378
Higher educated females	0.6798
Lower educated males	0.9362
Lower educated females	0.9486

Another important aspect that evaluates the Vision Zero and that is partially tied to the driving experience and driving quality is the age of the drivers. Young drivers tend to drive fast, careless and unprofessional as they like to show off their new skills and newly attained freedom to move around to their peers. They also tend to act hasty and are therefore prone to cause more crashes and collisions. The other risky group is the elderly people since their reactions are much slower in addition to their senses (especially their vision) being weaker. In connection to the latter, their eyesight is also a problem when the lighting conditions are scarce and therefore they should not drive after sunset or during heavy rainstorms. Some say that the “safe” drivers are those aged between 25 and 60 and they lean to saying that men are better drivers than women. However, it all depends on when in life the given drivers had received their driving permits and how long and often had they been driving. In terms of the gender there are too many factors and partially true stereotypes and they will definitely not enrich this discussion. Therefore, I will just mention that it is not your gender that makes you a good or bad driver, but it is your personality, your skills and your ability to adapt and react fast regardless of the road and traffic conditions.

Additionally, what is often mentioned in the research articles but what is missed by others who evaluate Vision Zero, is the aforementioned responsibility shift from the drivers to the infrastructure designers. While road designers are there to take the blame for the errors of the drivers and to rebuild and remodel roads to avoid such errors in the future, they cannot simply prevent all such accidents altogether without the drivers fulfilling their responsibilities. Drivers often take this for granted and think that if somebody else takes care of their safety on the roads, then they themselves can drive less attentively, faster and without wearing seatbelts. This becomes in a way a never-ending cycle and, partially, therefore many of the policy’s goals and sub-goals are still far from being reached. One of the solutions is that drivers need to become careful again along with becoming more considerate and sensible.

As can be seen from the above discussion, this research paper is missing quite some information to be treated as a correct and full region-wise evaluation of the Vision Zero. Nevertheless it gives a good and basic picture of which traffic outcomes occur to which gender and in which region and what might be the main cause of these occurrences. One can clearly see that alcohol is the reason of many heavy accidents occurring for the Southern males, while traffic congestion is what causes deaths of women in both Central and Southern Sweden. There seem to be no good solution or policy implication for the prior case as alcohol taxes are already quite high and people simply cannot be prevented from traveling abroad where drinking is cheaper. In the latter case, however, women can be aided with their issues by making public transportation cheaper, more available and reaching more destinations. The

effects of having higher or lower education on the likelihood of causing a traffic collision are a bit less clear especially in the case of higher education for women from the Northern part of the country in terms of them causing severe traffic accidents, but they are quite easily understandable for lower educated males from the Southern and Central Sweden when it comes to them causing deadly car crashes. This, in turn, can be solved by promoting education among such groups of people (e.g. vocational training) and telling them that their lives can be changed if they really want them to be changed. On the whole, the fact that highly educated women in the Northern regions of Sweden are more prone to be involved in lethal or serious car accidents is very surprising. I anticipate that either the methods used to analyze the data are not refined enough to really capture the reasons of this notion or that there is a problem with the data itself. The latter can be either due to the data having some errors in it or due to the aforementioned problem that some other missing variables might be the real driving forces behind these uncanny results.

It is also true that this paper covers only a short period of time and, in addition, many changes may have and actually have taken place in favor of Vision Zero and road safety since 2004. My hope, then, is that the enriched, upgraded and updated future version of this research will serve its purpose in helping policy-designers with remaking and reinventing the Vision Zero to adapt it to not only newer times but also to regional differences in the country.

## **8. Conclusion**

Vision Zero is long-term policy with measures and sub-goals that are constantly being updated with passing time. It was ratified in Sweden in 1997 and its final goal is to gradually eliminate all traffic accidents that end up with either the death or severe injury of at least one of the involved traffic members. Many researchers on road and traffic safety state that Vision Zero is more like a vision than a policy, that its goals are mostly purely utopian and that since the final goal is still far from being reached then Vision Zero may as well be changed to a policy that brings the necessary results better and faster. Nevertheless, many changes in the traffic safety have occurred in Sweden since 1997 and a magnitude of the measures that are included in Vision Zero are indeed making traffic safer for all of its members. My opinion is that this policy cannot be simply deemed as one that is working or not working because there is so much more that should be taken into account when one performs such an evaluation.

In terms of how well the policy is fairing in different regions, the results are quite straightforward in pointing out what factors hinder Vision Zero from impacting the traffic safety in an even better and more positive way. By performing the fixed effects panel data regressions with one of more of controls being among the explanatory variables and then performing region-wise OLS regressions using the same set of regressors if a particular FE regression had any significant results, I have managed to list out whether or not the Vision Zero is working in each of the three regions and what factors can be the main hindrances for policy's effects and measures. For Southern males it is the alcohol availability and therefore its consumption that acts as a cause to many accidents ending up in men getting seriously

injured. In addition, the fact that there is a big proportion of males with lower education in the Southern and Central Sweden which also apparently acts as a hinder for Vision Zero's methods. For females from the Central region of the country it is the amount of cars on the roads and traffic congestion that are the causes of many lethal car crashes with females involved. Alcohol also plays a role here, especially for the women inhabiting the Southern region.

Therefore, even though, the depiction given by this research paper is somewhat basic and missing quite a lot of information and variables, but it gives a good introductory picture to what the Vision Zero is lacking and what steps and measures should be included in its next short-term sub-goals. As such, the future versions of this research along with the updated tasks of the policy itself will make sure that the policy is not only working correctly for the country as a whole, but that it also is adjusted to regional differences within the country's borders.



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- **Data sources**

Accident outcomes - Swedish Traffic Administration (Trafikverket): see [footnote 1](#) for more information

Alcohol sales - Swedish National Institute of Public Health (Statens Folkhälsoinstitut): <http://app.fhi.se/PXwebFHI/database/Folkhalsodata/m12Alkohol/aTillganglighet/aTillganglighet.asp>

Number of registered cars - Transport Analysis Agency (Trafikanalys): <http://trafa.se/PageDocuments/tk21tab1.xls>

Education – Statistics Sweden (Statistiska Centralbyrån): <http://www.ssd.scb.se/databaser/makro/Produkt.asp?produktid=UF0506&lang=1>

Population – Statistics Sweden (Statistiska Centralbyrån): <http://www.ssd.scb.se/databaser/makro/Produkt.asp?produktid=BE0101&lang=1>

## Appendix

**Table A.5.1.** The results of the Hausman test

Model	Panel data model type	P-value
Lethal accidents for males	Fixed	0.0049
Lethal accidents for females	Fixed	0.0005
Severe accidents for males	Fixed	0.0368
Severe accidents for females	Fixed	0.0020

**Table A.5.2.** The results of the testing for heteroskedasticity

Model	Homoskedastic?	P-value
Lethal accidents for males	No	0.0000
Lethal accidents for females	No	0.0000
Severe accidents for males	No	0.0561
Severe accidents for females	No	0.0000

**Table A.6.1.** Full results of the OLS testing for the **first** model – p-values in parentheses.

<b>Lethal car accidents for men - REGION NORTH</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	0.290 (0.450)	n/a	0.358 (0.457)	n/a	0.313 (0.399)	0.663 (0.226)
Alcohol Consumption	n/a	-6.12e <sup>-07</sup> (0.899)	n/a	-1.62e <sup>-07</sup> (0.972)	n/a		-3.57e <sup>-06</sup> (0.792)
Number of Cars	n/a		n/a	2.10e <sup>-09</sup> (0.671)	n/a		8.46e <sup>-09</sup> (0.350)
Higher Education	n/a		n/a		n/a		1.19e <sup>-10</sup> (0.971)
Lower Education	n/a		n/a		n/a	5.18e <sup>-09</sup> (0.467)	1.88e <sup>-08</sup> (0.375)
Constant	n/a	-8.12e <sup>-06</sup> (0.564)	n/a	-1.09e <sup>-05</sup> (0.560)	n/a	-7.83e <sup>-06</sup> (0.538)	-3.55e <sup>-05</sup> (0.316)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.1. (cont.)** Full results of the OLS testing for the **first** model – p-values in parentheses.**Lethal car accidents for men - REGION CENTER**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	<b>0.226</b> <b>(0.008)</b>	n/a	<b>0.210</b> <b>(0.072)</b>	n/a	<b>0.214</b> <b>(0.015)</b>	0.275 (0.118)
Alcohol Consumption	n/a	-1.45e <sup>-06</sup> (0.266)	n/a	-1.46e <sup>-06</sup> (0.286)	n/a		-2.16e <sup>-06</sup> (0.241)
Number of Cars	n/a		n/a	-5.98e <sup>-11</sup> (0.716)	n/a		7.08e <sup>-11</sup> (0.808)
Higher Education	n/a		n/a		n/a		-5.89e <sup>-10</sup> (0.578)
Lower Education	n/a		n/a		n/a	1.43e <sup>-10</sup> (0.826)	9.32e <sup>-10</sup> (0.436)
Constant	n/a	-6.54e <sup>-06</sup> (0.177)	n/a	-5.00e <sup>-06</sup> (0.516)	n/a	-1.89e <sup>-06</sup> (0.629)	-5.69e <sup>-06</sup> (0.533)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Lethal car accidents for men - REGION SOUTH**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	-0.168 (0.377)	n/a	-0.120 (0.546)	n/a	-0.034 (0.865)	-0.031 (0.872)
Alcohol Consumption	n/a	-3.61e <sup>-06</sup> (0.189)	n/a	-3.81e <sup>-06</sup> (0.167)	n/a		<b>-3.95e<sup>-06</sup></b> <b>(0.119)</b>
Number of Cars	n/a		n/a	3.41e <sup>-10</sup> (0.526)	n/a		7.84e <sup>-10</sup> (0.281)
Higher Education	n/a		n/a		n/a		-8.71e <sup>-10</sup> (0.509)
Lower Education	n/a		n/a		n/a	8.89e <sup>-10</sup> (0.267)	<b>1.35e<sup>-09</sup></b> <b>(0.076)</b>
Constant	n/a	-8.83e <sup>-06</sup> (0.399)	n/a	-1.71e <sup>-05</sup> (0.319)	n/a	-2.62e <sup>-07</sup> (0.967)	-1.94e <sup>-05</sup> (0.286)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.2.** Full results of the OLS testing for the **second** model – p-values in parentheses.**Lethal car accidents for women - REGION NORTH**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.065 (0.668)	n/a	0.153 (0.284)	0.154 (0.354)	0.058 (0.733)	0.012 (0.923)	0.107 (0.335)
Alcohol Consumption		n/a		4.08e <sup>-08</sup> (0.984)			-4.10e <sup>-07</sup> (0.856)
Number of Cars		n/a	1.91e <sup>-09</sup> (0.102)	1.92e <sup>-09</sup> (0.158)			1.74e <sup>-09</sup> (0.138)
Higher Education		n/a			2.00e <sup>-09</sup> (0.706)		-2.66e <sup>-09</sup> (0.440)
Lower Education		n/a				<b>-4.12e<sup>-09</sup></b> <b>(0.060)</b>	-3.02e <sup>-09</sup> (0.294)
Constant	-2.71e <sup>-06</sup> (0.419)	n/a	-5.50e <sup>-06</sup> (0.134)	-5.42e <sup>-06</sup> (0.388)	-8.42e <sup>-06</sup> (0.594)	<b>-1.89e<sup>-05</sup></b> <b>(0.014)</b>	-1.04e <sup>-05</sup> (0.407)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Lethal car accidents for women - REGION CENTER**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.010 (0.954)	n/a	0.184 (0.248)	0.108 (0.515)	0.030 (0.872)	0.005 (0.976)	0.194 (0.360)
Alcohol Consumption		n/a		-9.05e <sup>-07</sup> (0.268)			-1.03e <sup>-06</sup> (0.238)
Number of Cars		n/a	<b>1.99e<sup>-10</sup></b> <b>(0.010)</b>	1.64e <sup>-10</sup> (0.144)			<b>3.17e<sup>-10</sup></b> <b>(0.085)</b>
Higher Education		n/a			3.63e <sup>-10</sup> (0.391)		-4.38e <sup>-10</sup> (0.256)
Lower Education		n/a				2.82e <sup>-10</sup> (0.656)	9.53e <sup>-10</sup> (0.166)
Constant	-1.92e <sup>-06</sup> (0.358)	n/a	<b>-6.75e<sup>-06</sup></b> <b>(0.006)</b>	<b>-8.85e<sup>-06</sup></b> <b>(0.018)</b>	-7.34e <sup>-06</sup> (0.322)	8.19e <sup>-07</sup> (0.893)	2.84e <sup>-06</sup> (0.714)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.2. (cont.)** Full results of the OLS testing for the **second** model – p-values in parentheses.

<b>Lethal car accidents for women - REGION SOUTH</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.060 (0.720)	n/a	<b>0.217</b> <b>(0.033)</b>	<b>0.181</b> <b>(0.003)</b>	0.042 (0.852)	0.061 (0.732)	<b>0.199</b> <b>(0.031)</b>
Alcohol Consumption		n/a		<b>2.24e<sup>-06</sup></b> <b>(0.046)</b>			2.20e <sup>-06</sup> (0.116)
Number of Cars		n/a	2.34e <sup>-10</sup> (0.246)	1.42e <sup>-10</sup> (0.181)			1.71e <sup>-10</sup> (0.376)
Higher Education		n/a			-1.20e <sup>-10</sup> (0.820)		1.41e <sup>-11</sup> (0.978)
Lower Education		n/a				-2.48e <sup>-11</sup> (0.928)	1.13e <sup>-10</sup> (0.725)
Constant	-2.26e <sup>-06</sup> (0.283)	n/a	<b>-7.19e<sup>-06</sup></b> <b>(0.056)</b>	1.21e <sup>-06</sup> (0.749)	-3.75e <sup>-07</sup> (0.969)	-2.53e <sup>-06</sup> (0.474)	1.51e <sup>-06</sup> (0.836)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.3.** Full results of the OLS testing for the **third** model – p-values in parentheses.

<b>Severe car accidents for men - REGION NORTH</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	0.037 (0.681)	0.054 (0.556)	0.053 (0.602)	n/a	n/a	0.111 (0.495)
Alcohol Consumption	n/a	2.28e <sup>-07</sup> (0.982)		4.45e <sup>-07</sup> (0.965)	n/a	n/a	3.41e <sup>-06</sup> (0.923)
Number of Cars	n/a		3.79e <sup>-09</sup> (0.431)	3.81e <sup>-09</sup> (0.458)	n/a	n/a	4.30e <sup>-09</sup> (0.835)
Higher Education	n/a				n/a	n/a	4.31e <sup>-08</sup> (0.550)
Lower Education	n/a				n/a	n/a	1.26e <sup>-08</sup> (0.794)
Constant	n/a	-4.24e <sup>-06</sup> (0.884)	-1.16e <sup>-05</sup> (0.692)	-1.06e <sup>-05</sup> (0.765)	n/a	- n/a	-7.67e <sup>-05</sup> (0.258)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.3. (cont.)** Full results of the OLS testing for the **third** model – p-values in parentheses.**Severe car accidents for men - REGION CENTER**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	0.012 (0.587)	-0.004 (0.886)	-0.002 (0.956)	n/a	n/a	-0.003 (0.956)
Alcohol Consumption	n/a	-2.21e <sup>-06</sup> (0.340)		-2.26e <sup>-06</sup> (0.351)	n/a	n/a	-1.86e <sup>-06</sup> (0.662)
Number of Cars	n/a		-2.80e <sup>-10</sup> (0.403)	-2.93e <sup>-10</sup> (0.310)	n/a	n/a	-4.39e <sup>-10</sup> (0.393)
Higher Education	n/a				n/a	n/a	1.15e <sup>-09</sup> (0.529)
Lower Education	n/a				n/a	n/a	-1.76e <sup>-09</sup> (0.956)
Constant	n/a	-7.41e <sup>-06</sup> (0.550)	7.49e <sup>-06</sup> (0.557)	2.88e <sup>-07</sup> (0.985)	n/a	n/a	-6.57e <sup>-06</sup> (0.784)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Severe car accidents for men - REGION SOUTH**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	n/a	<b>-0.104</b> <b>(0.013)</b>	-0.082 (0.180)	-0.101 (0.123)	n/a	n/a	-0.052 (0.391)
Alcohol Consumption	n/a	-4.74e <sup>-06</sup> (0.332)		-4.76e <sup>-06</sup> (0.359)	n/a	n/a	-4.55e <sup>-06</sup> (0.329)
Number of Cars	n/a		2.91e <sup>-11</sup> (0.974)	6.28e <sup>-11</sup> (0.953)	n/a	n/a	1.03e <sup>-09</sup> (0.490)
Higher Education	n/a				n/a	n/a	-1.17e <sup>-09</sup> (0.651)
Lower Education	n/a				n/a	n/a	<b>2.93e<sup>-09</sup></b> <b>(0.080)</b>
Constant	n/a	-4.91e <sup>-06</sup> (0.799)	7.22e <sup>-06</sup> (0.801)	-6.41e <sup>-06</sup> (0.847)	n/a	n/a	-1.94e <sup>-05</sup> (0.539)

- n/a – not available as this regression did not have any significant results in the panel data analysis part

**Table A.6.4.** Full results of the OLS testing for the **fourth** model – p-values in parentheses.

<b>Severe car accidents for women - REGION NORTH</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	<b>0.207</b> <b>(0.007)</b>	<b>0.194</b> <b>(0.011)</b>	<b>0.231</b> <b>(0.004)</b>	<b>0.219</b> <b>(0.005)</b>	<b>0.199</b> <b>(0.014)</b>	<b>0.213</b> <b>(0.008)</b>	<b>0.236</b> <b>(0.022)</b>
Alcohol Consumption		5.43e <sup>-06</sup> (0.401)		6.27e <sup>-06</sup> (0.310)			3.73e <sup>-06</sup> (0.738)
Number of Cars			4.62e <sup>-09</sup> (0.257)	<b>5.22e<sup>-11</sup></b> <b>(0.039)</b>			6.99e <sup>-09</sup> (0.221)
Higher Education					-6.96e <sup>-09</sup> (0.691)		-9.17e <sup>-09</sup> (0.767)
Lower Education						3.26e <sup>-09</sup> (0.731)	6.07e <sup>-09</sup> (0.684)
Constant	-1.41e <sup>-05</sup> (0.316)	-1.91e <sup>-06</sup> (0.924)	-2.20e <sup>-05</sup> (0.116)	-9.02e <sup>-06</sup> (0.623)	6.33e <sup>-06</sup> (0.900)	-1.69e <sup>-06</sup> (0.969)	3.21e <sup>-05</sup> (0.706)

<b>Severe car accidents for women - REGION CENTER</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	0.157 (0.197)	0.158 (0.221)	0.193 (0.151)	0.193 (0.177)	0.162 (0.194)	0.152 (0.231)	0.159 (0.365)
Alcohol Consumption		1.27e <sup>-06</sup> (0.967)		-3.01e <sup>-07</sup> (0.919)			9.00e <sup>-07</sup> (0.771)
Number of Cars			4.45e <sup>-10</sup> (0.476)	4.49e <sup>-10</sup> (0.517)			1.43e <sup>-11</sup> (0.987)
Higher Education					1.22e <sup>-09</sup> (0.609)		1.64e <sup>-09</sup> (0.554)
Lower Education						-1.56e <sup>-10</sup> (0.688)	-1.88e <sup>-09</sup> (0.697)
Constant	-1.49e <sup>-06</sup> (0.888)	-1.08e <sup>-06</sup> (0.929)	-1.34e <sup>-05</sup> (0.568)	-1.25e <sup>-05</sup> (0.574)	-1.97e <sup>-05</sup> (0.598)	-1.71e <sup>-05</sup> (0.665)	-4.21e <sup>-05</sup> (0.402)

<b>Severe car accidents for women - REGION SOUTH</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Interaction	<b>0.059</b> <b>(0.061)</b>	0.062 (0.111)	0.055 (0.253)	0.059 (0.305)	<b>0.074</b> <b>(0.053)</b>	<b>0.056</b> <b>(0.076)</b>	0.058 (0.355)
Alcohol Consumption		5.48e <sup>-07</sup> (0.818)		5.60e <sup>-07</sup> (0.824)			1.73e <sup>-06</sup> (0.534)
Number of Cars			-5.22e <sup>-11</sup> (0.919)	-5.52e <sup>-11</sup> (0.920)			-4.64e <sup>-10</sup> (0.521)
Higher Education					1.13e <sup>-09</sup> (0.275)		1.64e <sup>-09</sup> (0.304)
Lower Education						-3.75e <sup>-10</sup> (0.731)	-9.18e <sup>-10</sup> (0.522)
Constant	<b>-1.29e<sup>-05</sup></b> <b>(0.041)</b>	<b>-1.14e<sup>-05</sup></b> <b>(0.071)</b>	-1.17e <sup>-05</sup> (0.453)	-1.01e <sup>-05</sup> (0.523)	<b>-3.10e<sup>-05</sup></b> <b>(0.094)</b>	-1.71e <sup>-05</sup> (0.276)	<b>-3.41e<sup>-05</sup></b> <b>(0.021)</b>