The Impact of Mandatory Helmet Laws on Moped Driving Behaviour in the Netherlands

This thesis studies the effect of the Dutch moped helmet obligation on moped driving behaviour, using data collected with a survey design. I conduct a fixed effects analysis, finding that the helmet obligation has caused a significant decrease in overall moped use, as well as a substitution effect, where people now choose a yellow license plate moped over a blue license plate moped more often. While this substitution effect has led to more risky driving behaviour, I do not find evidence for the risk compensation hypothesis. The increase in risky driving behaviour is caused by increased speeds on yellow license plate mopeds, and is not due to the fact that moped drivers are obliged to wear helmets. I was not able to draw conclusions on whether the helmet obligation is a successful policy, as this research lacks data on traffic accidents, injuries and fatalities. Integrating this data into the results of this research is therefore a recommendation for future research.

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1. Introduction

In the Netherlands, as of the first of January 2023, it is mandatory to wear a helmet on (e)mopeds with a maximum speed of 25 km/h, recognizable by their blue number plate. This law is an addition to the law where it was already obligated to wear a helmet on (e)mopeds with a maximum speed of 45 km/h, recognizable by their yellow number plate. Before 2023, people who drove a moped with a blue number plate could decide themselves whether they would wear a helmet when driving their moped, while as of 2023, this will be punished with a fine of €100 (Ministerie van Infrastructuur en Waterstaat, 2022). As the government has followed up on their commitment to enforce the law firmly, the existence and consequences of the law are likely to be clear to every moped driver. This is a vital property of the law, as Valero-Mora et al. (2020) show that in many countries, drivers are often not aware of the existing helmet legislation. This leads to reduced compliance and reduced effectiveness of the law. Due to the nature of the new Dutch helmet law, however, the compliance is likely not a factor that needs worrying about, as it automatically boosts the awareness of the existence and the consequences of the legislation.

An important note regarding the new national helmet obligation in the Netherlands is that this policy was already implemented in parts of the cities of Utrecht and Amsterdam, prior to the start of the national legislation. The policy is therefore not entirely new to the country of the Netherlands. The reason for the nationwide expansion of the helmet legislation is the amount of traffic injuries and deaths among moped drivers. In 2018, a group of 130 doctors wrote a letter to the Dutch parliament, lobbying for more safety regulations for moped drivers. They stated that, even with a maximum speed of 25 km/h, there is a big risk of fatal injuries when one does not wear a helmet (WA.nl, 2023). According to the numbers of CBS, the number of fatal moped accidents in the Netherlands have increased with around 25% between 2016 and 2022, to a total of 51 deaths in 2022. Furthermore, according to BRON, in 2022, 13% of the total deaths in traffic were caused on roads where the maximum speed is 30 km/h. These are roads where mopeds were allowed to drive without the use of a helmet, indicating that mopeds with a blue number plate were allowed on roads that can be quite dangerous at times (Ministerie van Infrastructuur en Waterstaat, 2023).

In 1992, a similar policy was implemented in the city of Barcelona, where it became mandatory for riders of motorcycles with a power capacity inferior to 125 cc to wear helmets, which was up until then only compulsory for heavier motorcycles. Important to note here is that 125cc motorcycles are still quite powerful, as the blue and yellow license plate mopeds have a maximum power capacity of <50 cc. Using an interrupted time series analyses method, Ballart and Riba (1995) studied the effect of the Barcelona policy on the number of serious injuries and deaths among moped and motorcycles

drivers. They found that, after the helmet obligation, the number of injuries and deaths among smaller motorcycles and moped drivers decreased significantly, while the number of injuries and deaths among heavier motorcycles did not significantly change in the researched time period. The impact of the policy was abrupt and permanent, and the authors concluded that this impact was caused mostly by the legislation and potential sanctions itself. While the safety benefits of wearing a helmet were widely campaigned by the media, this seemed to yield no significant effect, as motorcyclists mainly started to wear helmets in order to not get sanctioned. This study therefore highlights the importance of enforcement for a safety policy, as the safety benefits themselves do not influence people enough to adopt certain types of safe behaviour.

A similar study was conducted by Ha et al. (2017), who researched the impact of helmet legislation on motorcycle safety in the Cu Chi district, a suburban area of the Vietnamese town Ho Chi Minh City. They found that, after the implementation of the mandatory helmet law in Vietnam, rates of head injuries and deaths among motorcycle riders decreased significantly. They did, however, only have data on deaths and injuries, and not on whether drivers actually wore a helmet at the time of an accident. Further research is therefore needed to be able to claim a causal relationship between the mandatory helmet law and a decrease in head injuries and deaths, as the authors could not conclusively prove that the safety benefits of helmets were the only reason for the decrease in head injuries and deaths.

Lepard et al. (2021) provide a systematic review on differences in outcomes of mandatory motorcycle helmet legislation by country income level. They find that in every country where mandatory motorcycle helmet laws are introduced, the odds of motorcycle fatalities decreased significantly, with no difference between country income levels. They did find, however, that while the odds of wearing a helmet after the introduction of legislation increased in each country, this increase was significantly greater in high-income countries than in low-middle income countries. This is likely due to a stronger awareness of the existence of the law among motorcyclists and to the enforcement of the law in high-income countries, following the earlier mentioned theory of Valero-Mora et al. (2020). The overall goal of the helmet legislation policies is, however, achieved in every country where such a policy was introduced, as fatalities and injuries decrease over each study that was reviewed in this research.

A similar systematic review was conducted by Peng et al. (2017). They reviewed sixty studies on the implementation or the repealing of universal helmet laws for motorcyclists in the United States, and found that implementing helmet legislation on average leads to a 47% increase in helmet use, a 32% decrease in total traffic fatalities and a decrease of 32% of total traffic injuries. Repealing universal

helmet legislation has an even larger effect, as this on average leads to a 39% decrease in helmet use, a 42% increase in total traffic fatalities and a 41% increase in total traffic injuries. Similar effects after a repeal of universal helmet legislations were found by Bledsoe et al. (2002), who researched the effect of the adult helmet law repeal of the state of Arkansas in 1997. They used data on traffic injuries and deaths over a period of six years, ranging from three years prior to the repeal to three years after the repeal. They found that non-helmeted deaths at a crash scene increased with around 35 percentage points after the repeal. Furthermore, motorcycle riders who crashed without wearing a helmet had around 25 percentage points more chance of a severe head injury after an accident than helmeted drivers had, while non-helmeted drivers also needed to spend a significant longer time on the intensive care than helmeted drivers. The repeal of the law therefore had a negative financial impact on the healthcare system, as well as increasing the risk of fatal accidents for (non-helmeted) motorcyclists.

Therefore, the current literature uniformly finds that the introduction of mandatory universal helmet legislation leads to a significant decrease in motorcycle injuries and fatalities, as well as to less severe (head) injuries after a crash. An important note here, however, is that all these studies are focussed on motorcycle drivers and accidents, and not on moped drivers. The difference between mopeds and motorcycles are quite substantive, as mopeds have a maximum engine power capacity of 50 cc, with a top speed of around 50 km/h. Light motorcycles often have a maximum engine power capacity of 125 cc, with a top speed of around 100 km/h. Heavier motorcycles can even have engine power capacities of over 1000 cc, with top speeds of over 200 km/h (Fodsports, 2022). The differences in speed between motorcycles and mopeds, and consequently the type of traffic situations which motorcycle or moped drivers find themselves in, can therefore differ quite a bit. Thus, while there is a lot of evidence in favour of universal motorcycle helmet legislation, it is unclear to what extend this evidence also applies to moped drivers.

Furthermore, the behavioural consequences of a universal helmet legislation policy have been researched much less extensively. Dee (2009) uses American data to assess the impact of helmet use and state helmet laws on motorcycle fatalities. He finds that, while wearing a helmet reduces fatality risk for motorcycle drivers with 34%, state laws on mandatory helmet use only reduce motorcycle fatalities with 27%. This indicates that while helmet-use laws generate significant health benefits, these benefits are possibly partially offset by an increases in risk-taking by motorcyclists.
In other research by Carpenter and Stehr (2011), the authors investigate the consequences of helmet laws for young bicycle riders. They find that while laws on helmet-use on bicycles for the youth lead to a reduction in fatalities and an increase in helmet use among young bicyclists, such laws also significantly reduce the number of children that ride their bicycle and increase the risky behaviour

observed on bicycles. These results were found both among parental reports, as well as among self-reports of high school students in the USA. The authors therefore conclude that children are exposed to the risk compensation hypothesis, which indicates that due to increased feelings of safety, the children are more prone to take risks, and therefore 'compensate' for the increased safety that the helmet offers. Gamble and Walker (2016) show that adults can be exposed to the risk compensation hypothesis as well. They conducted an experiment where participants needed to perform tasks in which risk taking and sensation seeking was measured. Each participant got to wear either a helmet or a baseball cap, which they were told functioned as an eye-tracking device. The group with the helmet scored significantly higher on risk taking and sensation seeking than the group with the baseball cap, even though the helmet did not provide additional safety and was introduced as a tracking device. This study therefore suggests that risk taking increases unconsciously when safety feelings are increased. Messiah et al. (2012) also find evidence for the risk compensation hypothesis, but only for male bicyclists. In a controlled intervention trial, bicyclists were followed through the city of Bordeaux, where their speed and helmet use were observed at various locations. The authors found that there was no significant difference in cycling speed between helmeted and non-helmeted female cyclists. For male cyclists, however, the cycling speeds did differ significantly between helmeted and non-helmeted riders. This indicates that males are more likely to be exposed to the risk compensation theory than females.

While the risk compensation hypothesis is supported by many studies, not all literature uniformly agrees on the existence of this risk compensation. Esmaeilikia et al. (2019) provide a systematic review on researches regarding bicycle helmets and risky behaviour. In total, the authors reviewed 23 studies, ranging from self-reported surveys to crash or experimental data. Most of these studies did not find a positive association between helmet wearing and risky behaviour, while some reported mixed evidence and others find support for the risk compensation hypothesis. There is therefore a lack of consensus in the literature regarding helmet use and risky behaviour. With evidence for and against risk compensation, it is likely that the setting in which each research is conducted contributes to whether evidence for the risk compensation hypothesis is found.

An important note regarding these studies on the risk compensation hypothesis is that these studies focus on helmeted bicycle riders, and not helmeted moped drivers. It is therefore uncertain to which extend the findings also apply to moped drivers. While bicycle riders and moped drivers usually wear different types of helmets, the perceived inconvenience of discomfort and safety feeling of helmets are not likely to be differ largely between them. However, the differences in speed between bicyclists and moped drivers, and even between yellow number plate and blue number plate moped drivers, can differ quite substantively. While many traffic situations between bicyclists and moped drivers are

likely to be similar, their speed differences do lead to an increased crash risk for moped drivers. Aarts and Van Schagen (2006) review eight different studies on the relationship between driving speed and crash rates. They find that the function between speed and crash rate is illustrated by the shape of a U, indicating that both driving faster and driving much slower than surrounding traffic exponentially increases the risk of crashing. Furthermore, the severity of crashes increases exponentially with speed, indicating that faster vehicles are more likely to suffer (severe) crashes. Bicycle riders and moped drivers do, however, often use the same roads. When drivers do not speed on those roads, many traffic situations that both types of drivers experience will then be quite similar, which gives reason to believe that the results of these studies are likely to be similar for bicycle drivers and moped drivers.

Another interesting behavioural aspect of helmet wearing is highlighted by Robinson (2006). She claims that there is not yet clear evidence on the positive influence of bicycle helmet laws. While many studies find a negative relationship between helmet wearing and the number of suffered head injuries, Robinson claims that this can also be the case due to a substitution effect that the mandatory helmet laws induce. Wearing helmets brings discomfort, which discourages the use of bicycles. People therefore tend to choose for other modes of transport, such as the car, which also bring certain risks. The substitution effect after implementing a helmet law is therefore always something that needs to be taken into account when analysing the effectiveness of such laws.

In addition to the previously mentioned behavioural phenomena, the current literature also finds several other factors that can potentially influence moped driving behaviour. Njå and Nesvåg (2007) combine risk assessment with culture theory, in order to understand the factors that influence accident proneness among moped and motorcycle drivers. They find that cultural norms and values can have significant impact on how individuals perceive and assess risk. Furthermore, the influence of peers can increase risky driving behaviour and disregard of safety regulations. Risk assessment at an individual level therefore often differs from the average individual risk assessments used by authorities, which can lead to a higher than average risk of accidents in certain situations for more risk-seeking and reckless drivers.

As well as the cultural aspects, personality traits can also influence the accident proneness of moped and motorcycle drivers. Antoniazzi and Klein (2019) study the relationship between personality traits and motorcycle rider behaviour, using personality data and data from the Motorcycle Rider Behaviour Questionnaire (MRBQ). They find that the personality traits sensation seeking and aggression were strongly associated with risky driving behaviour, such as driving errors, speeding and performing stunts. Furthermore, the authors investigated the effects that the Big Five personality traits have on driving behaviour. They find that traits such as extraversion, neuroticism and openness

to experience positively correlate with risky driving behaviour, each with their own underlying reasons. Traits such as conscientiousness and agreeableness are on their turn negatively correlated with risky driving behaviour, and increase the likeliness of following rules and the engaging in responsible behaviour.

This thesis will contribute to this behavioural literature and try to fill the gap in the literature on moped drivers by researching the effect that the introduced helmet obligation has on moped driving behaviour in the Netherlands. The obligation to wear a helmet likely affects the attractiveness of using a 25 km/h moped as preferred mode of transport, while wearing a helmet might also increase a driver's safety feelings, which might lead to more reckless driving behaviour, i.e. drivers might be exposed to the risk compensation hypothesis.

This thesis will therefore try to answer the following research question, leading to three different hypotheses:

"How does the helmet obligation policy in the Netherlands affect moped driving behaviour?"

Hypothesis 1: The blue license plate mopeds become less attractive and will be substituted for alternative modes of transport, such as the car, the bike, the yellow license plate mopeds or public transport.

Hypothesis 2: The yellow license plate mopeds become more attractive, relative to the blue license plate mopeds, leading to more dangerous moped traffic experiences, as the overall speed is higher.

Hypothesis 3: The implementation of the mandatory helmet law leads to more reckless driving behaviour, i.e. drivers are exposed to the risk compensation hypothesis.

According to CBS (2024), there were around 761.000 vehicles with a moped license in the Netherlands in 2023. The helmet obligation does therefore affect quite a large amount of people directly, while also indirectly affecting other traffic participants in the Netherlands. It is therefore highly relevant to research what the effects of such a policy are, in order to make sure whether this policy is appropriate and effective, and to research whether any positive effects can be extrapolated. Furthermore, as the policy has been implemented quite recently, there have not been any scientific studies that research the effectiveness of this particular policy. Kalders and Vissers (2020) have provided an evaluation of the effectiveness of the helmet obligation policy in Amsterdam, which has helped to justify the need for the national policy, but this evaluation is not based on scientific methods, and causal conclusions can therefore not be drawn. Gaining relevant scientific insights on the topic of the behavioural consequences of a helmet obligation can therefore help shine a light on other traffic issues and policies that might be in place or will be in place in the future.

In this thesis, I find a significant substitution effect, where blue license plate mopeds are substituted for alternative modes of transport, such as cars, bikes and public transport. Furthermore, yellow license plate mopeds become significantly more attractive as a mode of transport, relative to blue license plate mopeds. This increase is even larger for men than for women. Overall moped use, however, decreases significantly due to the helmet obligation policy.

I do not find any support that the helmet obligation leads to exposure to the risk compensation hypothesis. The helmet obligation itself has no significant effect on risky driving behaviour. However, the use of a yellow license plate moped does significantly increase risky and dangerous driving, indicating that the helmet obligation only yields an indirect effect on risky driving behaviour.

The remainder of this thesis is structured as follows. In Section 2, the theoretical framework is presented. Section 3 describes the data and used methodology and in Section 4, the obtained results are presented. These results are discussed in Section 5, after which Section 6 concludes this thesis.

2. Theoretic framework

In the current literature, many studies have been conducted on how people adjust their behaviour when exposed to more safety measures. The two most influential and ground laying works in this field have been developed by Peltzman (1975) and Wilde (1982). In his research "The Effects of Automobile Safety Regulation", Peltzman (1975) first introduces the idea of risk compensation. He evaluated the impact of American automobile safety regulations on traffic fatalities and injuries. He finds that regulations, such as mandatory seatbelt laws, are not as effective in reducing traffic fatalities as expected. While regulations do decrease the risk of fatal injuries in an accident, it also increases the number of total accidents. This unintended consequence of traffic safety regulation is due the behavioural change of car drivers. Peltzman theorizes that drivers adjust their behaviour when the perceived safety of their vehicle increases. This compensatory behaviour then manifested itself in driving faster and with less caution, nearly or entirely offsetting the safety benefits provided by the new regulation.

A second ground laying work for the risk compensation hypothesis was produced by Wilde (1982). In his research "The theory of risk homeostasis: Implications for safety and health", Wilde develops the theory of risk homeostasis. This theory states that people have a target level of risk they are willing to accept, and that they adjust their behaviour to maintain this particular level of risk. This target risk level is an individual, subconscious threshold for how much risk a person is comfortable with. Someone's target level can be influenced by many factors, such as personality, societal norms and experience. As people want to maintain their target level of risk, they are continuously assessing the level of risk involved in every activity someone engages in. For example, when driving a car, people are continuously assessing their speed, safety regulations on the road, safety features of their car, surrounding traffic, etc. When a person perceives the risk during a certain activity as lower than their target level of risk, they might engage in more risky behaviour to bring their perceived risk back to their targeted level of risk. This continuous process forms a feedback loop, where any decrease in perceived risk due to safety intervention is counteracted by an increase in risky behaviour, leading to a constant level of overall risk.

Adams (1985) builds on the foundation laid by Peltzman and Wilde in his book "Risk and Freedom: The Record of Road Safety Regulation". He elaborates on risk compensation by examining the individual and societal implications of various safety regulations. Adams focusses, however, not only on driving regulation and behaviour, but expands his focus to other types of regulations as well. By combining Peltzman's economic perspective and the psychological approach of Wilde, Adams could contextualize the risk compensation hypothesis within a much larger framework of human behaviour

and societal norms. Therefore, safety measures could lead to an overall increase in risky behaviour, not just in traffic situations, but in all aspects of life.

The integration of these works and theories has led to the formalization of the risk compensation hypothesis. This hypothesis has a behavioural and practical dimension, where the behavioural dimension leads to practical implications. The behavioural part of the risk compensation hypothesis posits that individuals continuously assess the perceived risk in their environment and respond accordingly. This implies that when a person feels that the risk in their environment increases, they will show less risky behaviour to restore a subjective sense of acceptable risk. This does, however, work both ways, and when a person feels that the risk in their environment decreases, they will show an increase in risky behaviour to restore said subjective sense of acceptable risk.

This behavioural mechanism leads to unintended consequences of safety interventions. As safety measures are designed to reduce accidents and injuries, these generally reduce people's perceived risk. Individuals might therefore alter their behaviour in response, showing more risky behaviour, which could potentially nullify the intended safety benefits. Effective safety policies must therefore also account for the behavioural adaptations of individuals, as the understanding of the mechanism that may compensate for increase safety is crucial for designing interventions that truly enhance overall safety.

3. Data and Methodology

3.1 Survey

As the helmet obligation law has been implemented only less than two years ago, not much publicly available data has been collected on this matter. Therefore, in order to be able to analyze what the effects of the helmet obligation are, I designed a survey to collect the data that is needed for this research. This survey has been distributed among my own network and has been posted on the Instagram page Strooiscooters010. The owner of this page, Laura Nijkamp, posts pictures of strangely parked mopeds in Rotterdam, accompanied by a small poem describing the picture satirically. This page has over twenty thousand followers, providing quite a large reach of potential respondents.

The survey consists of several sections, each branched carefully in order to make sure that respondents only fill out questions that are relevant to them. Firstly, respondents are asked whether they want to fill out the survey in English or in Dutch. Both languages are available in this survey as most of the respondents are likely to be Dutch. Providing the survey in Dutch therefore reduces the chance of language barriers in the survey and increases the probability that everyone who fills out the survey understands perfectly what is asked.

The next part of the survey is designed to determine what type of moped respondents usually drive. Firstly, respondents are asked whether they own a moped and if yes, what type of moped they own. When respondents do not own a moped, they are asked whether they have gotten rid of their moped after the introduction of the helmet obligation and whether they drive shared mopeds. Again, when the answer is yes, respondents are asked what type of shared mopeds they drive. When someone indicates that they do not drive any kind of moped, the survey ends for them and they are omitted from the analysis.

After determining the type of moped a respondent drives, they are asked questions about their moped driving habits. These questions include how much they drive their moped and if this has changed after the introduction of the helmet obligation, as well as whether their preferred type of moped has changed after the helmet obligation. Furthermore, when respondents report that their habits or preferences have changed after the helmet obligation, they are asked what the reason is for their behaviour change, as well as what their current preferred substitutes are.

The next section of the survey is designed to assess the driving behaviour of participants. This section is presented to all respondents, and is designed based on the research of Steg and Van Brussel (2009). In their research, they have adapted the Driver Behaviour Questionnaire (DBQ) as designed by Reason et al. (1990) to fit for Dutch moped drivers, creating the Moped Rider Behaviour Questionnaire (MRQ). The MRQ consists of 43 different items, assessing errors, lapses and violations of moped drivers, resulting in a score that can be interpreted as an assessment of someone's driving

behaviour. In the survey used for this research, the MRQ has been reduced to the eleven most relevant items for this study. This reduction is due to concerns of the length of the survey. When all items were to be included, the survey would become much too long, likely resulting in much less participants and less reliable responses. Therefore, the eleven most relevant traffic situations have been selected, based on the likelihood that these situations could occur often when driving a moped. For each situation, questions are asked on how much a respondent encounters the sketched situation, as well as whether the respondent encounters this particular situation more, less or about the same number of times as before the helmet obligation. After this section, participants are asked about their opinions on the helmet obligation and whether they have ever been in an accident on the moped. Lastly, the survey is concluded with several questions on about someone's demographic traits. The full survey can be found in the Appendix.

3.2 Variables

3.2.1 Type of moped

In order to be able to analyse whether the hypotheses formulated in Section 1 hold, various analyses must be done. Firstly, in order to assess whether blue license plate mopeds become less attractive, I need to create a variable indicating which types of mopeds are mostly used, both before and after the introduction of the helmet obligation. As mentioned in the previous section, for both moped owners and shared moped users, the question is asked what type of moped they possess or what type of shared moped they generally drive. Consequently, the question is asked whether this is different than what type of moped they used to drive before the introduction of the helmet obligation. This provides me with data on whether a respondent generally drives a blue or yellow moped, both before and after the first of January 2023. Creating this variable results in a dummy variable, taking value 0 for blue license plate mopeds and value 1 for yellow license plate mopeds, both in period 0 (pre-helmet obligation) and period 1 (post-helmet obligation).

3.2.2 Moped use

Next, after analysing whether blue license plate mopeds become less attractive, relative to yellow license mopeds, it could still be the case that overall, blue license plate mopeds have become more attractive. Therefore, it must also be assessed what effect the helmet obligation has on overall moped use. In order to create a variable on moped use, respondents were asked how often they generally use a moped. The survey offered six answer options, including 'Every day', 'More than once a week', 'Approximately once a week', 'More than once a month', 'Approximately once a month' and 'Less than once a month'. This data was constructed into a categorical moped use variable for the post-helmet obligation period, where 'Less than once a month' is valued 0, 'Approximately once a month' is valued 1, 'More than once a month' is valued 2, 'Approximately once a week' is valued 3 'More than once a

week' is valued 4 and 'Every day' is valued 5.

To construct a value for the moped use variable in the pre-helmet obligation period, respondents were asked how their current moped use differs from their moped use of before the helmet obligation. For this question, five options were given, with the option 'Much less often' valued at -2, the option 'Somewhat less often' at -1, the option 'Approximately just as much' at 0, the option 'Somewhat more often' at 1 and the option 'Much more often' at 2. By subtracting these values from the original moped use question values, a new value is computed for the quantity of moped use in the pre-helmet obligation period.

3.2.3 Driving behaviour

As mentioned in Section 3.1, the MRQ as designed by Steg and Van Brussel (2009) has been the basis of the variable driving behaviour. The eleven items that were used in this research can be found in Table 1.

Table 1 Situations of the MRQ used in the survey for this study

1. Not noticing a crossing pedestrian while turning into a side-street.
2. Cutting corners and briefly ending up on the wrong side of the road.
3. Not recognizing that you should have given way and almost getting into a collision as a result.
4. Not noticing you should drive on the main road instead of the bike path.
5. Deliberately driving faster than allowed in built-up areas.
6. Deliberately driving too close to someone in front of you.
7. Driving on the sidewalk as a shortcut.
8. Deliberately driving through a risky orange light or deliberately running a red light.
9. Deliberately driving in the wrong direction in a one-way street.
10. Driving a moped when you have consumed too much alcohol.
11. Driving a moped without wearing a helmet.

For each of these situations, the question was asked: "How often does the following situation occur when you drive a moped?" As answers, the following five options were allowed: "Never", "Hardly ever", "Sometimes", "Regularly" and "Almost always". Furthermore, after each item, the question is asked whether participants experience the described situations more, less or about the same number of times as before the implementation of the helmet obligation.

In order to create one variable for driving behaviour using these questions, I have given each option a value, where "Never" is valued 0, "Hardly ever" is valued 1 and so forth until "Almost always" is valued 4. For each individual, adding the values of all eleven items then gives their total score for driving behaviour, where the higher someone scores, the riskier and more dangerous their driving behaviour is. Therefore, when an individual would answer all questions with the option 'Never', they

would total the minimum score of 0 points. Consequently, when an individual would answer all questions with the option 'Almost always' they would total the maximum score of 44 points. As the question is posed as how often respondents currently experience certain situations, the added score of all items represents the driving behaviour of respondents after the implementation of the helmet obligation. In order to create a variable of one's driving behaviour before the implementation of the helmet obligation, I have also given values to the question on the difference in how often respondents experience those situations. Here, "Less" has been given value -1, "About the same" is valued 0 and "More" is valued 1. By subtracting these scores from the original scores, a new score can be computed, which then represents one's driving behaviour of before the implementation of the helmet obligation.

3.3 Sample

Between the start of the distribution of the survey on the 10th of June and the closing of the survey on the 9th of July, a total of 527 responses were collected. Of these 527 responses, 201 were only partially completed, and have therefore been deleted from the sample. Furthermore, out of the 326 completed responses, 63 respondents reported to not own a moped and to never have driven a shared moped, resulting in their deletion of the sample as well. Therefore, the total sample consists of 263 unique individuals that completed the survey, of which 252 individuals completed the survey in Dutch and 11 individuals completed the survey in English. Finally, 17 of these individuals reported to live in Amsterdam or Utrecht. These cities already had a partial helmet obligation in place, and therefore, the analysis will be conducted both with and without the inclusion of these participants, in order to check the robustness of the results.

3.3.1 Descriptive statistics

Table 2 shows the descriptive statistics of the full sample at baseline, i.e., the descriptive statistics of the sample, measured in the pre-helmet obligation period. At baseline, the dataset contains a total of 263 unique respondents. Every respondent was forced to fill out every question they were asked in the survey, so there will not be any missing values due to skipped questions.

The first variable presented is the variable female. This is a dummy variable taking value zero if the respondent is male and value one when the respondent is female. The mean value of this variable is 0.365, which indicates that 36.5% of the sample is female and the other 63.5% are male.

The next variable is the variable age. In the survey, respondents were asked to state their year of birth. The variable age was constructed by subtracting each individuals birthyear from 2022, the year prior to the introduction of the helmet obligation. This led to an age variable with a maximum age of

Table 2 Descriptives statistics of the sample at baseline

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Female	263	0.365	0.482	0	1
Age	263	25.452	7.987	16	58
Highest achieved education					
Primary school	263	0.011	0.106	0	1
Secondary school	263	0.141	0.348	0	1
MBO	263	0.163	0.371	0	1
HBO	263	0.327	0.470	0	1
Bachelor's degree	263	0.175	0.381	0	1
Master's degree	263	0.179	0.384	0	1
PhD	263	0.004	0.062	0	1
Employment status					
Student	263	0.285	0.452	0	1
Part-time employed	263	0.194	0.396	0	1
Full-time employed	263	0.471	0.500	0	1
Freelance	263	0.008	0.087	0	1
Job seeker	263	0.038	0.192	0	1
Unfit for work	263	0.004	0.062	0	1
Nationality					
Dutch	263	0.977	0.150	0	1
Indian	263	0.008	0.087	0	1
Indonesian	263	0.004	0.062	0	1
Italian	263	0.004	0.062	0	1
Lithuanian	263	0.004	0.062	0	1
Pakistani	263	0.004	0.062	0	1
Hometown					
Amsterdam region	263	0.049	0.217	0	1
Utrecht region	263	0.034	0.182	0	1
Nijmegen region	263	0.027	0.161	0	1
Rotterdam region	263	0.570	0.496	0	1
Eindhoven region	263	0.099	0.299	0	1
Delft region	263	0.046	0.209	0	1
Den Haag region	263	0.042	0.201	0	1
Enschede region	263	0.034	0.182	0	1
Groningen region	263	0.049	0.217	0	1
Leiden region	263	0.049	0.217	0	1
Moped variables					
Moped owner	263	0.369	0.483	0	1
Prefer yellow license plate	215	0.209	0.408	0	1
Have had a moped accident	263	0.319	0.467	0	1
Driving behaviour score	263	10.768	5.802	0	34
Moped use					
Less than once a month	263	0.095	0.294	0	1
About once a month	263	0.103	0.304	0	1
More than once a month	263	0.327	0.470	0	1
About once a week	263	0.137	0.344	0	1
More than once a week	263	0.148	0.356	0	1
Daily	263	0.190	0.393	0	1

58 and a minimum age of 16. This age below 18 is possible as the age at baseline is two years lower than an individual's age in period one, which is measured at the current day. Therefore, the youngest individual was 18 years old at the time of filling out the survey. Furthermore, the minimum age to get a moped driving license in the Netherlands is 16, indicating that this youngest individual was indeed eligible to ride a moped both before and after the introduction of the helmet obligation.

The mean value of the age variable is 25.452, indicating that the average age of the sample is just over 25 years old. The standard deviation of this variable is 7.987.

The next demographic variables are all categoric variables, split up in a dummy variable of each category. The first categorical variable is the variable highest achieved education. This variable has a total of 263 observations. The first category, primary school, has a mean value of 0.011, indicating that 1.1% of the sample has not followed more education than primary school. The mean value of the secondary school variable is 0.141, indicating that 14.1% of the sample's highest achieved education is secondary school. The mean value of the MBO category is 0.163, meaning that 16.3% of the sample has followed MBO education after secondary school, and the mean of the HBO category is 0.327, indicating that 32.7% of the sample has followed HBO education after secondary school. Next, the mean value of the category bachelor's degree is 0.175, indicating that 17.5% of the sample are in possession of a bachelor's degree. Furthermore, the mean value of the category master's degree is 0.179, indicating that 17.9% of the sample are in possession of a master's degree. Lastly, the category PhD has a mean value of 0.004, indicating that 0,4%, or one person, in the sample is in possession of a doctorate.

The next categorical variable is the variable employment status. For this variable, respondents are asked what type of employment status describes their current situation best. This variable has a total of 263 observations. Firstly, the category of student has a mean value of 0.285, indicating that 28.5% of the sample is currently still studying. The variable part-time employed has a mean value of 0.194 and the variable full-time employed has a mean value of 0.471, meaning that 19.4% of the sample is currently working part-time and 47.1% of the sample is currently working full-time. The category freelance has a mean value of 0.008, indicating that 0.8% of the sample engages in freelance work and the category job seeker has a mean value of 0.038, meaning that 3.8% of the sample is currently looking for a job. Lastly, the category unfit for work has a value of 0.004, indicating that 0.04% of the sample is unable to work a job.

The categorical variable nationality also has 263 observations. Here, the category Dutch has a mean value of 0.997, indicating that 97.7% of the sample has the Dutch nationality. The category Indian has mean value of 0.008, meaning that 0.08% of the sample has the Indian nationality. For the categories Indonesian, Italian, Lithuanian and Pakistani, all mean values equal 0.004, indicating that all these countries each represent 0.04% of the sample.

The next category variable describes where each respondent lives. In total, 26 different hometowns were reported in the survey. In the analysis, these 26 different values will be used, but for convenience, I have allocated all smaller and less mentioned hometowns to the ten most mentioned regions in the sample. This variable again has a total of 263 observations. First, the Amsterdam region has a mean value of 0.049, indicating that 4.9% of the sample lives in or close to the city of Amsterdam. Next, the Utrecht region contains a mean value of 0.034, meaning that 3.4% of the sample lives in or close to the city of Utrecht. The Nijmegen region has a mean value of 0.027, indicating that 2.7% of the sample lives in or close to the city of Nijmegen. Next, the Rotterdam region has a mean value of 0.570, meaning that 57.0% of the sample live in or close to the city of Rotterdam. Furthermore, the category of the Eindhoven region has a mean value of 0.099, indicating that 9.9% of the sample lives in or close to the city of Eindhoven. The Delft region has a mean value of 0.046, indicating that 4.6% of the sample lives in or close to the city of Delft. Furthermore, the The Hague region has a mean value of 0.042, meaning that 4.2% of the sample lives in or near the city of The Hague. The Enschede region has a mean value of 0.034, indicating that 3.4% of the sample lives in or close to the city of Enschede. Lastly, both the Groningen region and the Leiden region have a mean value of 0.049, indicating that both city regions each represent 4.9% of the whole sample.

Next, some variables have been described to gain a better understanding of the moped use of the sample at baseline. Firstly, the dummy variable moped owner is presented, taking value zero if a respondent does not own a moped, and value one if an individual does own a moped. The mean value of this variable is 0.369, indicating that 36.9% of the sample was in possession of a moped before the introduction of the helmet obligation.

Next, the dummy variable prefers yellow license plate is presented. This variable takes value zero if an individual has reported that they prefer to ride on a blue license plate moped, and value one when they prefer to ride on a yellow license plate moped. This variable contains only 215 observations. This is the case as the other 48 respondents have reported that they either have no preference or do not know what type of moped they prefer. These values are therefore not of interest for this research. The variable prefers yellow license plate has a mean value of 0.209, indicating that at baseline, 20.9% of the sample preferred to use yellow license plate mopeds.

The next dummy variable presented is 'have had a moped accident'. This variable takes value zero if an individual has never had a moped accident, either one-sided or with other traffic participants involved, and value one if an individual has ever had moped accident. This variable contains a mean value of 0.319, indicating that 31.9% of the sample has experienced a moped accident at least once. The variable driving behaviour score represents how risky and dangerous someone drives their moped, with value 0 meaning not risky at all and value 44 indicating very risky, all the time. The

minimum score of the sample is 0 and the maximum score is 34. The mean driving behaviour score of the sample equals 10.768, with a standard deviation of 5.802.

The last variable presented is the categorical variable moped use. This variable describes how often respondents use a moped at baseline. The first category, less than once a month, contains a mean value of 0.095, indicating that 9.5% does sometimes use a moped, but only less than once a month. The second category, about once a month, contains a value of 0.103, indicating that 10.3% of the sample uses a moped approximately once a month. The category more than once a month has a mean value of 0.327, indicating that 32.7% of the sample uses their moped less than weekly, but more than once a month. Next, the category about once a week has a mean value of 0.137, indicating that 13.7% of the sample makes use of a moped weekly. The category more than once a week contains a mean value of 0.148, indicating that 14.8% of the sample uses their moped at least twice a week, and the last category, daily, contains a mean value of 0.190, indicating that 19.0% of the sample uses their moped at least once a day.

3.4 Methodology

To estimate the effect of the helmet obligation on moped driving behaviour, I will analyse the data using a fixed effects estimation model. The fixed effect model is preferred over a random effects model, as it controls for all unobserved time-invariant heterogeneity by accounting for individual specific characteristics that are stable over time. Due to the choice to collect the data using a survey design, it is likely that there are unobserved traits that might influence one's driving behaviour that are not represented in the dataset. For example, personal attitudes towards risk taking and driving behaviour were not well measurable using this survey design, while these are highly likely to have an effect on one's driving behaviour. However, Vassallo et al. (2014) find a fair degree of stability in risky driving for young traffic participants and using a fixed effects estimation model will therefore account for unobserved characteristics like these.

The fixed effects model focusses on within-individual variation, which effectively removes the influence of time-invariant factors and isolates the impact of the helmet obligation on driving behaviours. While this does mean that the model cannot include time-variant variables in the estimation, this limitation is outweighed by the controlling for unobserved heterogeneity, which ensures more robust and unbiased estimates of the model.

A downside of the fixed effects model is the fact that the fixed effects estimator may have lower efficiency than a random effects model. A random effects model, however, relies on the assumption that the independent variables are uncorrelated with the error term. This assumption is very unlikely to hold. As mentioned before, the choice of using a survey design has led to the difficulty of measuring some variables. For example, while personal attitudes towards risk taking and driving

behaviour might be relatively stable over time, this can still affect the way how someone reacts and adapts to the helmet obligation. Using random effects estimation method will therefore very likely produce biased estimates. In the trade-off between efficiency and causality, causality is the more important factor, therefore justifying the choice of using a fixed effects model to estimate the effects of the moped helmet obligation on driving behaviours.

In order to test Hypothesis 1 and the first part of the Hypothesis 2, which suggests that blue license plate mopeds will become less attractive due to the helmet obligation, and consequently that yellow moped license plates will become more attractive due to the helmet obligation, Equations 1 and 2 will be estimated.

$$Typeofmoped_{it} = \alpha_i + \beta_1 Period_t + \varepsilon_{it} \qquad (1)$$

$$Mopeduse_{it} = \alpha_i + \beta_1 Period_t + \varepsilon_{it} \qquad (2)$$

Where $Mopeduse_{it}$ represents how often individual i uses their moped in period t, $Typeofmoped_{it}$ represents whether individual i drives a blue or yellow license plate moped in period t, α_i represents the individual fixed effects, $Period_t$ indicates whether the period is pre- or post-helmet obligation, β_1 measures the change in blue moped drivers due to the helmet obligation and ε_{it} represents the error term for individual i in period t. Both equations will be estimated to first show that blue license plate mopeds become less popular relative to yellow license plate mopeds, and consequently show that mopeds become less popular overall.

For the second part of Hypothesis 2 and for Hypothesis 3, which suggests that the increase in yellow license plate mopeds will increase in more dangerous traffic situations and that the helmet obligation will lead to more risky driving behaviour, Equation 3 will be estimated.

$$Drivingbehaviour_{it} = \alpha_i + \beta_1 Period_t + \beta_2 Typeofmoped_{it} + \beta_3 (Period_t \times Typeofmoped_{it}) + \varepsilon_{it} \ (3)$$

Where $Drivingbehaviour_{it}$ represents the driving behaviour score of individual i in period t, α_i represents the individual fixed effects, $Period_t$ indicates whether the period is pre- or post-helmet obligation, β_1 measures the effect of the helmet obligation on driving behaviour, β_2 measures the effect of the moped type of individual i in period t on their driving behaviour. β_3 measures the effect of the interaction term, which is estimated to assess whether there is a difference between the policy effect for blue license plate moped and yellow license plate moped drivers, indicating whether yellow moped drivers end up in more dangerous traffic situations. Lastly, ε_{it} represents the error term for individual i in period t. The results of Equations 1, 2 and 3 can be found in the next section.

4. Results

4.1 Fixed effects regression analyses

In order to analyse whether Hypothesis 1 holds, both Equation 1 and 2 are estimated. Hypothesis 1 stated the following: 'the blue license plate mopeds become less attractive and will be substituted for alternative modes of transport, such as the car, the bike, the yellow license plate mopeds or public transport.'

Table 3 Fixed effects regression results for the effect of the helmet obligation on type of moped choice

Variable	Coefficient
Post helmet obligation period	0.181**
	(0.026)
Constant	0.209**
	(0.019)
Observations	430
Individuals	215
R² within	0.181
R² overall	0.039

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

The results from Equation 1 can be found in Table 3. The model includes a total of 430 observations across over 215 individuals, with each individual being observed in both the pre-helmet obligation period and the post-helmet obligation period once. The coefficient for the constant term equals 0.209, with a standard error of 0.019, and is significant at the 1% level. This constant term represents the average individual value of the moped type variable in the pre-helmet obligation period, indicating that before the helmet obligation was implemented, 20.9% of the sample preferred to drive yellow license plate mopeds, and the other 79.1% of the sample preferred to drive blue license plate mopeds.

The coefficient for the post-helmet obligation variable equals 0.181, with a standard error of 0.026. This coefficient is significant at the 1% level. This result implies that the implementation of the helmet obligation has led to a significant increase of 18.1 percentage points of the proportion of the sample that prefers to drive yellow license plate mopeds, ceteris paribus.

This finding therefore proves that the first part of Hypothesis 1 holds, implying that blue license plate mopeds become less attractive, relative to yellow license plate mopeds. In order to assess whether

blue license plate mopeds have become less attractive overall as well, Equation 2 has been estimated. The results of this equation can be found in Table 4.

Table 4 Fixed effects regression results for the effect of the helmet obligation on quantity of moped use

Variable	Coefficient
Post helmet obligation period	-0.779**
	(0.061)
Constant	2.711**
	(0.043)
Observations	526
Individuals	263
R^2 within	0.387
R^2 overall	0.051

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

The model includes a total of 526 observations across over 263 individuals, with each individual being observed in both the pre-helmet obligation period and the post-helmet obligation period once. This model is, however, not interpretable, as the dependent variable is of categoric nature. The results from Equation 2 are still presented, as it does paint a picture of the intuition behind the reduction in moped use. The coefficient of the post-helmet obligation period is equal to -0.779, with a standard error of 0.061. This coefficient is significant at the 1% level. While the magnitude of this coefficient cannot be interpreted, this result does indicate that there is a significant reduction in moped use, ceteris paribus. Therefore, I can conclude that Hypothesis 1 holds, and blue license plate mopeds do indeed become less attractive. In the survey, participants were also asked what alternative transport modes they use instead of a moped. The answers to this question can be found in Table 6.

First, however, as the magnitude of the effect in Table 4 cannot be interpreted clearly, I have split the moped use variable up into dummy variables, which allows me to interpret the magnitude of the effect of the helmet obligation on moped use per category. The results of these estimations can be found in Table 5.

The results in Table 5 show what effect the post-helmet obligation period variable has within the moped use variable. Interestingly, there is no significant change in the 'more than once a week' and 'approximately once a week' categories. This is likely due to the fact that many respondents who were originally placed in these categories and reduced their moped use, are replaced by respondents who reduced their moped use from higher categories.

There is a significant reduction of 6.8 percentage points for people who use a moped every day and of 20.5 percentage points of people who use their moped once a month. Furthermore, there are significant increases in the 'approximately once a month' and 'less than once a month' categories, with respectively 7.2 percentage points and 23.2 percentage points.

Table 5 Fixed effects regression results for the effect of the helmet obligation on each dummy variable of quantity of moped use

	Less than once a month	Approx. once a month	More than once a month	Approx. once a week	More than once a week	Every day
Variable						
Post helmet obligation period	0.232**	0.072*	-0.205**	-0.023	-0.008	-0.068**
	(0.027)	(0.026)	(0.032)	(0.025)	(0.022)	(0.017)
Constant	0.095**	0.103**	0.327**	0.137**	0.148**	0.19**
	(0.019)	(0.019)	(0.023)	(0.018)	(0.016)	(0.012)
Observations	526					
Individuals	263					

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

This overview also provides an indication of which type of moped drivers were most affected by the helmet obligation policy, in terms of quantity of use. It is highly likely that respondents who drove a moped somewhat regularly, currently choose for an alternative more often, while respondents who drove their moped very regularly might have been affected somewhat by the helmet obligation, but still continue to drive their moped more often than the average person does.

Table 6 Descriptive statistics on the preferred alternative transport modes, as substitutions for mopeds

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
Car	141	0.390	0.490	0	1
Own bike	141	0.631	0.484	0	1
Shared bike	141	0.078	0.269	0	1
Public transport	141	0.539	0.500	0	1
Walking	141	0.043	0.203	0	1
Motorcycle	141	0.021	0.145	0	1
Taxi	141	0.007	0.084	0	1

Table 6 shows the alternatives to moped use that respondents generally choose. This question was answered by 141 individuals, who were allowed to choose multiple options. The results show that the car, one's own bike and public transport are the most popular alternative transport modes to mopeds, with 39.0% of the sample reporting they often use the car as alternative, 63.1% of the sample reporting they often use the bike as alternative and 53.9% of the sample reporting they often

use public transport as alternative. This again supports Hypothesis 1, where I predicted that these three modes of transport would be the most attractive as substitutes for blue license plate mopeds.

As the results from Equation 1 provide supportive evidence for Hypothesis 1, this implies that the first part of Hypothesis 2 is also supported. This hypothesis stated the following: 'the yellow license plate mopeds become more attractive, relative to the blue license plate mopeds, leading to more dangerous moped traffic experiences, as the overall speed is higher.' While we have seen that overall moped use has become less attractive due to the helmet obligation, it has led to a relative increase in attractiveness for yellow license plate moped, compared to blue license plate moped. Evidence for this is presented in Table 3 and has been discussed previously. In order to be able to state that Hypothesis 2 holds, however, I need to estimate what the effect is of using a yellow license plate moped on one's driving behaviour. This has been estimated with Equation 3, as discussed in Section 3.4. The results from Equation 3 can be found in Table 7.

Table 7 Fixed effects regression results for the effect of the helmet obligation on driving behaviours

Variable	Coefficient
Post helmet obligation period	0.145
	(0.200)
Yellow license plate moped	1.361**
	(0.501)
Interaction term (Period x Type of moped)	-0.634
	(0.396)
Constant	10.469**
	(0.152)
Observations	430
Individuals	215
R² within	0.037
R² overall	0.045

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

The variable of interest for Hypothesis 2 is the type of moped variable. This is a dummy variable that takes value zero for a blue license plate moped a value one for a yellow license plate moped. This variable represents the effect that driving a yellow license plate moped has on one's driving behaviour.

The constant of the driving behaviour score equals 10.469. This indicates that on average, someone scores 10.469 points out of the possible 44 points to be scored, ceteris paribus. The standard error of the constant is 0.152 and the constant is significant at the 1% level. The coefficient of the variable of

interest, type of moped, equals 1.361, with a standard error of 0.501. This coefficient is significant at the 1% level. This should be interpreted as that driving a yellow license plate moped significantly increases one's risky and dangerous driving behaviour with 1.361 points on the developed scale, compared to when that individual would be driving a blue license plate moped, ceteris paribus. These results are consistent with the findings of Aarts and Van Schagen (2006). They find that driving faster increases the risk of accidents. As the only difference between yellow mopeds and blue moped is their speed limit, and yellow moped drivers report significantly higher scores for their risky and dangerous driving behaviour, one can conclude that the higher speeds of yellow moped drivers lead to more risky and dangerous traffic situations, and consequently conclude that Equations 1 and 3 provide evidence that Hypothesis 2 holds as well.

Interesting to note here is the included interaction term. This interaction term of the post-helmet obligation period and the type of moped illustrates whether the effect of the helmet obligation differs between the yellow and blue license plate mopeds. The coefficient of the interaction term equals -0.634, with a standard error of 0.396. This should be interpreted as that the effect of the helmet obligation leads to a 0.634 point lower increase in risky and dangerous driving behaviour for yellow license plate moped drivers than for blue license plate moped drivers, ceteris paribus. This effect is, however, not significant at the 5% level and does therefore not significantly differ from zero. The increase in risky and dangerous driving behaviour of yellow moped drivers can therefore be solely attributed to the difference in speed between the two types of mopeds, and the helmet obligation itself does not contribute to this increase significantly.

Table 7 also provides the necessary information to analyse whether Hypothesis 3 holds. This hypothesis was formulated as follows: 'the implementation of the mandatory helmet law leads to more reckless driving behaviour, i.e. drivers are exposed to the risk compensation hypothesis'. The variable of interest for Hypothesis 3 is the variable post-helmet obligation period, which takes value zero when the period is pre-helmet obligation and value one when the period is post-helmet obligation. Again, the constant of the driving behaviour score equals 10.469. This indicates that on average, someone scores 10.469 points out of the possible 44 points to be scored, ceteris paribus. The standard error of the constant is 0.152 and the constant is significant at the 1% level. The coefficient of the post-helmet obligation period variable equals 0.145, with a standard error of 0.200. This can be interpreted as that the introduction of the helmet obligation increases the risky and dangerous driving behaviour of moped drivers with 0.145 points on the developed scale, ceteris paribus. This coefficient is, however, not significant at the 5% level, indicating that the effect does not significantly differ from zero. Furthermore, the interaction effect between the time period and the type of moped is not significant at the 5% as well. The coefficient equals -0,634, indicating that due to

the helmet obligation, blue license plate moped drivers face an increase of 0.634 points on the developed driving behaviour scale, relative to yellow license plate moped drivers. This result might seem counterintuitive, but it does actually make quite some sense. This is the case as for yellow license plate mopeds drivers, the helmet obligation has made effectively no difference, as moped drivers were already obligated to wear a helmet on these types of mopeds before the first of January 2023. The fact that the interaction term is insignificant, however, proves that the helmet obligation has had no significant effect on driving behaviour for blue license plate moped drivers as well, indicating that moped drivers are not driving more reckless because of the helmet obligation. Both yellow and blue license plate moped drivers are therefore not exposed to the risk compensation hypothesis, and I can conclude that Hypothesis 3 does not hold.

4.2 Robustness checks

As mentioned before, the cities of Amsterdam and Utrecht already had a partial helmet obligation in place, before the first of January 2023. Therefore, it might be the case that these cities have caused some sort of bias in the results of Section 4.1. To check whether the results of Equations 1, 2 and 3 are robust to the potential biases these hometowns might have caused, all equations have been estimated again, excluding respondents who reported to live in either the city of Amsterdam or the city of Utrecht.

Table 8 Fixed effects regression results for the effect of the helmet obligation on type of moped choice, excluding observations from Amsterdam and Utrecht

Variable	Coefficient
Post helmet obligation period	0.176**
	(0.027)
Constant	0.185**
	(0.019)
Observations	398
Individuals	199
R² within	0.176
R² overall	0.039

Standard errors are in parentheses; * p<0.05, ** p<0.01.

The results of Equation 1, excluding respondents living in Amsterdam or Utrecht, can be found in Table 8. In total, this leads to a reduction of 32 observations, among 16 individuals, leaving the estimation done with 398 observations. The constant is equal to 0.185, with a standard error of 0.019. The constant is significant at the 1% level. The coefficient for the post-helmet obligation period is equal to 0.176, with a standard error of 0.027. This coefficient is significant at the 1% level.

Comparing the results with and without the inclusion of Amsterdam and Utrecht, I see that, while the significance of the results does not change, both the constant and the effect of the helmet obligation on type of moped choice both decrease somewhat in magnitude. This is the case as the proportion of yellow license plate mopeds was much higher in Amsterdam and Utrecht before the helmet obligation than in the rest of the Netherlands, likely due to the fact that there was already a partial helmet obligation in place in those cities. Running an f-test to see whether the effect of the helmet obligation on the type of mopeds used is different when excluding the cities of Amsterdam and Utrecht gives a value of 0.462. Therefore, the effect of the helmet obligation does not differ significantly when Amsterdam and Utrecht are excluded, and Equation 1 is robust to the potential biases the inclusion of these cities would cause.

Table 9 Fixed effects regression results for the effect of the helmet obligation on quantity of moped use, excluding observations from Amsterdam and Utrecht

Variable	Coefficient
Post helmet obligation period	-0.801**
	(0.064)
Constant	2.683**
	(0.045)
Observations	492
Individuals	246
R^2 within	0.393
R^2 overall	0.055

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

The results of Equation 2 can be found in Table 9. Again, the same phenomenon as with Equation 1 occurs. While the significance of the post-helmet obligation variable stays the same, significant at the 1% level, its coefficient changes to -0.801, with a standard error of 0.064. The magnitude of the effect has increased somewhat when excluding the cities of Amsterdam and Utrecht. This can again be attributed to the partial helmet obligation that was already in place in those cities. For residents from the cities of Amsterdam and Utrecht, effectively nothing did change at the first of January 2023, in terms of wearing a helmet on their moped. Therefore, it is also to be expected that in terms of changes in moped use, not much would change after the national helmet obligation. Therefore, when excluding these cities, it makes sense that the effect on moped use becomes larger. However, running an f-test to see whether the effect of the helmet obligation on quantity of moped use is different when excluding the cities gives a value of 0.181. Therefore, the effect of the helmet obligation does

not differ significantly when Amsterdam and Utrecht are excluded, and Equation 2 is robust to the potential biases the inclusion of these cities would cause.

Table 10 Fixed effects regression results for the effect of the helmet obligation on driving behaviours, excluding observations from Amsterdam and Utrecht

Variable	Coefficient
Post helmet obligation period	0.142
	(0.206)
Yellow license plate moped	1.181*
	(0.548)
Interaction term (Period x Type of moped)	-0.466
	(0.434)
Constant	10.403**
	(0.155)
Observations	398
Individuals	199
R^2 within	0.029
R^2 overall	0.052

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

The results of Equation 3 can be found in Table 10. Here, the coefficient of the type of moped variable decreases to 1.181, with a standard error of 0.548. The significance of the coefficient has also reduced a bit, and is now only significant at the 5% level. The fact that the magnitude of the effect decreases after excluding the cities of Amsterdam and Utrecht can likely not be attributed to the helmet obligation that was already in place in those cities. The already implemented policy would be more likely to cause stability over time, as individuals are more experienced with faster mopeds due to the policy. This is, however, not the case, as the magnitude of the effect decreases when Amsterdam and Utrecht are excluded. Therefore, this decrease is likely caused by the fact that big cities as Amsterdam and Utrecht cause more risky and dangerous driving behaviour, as it is more dangerous to drive in such big, crowded cities. Thus, this change in magnitude can likely be attributed to city size rather than to the already existing helmet obligation. Furthermore, conducting an f-test on the coefficients gives a f-value of 0.480, indicating that there is no significant difference between the coefficients after omitting the cities of Amsterdam and Utrecht.

As for the post-helmet obligation period variable, the coefficient is 0.142, with a standard error of 0.206. This variable is not significant at the 5% level. This coefficient does only differ 0.003 from the coefficient where Amsterdam and Utrecht were included, indicating that the driving behaviour score was roughly constant over time in those cities. This is not an unexpected outcome, as the helmet

obligation was already partly implemented in the cities of Amsterdam and Utrecht. The post-helmet obligation period variable should therefore have no effect in this cities, as the effect should have occurred when the policy was implemented. Furthermore, the f-test on the difference between the two coefficient resulted in a f-statistic of 0.926, indicating that there is no significant difference between the two coefficients.

Lastly, the magnitude of the coefficient of the interaction term decreases as well, where the coeffient now equals -0.466, with a standard error of 0.434. This coefficient is not significant at the 5% level. The decrease in magnitude is no surprise, as we have seen that the type of moped coefficient has decreased in magnitude as well. Therefore, the same reasons as discussed for the decrease in Table 9 apply here, as it is likely that more crowded cities lead to more risky and dangerous driving behaviours. The f-statistic on the difference between the interaction effect with and without the cities of Amsterdam and Utrecht equals 0.484, indicating that there is no significant difference between these coefficients as well. Equation 3 is therefore also robust to the potential biases that the inclusion of the inclusion of the cities of Amsterdam and Utrecht might have caused, and the already existing helmet obligation in these cities have had no significant effect on the results of this thesis.

4.3 Gender heterogeneity checks

In Section 1, I have discussed the works of Messiah et al. (2012), who find that males are more likely to be exposed to the risk compensation hypothesis than females. While I do not find any evidence for the existence of the risk compensation hypothesis for helmeted moped drivers in this thesis, this might be due to some gender heterogeneity in the data that has not been controlled for. Therefore, in order to fully understand the effects that the helmet obligation might have, I will estimate Equations 1, 2 and 3 again, now while interacting the gender variable with all variables of interest. A significant interaction term including the gender variable would indicate that that particular effect, i.e. post-helmet obligation period or yellow type of moped preference, is significantly different between men and women. The results of these equations can be found in Tables 11, 12 and 13.

Just as in Section 4.1, the coefficient of the constant equals 0.209, with a standard error of 0.019, and is significant at the 1% level. This constant term represents the average individual value of the moped type variable in the pre-helmet obligation period, indicating that before the helmet obligation was implemented, 20.9% of the sample preferred to drive yellow license plate mopeds, and the other 79.1% of the sample preferred to drive blue license plate mopeds.

The coefficient of the post-helmet obligation period equals 0.235, with a standard error of 0.033 and is significant at the 1% level. Due to the included interaction term, this can be interpreted as that the implementation of the helmet obligation has led to a significant increase of 23.5 percentage points of

the proportion of males in the sample that prefer to drive yellow license plate mopeds, ceteris paribus.

Table 11 Fixed effects regression results for the effect of the helmet obligation on type of moped choice, with the inclusion of an interaction term to test the differences between males and females

Variable	Coefficient
Post helmet obligation period	0.235**
	(0.033)
Interaction term (Period x Female)	-0.147**
	(0.054)
Constant	0.209**
	(0.018)
Observations	430
Individuals	215
R² within	0.209
R² overall	0.060

Standard errors are in parentheses; * p<0.05, ** p<0.01.

The increase in yellow license plate moped preference for females is represented by the interaction term. The coefficient of the interaction term equals -0.147, with a standard error of 0.054 and is significant at the 1% level. This result indicates that for females, the increase in yellow license plate moped preference due to the helmet obligation is 14.7 percentage points lower than for males. The helmet obligation therefore has a significantly different effect on moped type preferences between men and women., where or men, there has been a significantly larger increase in yellow license plate type moped preference than for women. This result is not surprising, as yellow license plate mopeds are more dangerous than blue license plate mopeds. Combining the findings of Aarts en Van Schagen (2006), who find that driver faster brings leads to an increased crash risk, and Messiah et al. (2012), who find that men take significantly larger risks in traffic than women, it is to be expected that men are keener to use faster vehicles than women, and therefore that this substitution effect that the helmet obligation has caused is significantly larger for males than for females.

The results of Equation 2, with the inclusion of a gender interaction term, can be found in Table 12. Here, the coefficient of the constant equals 2.711, with a standard error of 0.43. The constant term is significant at the 1% level. Again, due to the categoric nature of the dependent variable quantity of moped use, the coefficients of this equation are hard to interpret. In order to be able to test whether there is a difference between the effect of the helmet obligation on quantity of moped use for men

and women, the significance of the coefficients is important.

Table 12 Fixed effects regression results for the effect of the helmet obligation
on quantity of moped use, with the inclusion of an interaction term to test
the differences between males and females

Variable	Coefficient
Post helmet obligation period	-0.838**
	(0.076)
Interaction term (Period x Female)	0.161
	(0.126)
Constant	2.711**
	(0.043)
Observations	526
Individuals	263
R² within	0.391
R² overall	0.051

Standard errors are in parentheses; * p<0.05, ** p<0.01.

The coefficient of the post-helmet obligation period equals -0.838, with a standard error of 0.076. This coefficient is significant at the 1% level, indicating that the helmet obligation has led to a significant reduction in quantity of moped use. The coefficient of the interaction term equals 0.161, with a standard error of 0.126. This coefficient is not significant at the 5% level. This indicates that, while women reduce their moped use somewhat less than men due to the helmet obligation, this difference in reduction is not significant, and the helmet obligation yields no different effects for men and women in terms of quantity of moped use.

The results of Equation 3, with the inclusion of gender interaction terms, can be found in Table 13. The coefficient of the constant term equals 10.484, with a standard error of 0.155. This coefficient is significant at the 1% level. This should be interpreted that, in the pre-helmet obligation period, the average driving behaviour score of the sample was 10.484 on the developed scale. The coefficient of the post-helmet obligation period equals 0.130, with a standard error of 0.255. This coefficient is not significant at the 5% level, indicating that the helmet obligation itself had no significant effect on risky driving behaviour. The coefficient of the interaction term between the period and the gender variable equals 0.341, with a standard error of 0.355. This coefficient is not significant at the 5% level, which indicates that while the helmet obligation has led to a slightly larger increase in risky driving

behaviour for women than for men, this difference is, however, not significant and the helmet obligation itself had no different effects for men and women.

Table 13 Fixed effects regression results for the effect of the helmet obligation on driving behaviours, with the inclusion of an interaction term to test the differences between males and females

Variable	Coefficient
Post helmet obligation period	0.130
	(0.255)
Yellow license plate moped	1.468**
	(0.543)
Interaction term (Period x Type of moped)	-0.629
	(0.400)
Interaction term (Period x Female)	0.034
	(0.355)
Interaction term (Type of moped x Female)	-0.574
	(1.023)
Constant	10.484**
	(0.155)
Observations	430
Individuals	215
R² within	0.039
R² overall	0.053

Standard errors are in parentheses; * $p<0.05$, ** $p<0.01$.

Furthermore, the coefficient of the prefers yellow license plate variable equals 1.468, with a standard error of 0.543. This coefficient is significant at the 5% level, indicating that driving a yellow license plate moped on average leads to an increase of 1.468 points on the developed driving behaviour scale, relative to driving a blue license plate moped. The coefficient of the interaction term between the type of moped and gender variables equals -0.574, with a standard error of 1.023. This coefficient is not significant at the 5% level. This implies that while driving a yellow license plate moped leads to a slightly higher risky driving behaviour score for men than for women, this difference is not significant and driving a faster moped does not yield a different effect on risky driving behaviour for men and women.

5. Discussion

5.1 Interpretation of results

In this thesis, I study the effects of the helmet obligation policy in the Netherlands on driving behaviour. I find that the policy leads to significant substitution effects, where the blue license plate moped becomes a less attractive transport mode, as it is often replaced by other transport modes, such as the car, the bike and public transport. Furthermore, I find that the yellow license plate moped becomes significantly more attractive, relative to the blue license plate moped. Likely this is the case because many individuals made the choice to drive a blue license plate moped before the helmet obligation policy, for the sole reason of not having to wear a helmet. After the first of January, this reason was no longer relevant, and people choose more often for the yellow license plate mopeds. The most likely reason for this substitution is the fact that yellow license plate mopeds can travel 20 km/h faster than blue license plate mopeds, which often saves a lot of time when choosing to travel by moped. This substitution effect is significantly larger for males than for females, indicating that men are less reluctant to drive at high speeds, which is consistent with the findings of Messiah et al. (2012).

In this thesis, I do, however, also find that this substitution comes with a significant increase in risky and dangerous driving behaviour. This is consistent with the findings of Aarts en Van Schagen (2006), who find that driving faster comes with an increased crash risk. While I do not have data on the number of crashes before and after the helmet obligation, the fact that respondents report to drive significantly riskier and more dangerous on faster mopeds indicates that their crash risk is higher as well.

I do not find evidence that the helmet obligation policy leads to exposure to the risk compensation hypothesis. While the current literature is divided on whether wearing a helmet increases someone's risk taking level, some researches do find evidence for it. For example, Dee (2009) finds that an x% increase in helmet use for motorcyclists leads to a <x% decrease in traffic fatalities and injuries, indicating that part of the benefit of helmet wearing is offset by an increase in risky and dangerous driving behaviour. Furthermore, Carpenter and Stehr (2011) find that mandatory bicycle helmet wearing for children leads to both a decrease in youth that rides a bike and an increase in risk taking for the youth when they do ride a bike. However, whether moped helmets increase risk taking for moped drivers had not been researched yet. In this research, I do not find evidence that moped drivers take more risk after the introduction of the helmet obligation. For both blue license plate and yellow license plate moped drivers, their score on risky and dangerous driving behaviour does not change significantly after the first of January 2023.

This thesis therefore only finds evidence that the helmet obligation indirectly influences driving

behaviour, as the helmet obligation leads to the substitution from blue license plate to yellow license plate mopeds, and the use of yellow license plate mopeds increases risky and dangerous driving behaviour.

5.2 Internal validity

As discussed in Section 3.4, I have used a fixed effects model to estimate the effects of the helmet obligation. This model produces causal estimates when there has been accounted for all time-variant factors that influence the dependent variable. This is, however, not likely to be the case in this thesis. For example, stress and fatigue levels are factors that can differ between each time someone drives a moped, and can therefore cause omitted variable bias in this research.

Furthermore, due to the fact that the used data was collected via a survey, several other biases might occur. Firstly, it is likely that the sample suffers from selection bias. All respondents were reached via either my own network or the network of the Instagram page Strooiscooters010. It is likely that this has led to a nonresponse bias, as respondents from my own network mostly have filled out the survey to do me a favour, and respondents from the Strooiscooter010 network have likely filled out the survey to help an unknown person, which can be seen as altruism. People who have not filled out the survey are likely to be less altruistic than everyone who did fill out the survey, which can lead to a bias. Furthermore, due to the fact that the survey is distributed via only two networks, the sample is not a good representative of the total Dutch population, leading to a sampling bias as well. Another bias that is likely to occur because of the survey is a recall bias. As I ask questions about someone's behaviour of around two years ago, it is likely that respondents do not recall perfectly how they behaved back then. For this reason, I have only used the before and after the helmet obligation periods, but it is still the case that people recall their current behaviour much better than their behaviour from two years ago, which might have led to inaccurate data for the pre-helmet obligation period. Furthermore, in the survey I ask questions on risky and dangerous behaviour. As this is likely to be perceived as negative, respondents may have answered some questions in a socially acceptable way. While I have explicitly stated in the survey that all answers all anonymous and that there will be no consequences to socially unacceptable answers, it can still not be ruled out that people have presented themselves as less risky or dangerous than they actually are, resulting in a potential social desirability bias as well.

Lastly, the results might be biased due to the short recorded time period. While Ballart and Riba (1995) find that the impact of a policy such as the helmet obligation is abrupt and permanent, which indicates that having one time period for the post-helmet obligation period is sufficient, it would benefit the variability of the data and the statistical power of the analysis when more pre-helmet obligation periods would be included. Furthermore, this would create the possibility to perform a

trend analysis and to use of a difference-in-difference model to analyse the data, which would be a better fit to analyse the true causal effect of the helmet obligation on driving behaviour.

5.3 External validity

Since the results of this thesis are possibly biased, there is cause to doubt the internal validity of this study, which decreases the relevance of the external validity. The results of this thesis are, however, to some extent externally valid. Lepard et al. (2021) find similar effects for mandatory motorcycle helmet legislation among high-income countries. When traffic characteristics of these high-income countries are comparable to the Netherlands, in terms of similar types road users, similar amounts of road users, road quality, etc., the results from this thesis are likely to be similar for samples from those countries. Generalizing the results of this thesis should therefore be done cautiously, but the results of this thesis might have some predictive power for other high-income countries as well.

5.4 Recommendations for future research

As discussed in Section 5.2, there are some concerns whether the results of these thesis can be interpreted as causal estimates. Therefore, future research should try to provide a more accurate and unbiased estimation of the effect of the helmet obligation on driving behaviour. For starters, future research should work with a larger sample that is representative of the Dutch moped driver population. Furthermore, the used data should be collected over a longer period of time, including several years before the introduction of the helmet obligation, in order to be able to do a trend analysis and conduct a difference-in-difference estimation method to find the true causal effects. The preferred type of data collection might also be different than using a survey design, as this would prevent many of the biases in this thesis from occurring. By monitoring revealed preferences from study participants or with the use of public data on accidents and fatalities, the data would be less sensitive to biases and the results from the analyses would be more reliable.

Lastly, future research should dive more into the heterogeneity in the potential effect of the helmet obligation and other driving behaviours. In this thesis, all time-invariant factors were not included in the analysis. Therefore, by including (semi) time-invariant factors such as gender, education, city size, road quality, etc., more interesting and relevant insights can be gathered, which can be a big asset for future policy making.

Overall, it is difficult to draw conclusions on whether the helmet obligation is a successful policy, based on this research. I have provided evidence that the helmet obligation has led to a reduction in moped use and to a substitution effect, where yellow license plate mopeds have seen a relative increase in usage and blue license plate mopeds a relative decrease in usage. This is likely to be an unintended consequence of the helmet obligation policy, as yellow license plate mopeds can drive faster than blue license plate mopeds, which, as discussed, leads to more dangerous traffic situations

and more risky and dangerous driving behaviour. Whether this unintended, negative effect of the helmet obligation outweighs the intended, positive effect of the reduction in quantity of moped use cannot be determined without data on traffic accidents, injuries and fatalities. As wearing a helmet generally increases one's safety on the moped, data on how the number of traffic accidents, injuries and fatalities have changed after the implementation of the helmet obligation is vital in determining whether the helmet obligation is an appropriate and effective policy. Future research should therefore aim to collect this data and try to draw conclusions on the appropriateness and effectiveness of the helmet obligation policy accordingly.

6. Conclusion

In the Netherlands, as of the first of January 2023, it is mandatory to wear a helmet on blue license plate type mopeds. This helmet obligation was an addition to the already existing helmet obligation for yellow license plate type mopeds. This thesis aimed to find the effects that the introduced helmet obligation has on driving behaviours.

The data for this thesis was collected using a survey design, distributed amongst my own network and the network of the Instagram page Strooiscooters010. The retrieved data was analysed using a fixed effects model, estimating the effects of the helmet obligation on quantity of moped use, type of moped use and risky and dangerous driving behaviours.

I find that the helmet obligation has led to a significant substitution effect, making blue license plate mopeds a less attractive mode of transport. These types of mopeds have been substituted mainly for cars, bikes and public transport. Furthermore, yellow license plate mopeds have become a significantly more attractive mode of transport, relative to the blue license plate mopeds. This substitution effect is even larger for men than for women. I find that this increase in yellow license plate moped use also results into more risky and dangerous driving. The yellow license plate moped type has a significant positive effect on the developed scale of risky and dangerous driving behaviour. The helmet obligation itself has no significant effect on risky and dangerous driving behaviour. After the first of January 2023, there are no significant changes on the driving behaviour scale due to the fact that individuals are now obligated to wear a helmet. An interaction term between the period and type of moped yielded no significant effect as well, indicating that helmet obligation had no significantly different effect on blue license plate and yellow license plate mopeds. The helmet obligation therefore only has had a significant indirect effect on risky and dangerous driving behaviour on mopeds, which runs through the positive substitution effect it had on yellow license plate type mopeds.

Future research should focus on reducing the concerns of bias in the analysis. By collecting survey data from a more representative sample or by using public moped accident and fatality data, some concerns that arise about the current sample can be taken away. Furthermore, future research should collect data on more periods of time before the first of January 2023. This way, a trend analysis can be done and the causal effect can be estimated using a difference-in-difference estimation method, which is likely to produce more causal estimates for this type of policy evaluations. Lastly, future research should increase the focus on the potential heterogeneity within the effect of the helmet obligation, providing more relevant insights on what the true causal effect of the helmet obligation is on driving behaviour. This way, more understanding can be gained on what the true effects of the helmet obligation policy are, which can help shape and evaluate any future policy on traffic safety.

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8. Appendix

Survey questions

Dear participant,

Thank you for taking part in this survey!

For my master's thesis, I am researching **the effect that the helmet obligation has on people's driving behaviour on their mopeds.** This helmet obligation refers to the legislative change that went into effect on January 1st, 2023, which mandates that people on mopeds with a blue license plate must also wear a helmet while driving.

To research this, I will ask a number of questions about your moped use and driving behaviour over the past few years. Please note that all responses are completely anonymous and will only be used for scientific purposes. Responses cannot be traced back to you in any way, so please be as honest as possible.

Your results will not be included if you do not complete the survey in its entirety. You have the right to stop the survey at any time and your participation is completely voluntary. By proceeding, you give your consent for your responses to be used in this research.

P.S: This survey contains credits to get free survey responses at SurveySwap.io

Do you currently own a moped?

○ Yes (1)

○ No (2)

Did you already own this or another moped prior to the first of January 2023 (introduction of the helmet obligation)?

○ Yes (1)

○ No (2)

What is the speed limit on your moped?

○ 45 km/h (1)

○ 25 km/h (2)

Is this limit higher or equal to the speed limit of your moped prior to the first of January 2023 (introduction of the helmet obligation)?

○ Equal, the limit is still 45 km/h (1)

○ Higher, I have purchased a new moped with a limit of 45 km/h (2)

○ Higher, I have modified my moped to increase its speed to 45 km/h (3)

How often do you generally use your moped?

○ Every day (1)

○ More than once a week (2)

○ Approximately once a week (3)

○ More than once a month (4)

○ Approximately once a month (5)

○ Less than once a month (6)

Do you, on average, use your moped more or less than before the first of January 2023 (introduction of the helmet obligation)?

○ Much more often (1)

○ Somewhat more often (2)

○ Approximately just as much (3)

○ Somewhat less often (4)

○ Much less often (5)

End of Block: Use of moped

Start of Block: Why less moped use?

Why do you make less use of your moped since the first of January 2023 (introduction of the helmet obligation)? (Possible to choose multiple answers)

- ☐ I rather not drive wearing a helmet (1)

- ☐ I have less need for my moped (2)

- ☐ It has become easier for me to make use of other modes of transport (3)

- ☐ The moped has become too expensive for me (4)

- ☐ Other, namely (5) _____

Which alternative transport modes do you now use more often, instead of the moped? (Possible to choose multiple answers)

- ☐ Car (1)

- ☐ My own bike (2)

- ☐ Shared bikes (3)

- ☐ Shared mopeds (4)

- ☐ Public transport (5)

- ☐ Other, namely (6) _____

End of Block: Why less moped use?

How often does the following situation occur when you drive a moped?

Not noticing a crossing pedestrian while turning into a side-street.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

How often does the following situation occur when you drive a moped?

Cutting corners and briefly ending up on the wrong side of the road.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

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How often does the following situation occur when you drive a moped?

Not recognizing that you should have given way and almost getting into a collision as a result.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

How often does the following situation occur when you drive a moped?

Not noticing you should drive on the main road instead of the bike path.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

Page Break

How often does the following situation occur when you drive a moped?

Deliberately driving faster than allowed in built-up areas.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

How often does the following situation occur when you drive a moped?

Deliberately driving too close to someone in front of you.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

Page Break

How often does the following situation occur when you drive a moped?

Driving on the sidewalk as a shortcut.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

How often does the following situation occur when you drive a moped?

Deliberately driving through a risky orange light or deliberately running a red light.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

How often does the following situation occur when you drive a moped?

Deliberately driving in the wrong direction in a one-way street.

○ Never (1)

○ Hardly ever (2)

○ Sometimes (3)

○ Regularly (4)

○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

○ More (1)

○ Less (2)

○ Just as often (3)

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How often does the following situation occur when you drive a moped?

Driving a moped when you have consumed too much alcohol.

- ○ Never (1)

- ○ Hardly ever (2)

- ○ Sometimes (3)

- ○ Regularly (4)

- ○ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

- ○ More (1)

- ○ Less (2)

- ○ Just as often (3)

How often does the following situation occur when you drive a moped?

Driving a moped without wearing a helmet.

    ◯ Never (1)

    ◯ Hardly ever (2)

    ◯ Sometimes (3)

    ◯ Regularly (4)

    ◯ Almost always (5)

Do you experience the described situation generally more, less or about the same amount of times in the past year and a half compared to the period before the first of January 2023 (introduction of the helmet obligation)?

    ◯ More (1)

    ◯ Less (2)

    ◯ Just as often (3)

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I feel safer when I wear a helmet on the moped.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

I find wearing a moped helmet comfortable.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

I encounter dangerous traffic situations more often now that I have to wear a helmet as a standard.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

I take more risks on the moped now that I have to wear a helmet as a standard.

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

End of Block: Driving behaviour questions

Start of Block: Accident

Have you ever had an accident or fallen off the moped?

○ Yes, I have had an accident on the moped (1)

○ No, I have never had an accident on the moped (2)

End of Block: Accident

Start of Block: Helmet accident

Were you wearing a helmet during this accident?

○ Yes, I was wearing a helmet (1)

○ No, I was not wearing a helmet (2)

Have you ever owned a moped and sold it between now and January 1, 2023 (the introduction of the helmet obligation)?

○ Yes (2)

○ No (3)

Why have you sold that moped? (Possible to choose multiple answers)

☐ I didn't need it anymore (1)

☐ It became too expensive (2)

☐ I didn't want to drive wearing a helmet (3)

☐ I make use of more sustainable alternatives (4)

☐ I wanted to become more active (5)

☐ Other, namely (6) _____

Have you ever used a shared moped?

○ Yes (2)

○ No (3)

How often do you generally use a shared moped?

○ Every day (1)

○ More than once a week (2)

○ Approximately once a week (3)

○ More than once a month (4)

○ Approximately once a month (5)

○ Less than once a month (6)

Do you generally make use of shared mopeds with a yellow license plate (45 km/h) or with a blue license plate (25 km/h)?

○ Mostly yellow license plate (1)

○ Mostly blue license plate (2)

○ About the same (3)

○ I don't know (4)

Did you already mainly use yellow license plate shared mopeds before the first of January 2023 (introduction of the helmet obligation)?

○ Yes, I always mainly used yellow license plate mopeds (1)

○ No, before the first of January 2023 I mainly used blue license plate mopeds (2)

Why did you start using yellow license plate mopeds more? (Possible to choose multiple answers)

☐ My driving skills have improved, allowing me to drive at higher speeds (1)

☐ If you have to wear a helmet anyway, I like to use a faster moped (2)

☐ I generally drive on faster roads, which makes a faster moped more useful (3)

☐ Other, namely (4) _____

Do you generally make more or less use of shared mopeds than before the first of January 2023 (introduction of the helmet obligation)?

○ Much more (1)

○ Somewhat more (2)

○ About the same (3)

○ Somewhat less (4)

○ Much less (5)

Why do you make less use of shared mopeds since the first of January 2023 (introduction of the helmet obligation)? (Possible to choose multiple answers)

☐   I rather not drive wearing a helmet (1)

☐   I have less need for a moped (2)

☐   It has become easier for me to make use of other modes of transport (3)

☐   The moped has become too expensive for me (4)

☐   Other, namely (5) _____

Which alternative transport modes do you now use more often, instead of the shared moped? (Possible to choose multiple answers)

☐   Car (1)

☐   My own bike (2)

☐   Shared bikes (3)

☐   Public transport (4)

☐   Other, namely (5) _____

What is your gender?

○ Male (1)

○ Female (2)

○ Non-binary / third gender (3)

○ Prefer not to say (4)

✳

What is your year of birth?

_____

What is your highest level of completed education?

○ I have no education (1)

○ Primary school (2)

○ Secondary school (3)

○ MBO (4)

○ HBO (5)

○ Bachelor's degree (6)

○ Master's degree (7)

○ Other, namely (8) _____

What is your current employment status?

○ Full-time employed (1)

○ Part-time employed (2)

○ Job seeker (3)

○ Retired (4)

○ Student (5)

○ Other, namely (6) _____

What is your nationality?

○ Dutch (1)

○ Other, namely (2) _____

In what city do you live?

○ Rotterdam (1)

○ Amsterdam (2)

○ Delft (3)

○ Leiden (4)

○ Utrecht (5)

○ Groningen (6)

○ Wageningen (7)

○ Eindhoven (8)

○ Other, namely (9) _____

End of Block: Demographics

Survey flow

Block: Language choice (1 Question)   64

Branch: New Branch
    If
        If Do you wish to complete this survey in Dutch or in English? English Is Selected

Standard: Start story (1 Question)
Standard: Moped ownership English (1 Question)

Branch: New Branch
    If
        If Do you currently own a moped? Yes Is Selected

Block: Period of moped ownership (1 Question)
Block: Moped speed limit (1 Question)

Branch: New Branch
    If
        If What is the speed limit on your moped? 45 km/h Is Selected

Block: Different speed (1 Question)

Block: Use of moped (2 Questions)

Branch: New Branch
    If
        If Do you, on average, use your moped more or less than before the first of January 2023 (introducti... Somewhat less often Is Selected
        Or Do you, on average, use your moped more or less than before the first of January 2023 (introducti... Much less often Is Selected

Block: Why less moped use? (2 Questions)

Block: Driving behaviour questions (26 Questions)
Block: Accident (1 Question)

Branch: New Branch
    If
        If Have you ever had an accident or fallen off the moped? Yes, I have had an accident on the moped Is Selected

Block: Helmet accident (1 Question)

Block: Demographics (6 Questions)

EndSurvey: Advanced

Branch: New Branch
    If
        If Do you currently own a moped? No Is Selected

Block: Discarded moped (1 Question)

Branch: New Branch
    If
        If Have you ever owned a moped and sold it between now and January 1, 2023 (the introduction of the... Yes Is Selected

    Block: Why discarded? (1 Question)

Block: Use shared moped? (1 Question)

Branch: New Branch
    If
        Invalid Logic Click Here to Edit Logic

    Block: Demographics (6 Questions)

    EndSurvey: Advanced

Branch: New Branch
    If
        If Have you ever used a shared moped? Yes Is Selected

    Block: Shard moped use often (2 Questions)

    Branch: New Branch
        If
            If Do you generally make use of shared mopeds with a yellow license plate (45 km/h) or with a blue l... Mostly yellow license plate Is Selected

        Block: Yellow changed? (1 Question)

        Branch: New Branch
            If
                If Did you already mainly use yellow license plate shared mopeds before the first of January 2023 (i... No, before the first of January 2023 I mainly used blue license plate mopeds Is Selected

            Block: Reason more yellow (1 Question)

    Block: More or less shared moped (1 Question)

    Branch: New Branch
        If
            If Do you generally make more or less use of shared mopeds than before the first of January 2023 (in... Somewhat less Is Selected
            Or Do you generally make more or less use of shared mopeds than before the first of January 2023 (in... Much less Is Selected

        Block: Why less shared mopeds (2 Questions)

Block: Driving behaviour questions (26 Questions)
Block: Accident (1 Question)

Branch: New Branch
    If
        If Have you ever had an accident or fallen off the moped? Yes, I have had an accident on the moped Is Selected

    Block: Helmet accident (1 Question)

Block: Demographics (6 Questions)

EndSurvey: Advanced

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