ÉCOLE DES HAUTES ÉTUDES EN SCIENCES SOCIALES
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Four Essays on the Economics of Road Risks in India

Vier essays over de economie van verkeersrisico's in India

THESIS

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pour l'obtention du grade de docteur en sciences économiques
de l'École des Hautes Études en Sciences Sociales

et du diplôme de
Docteur de l'Université Erasme de Rotterdam
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Four essays on the economics of road risks in India

Abstract

My dissertation aims at understanding the environmental and behavioral determinants of road traffic accidents in a developing country, India. To do so, a panel database on Indian states over a period going from 1996 to 2006 has been built. A household survey among drivers and passengers of motorbikes has been also implemented in Delhi in 2011, this to overcome the absence of individual data on road habits.

Chapter 1 is a macroeconomic study on the Indian subcontinent. The results found suggest that India should invest more particularly in road infrastructures, in the strict implementation of road rules and in education programs on road related risks. Given that 70% of motorized vehicles are two-wheelers in India, I decided to focus the rest of my analysis on this subgroup. Chapter 2 provides a presentation of the survey. I study in Chapter 3 the adequate measurement of risk aversion in the context of a developing country. I explore the impact of questions and interviewers on the elicited individuals' preferences towards risk. In Chapter 4, a theoretical model on the influence of risk aversion on prevention activities is first adapted to the road safety context. When looking at the data, we found that more risk averse drivers are more likely to wear a helmet while there is no significant effect on choice of speed. As for passengers, they seem to adapt their helmet use to their environment and in particular to their driver's skills. In Chapter 5, I show that previous experiences of road crash and police stop impact subjective expectations. Fear of injuries lead to a greater use of helmet on long distance journeys, while police threat rather determines the helmet use on short trips.

Quatre essais sur l'économie du risque routier en Inde

Résumé

Ma thèse a pour objectif de mieux cerner les facteurs environnementaux et comportementaux des accidents de la route dans un pays en développement, l'Inde. Dans ce but, une base de données de panel couvrant les états indiens sur une période allant de 1996 à 2006 a été construite. Une enquête ménage parmi les conducteurs et passagers de deux roues a aussi été mise en place à Delhi en 2011, ceci pour surmonter l'absence de données individuelles sur les habitudes en matière de sécurité routière.

Le Chapitre 1 est une étude macroéconomique sur le sous continent indien. Les résultats suggèrent que l'Inde devrait investir plus particulièrement dans les infrastructures routières; dans la mise en application stricte du code de la route ainsi que dans des programmes de prévention routière. Etant donné que 70% des véhicules motorisés sont des deux roues en Inde, j'ai décidé de concentrer le reste de mon analyse sur ce sous groupe. Le Chapitre 2 présente l'enquête. J'étudie dans le Chapitre 3 l'adéquation des outils de mesure de l'aversion au risque dans le contexte d'un pays en voie de développement. J'explore l'influence des questions et des enquêteurs sur les préférences individuelles pour le risque élicitées. Dans le Chapitre 4, un modèle théorique sur l'influence de l'aversion au risque sur les activités de prévention est tout d'abord adapté au contexte de la sécurité routière. L'examen des données montre que plus un conducteur est averse au risque plus il est enclin à porter le casque; aucun effet significatif n'est obtenu sur la vitesse. Quant aux passagers, ces derniers semblent adapter l'utilisation du casque à leur environnement et en particulier aux compétences de leurs conducteurs. Dans le Chapitre 5, je montre que les expériences passées d'accidents de la route ou d'arrestations policières impactent les anticipations subjectives. La crainte d'être blessé accroît le port du casque pour les trajets longs, tandis que la menace policière influe sur l'utilisation du casque sur de plus courtes distances.

Vier essays over de economie van verkeersrisico's in India

Samenvatting

Het doel van dit proefschrift is om meer inzicht te krijgen in de determinanten van verkeersongelukken in een ontwikkelingsland, in dit geval India. Daarbij is gekeken naar omgevings-, institutionele en gedragsfactoren. Op basis van rijke en oorspronkelijke datasets wordt beoogd om nieuw licht te werpen op dit onderwerp en bij te dragen aan het debat over verkeersveiligheidsprogramma's in ontwikkelingslanden.

Het eerste hoofdstuk beschrijft een macro-economisch onderzoek op het Indiase subcontinent. Op grond van de analyse van verschillen in verkeerssterfte tussen Indiase deelstaten en door de tijd heen kan geconcludeerd worden dat India meer zou moeten investeren in het wegennet, de strikte implementatie van verkeersregels en voorlichtingsprogramma's over verkeersgerelateerde risico's. Aangezien 70% van de gemotoriseerde voertuigen in India tweewielers zijn, en ruim de helft van de verkeersslachtoffers in dit land hoofdletsel oploopt, is het onderzoek gericht op motorrijders. Omdat er geen individuele gegevens over verkeersgedrag voorhanden waren, is er in 2011 een enquête gehouden onder motorrijders in Delhi. In hoofdstuk 2 volgt een gedetailleerde beschrijving van de steekproef en vragenlijst. Voordat in hoofdstuk 4 en 5 wordt ingegaan op de invloed van individuele voorkeuren en opvattingen op het gebied van veilig gedrag in het verkeer, wordt in hoofdstuk 3 beschreven hoe risico-aversie in de context van een ontwikkelingsland gemeten moet worden. Hoofdstuk 4 begint met een theoretisch model van de invloed van risico-attitudes op zelfbescherming en het nemen van voorzorgsmaatregelen, toegesneden op de verkeersveiligheidscontext. Daarna worden de resultaten van het empirisch onderzoek beschreven. Het blijkt dat motorrijders die hoger scoren op risico-aversie vaker een helm dragen, maar dat risico-voorkeuren geen significant effect hebben op hoe hard iemand rijdt, zoals de theorie voorspelt. Bovendien lijken een lage snelheid en het dragen van een helm substituten te zijn. Passagiers lijken hun keuze om een helm te dragen af te stemmen op hun omgeving en in het bijzonder op de rijvaardigheid van de bestuurder. Ten slotte wordt in hoofdstuk 5 ingegaan op het effect van verwachtingen over letsel en verkeersboetes op het dragen van een helm. Het is interessant dat de angst voor letsel het dragen van een helm bij lange-afstandsritten bevordert, terwijl de dreiging van een bekeuring vooral bepalend is voor het dragen van een helm op korte trajecten. Op grond van de resultaten wordt aanbevolen om de verkeersboetes te verhogen en tegelijkertijd de verkeersregels strikter te handhaven, en ook om in informatiecampagnes meer de nadruk te leggen op het nut van het dragen van een helm op korte motorritten dicht bij huis.

Contents

Introduction

Contents

The World Health organization (WHO) estimates that road traffic crashes cause over 1.24 million deaths and probably more than 25 million severe injuries per year (WHO; 2013). Globally, road traffic injuries are already today among the three major causes of death for the age group 5 to 44 years (WHO; 2013). Moreover, the WHO's Global Status Report in Road Safety states that over 80% of the world's road fatalities occur in middle income countries, although these countries only account for about 52% of the world's registered vehicles (WHO; 2013).[1] Over the next 15 years, unless immediate action is taken, the WHO anticipates that the number of people dying annually in road traffic crashes may rise to 2.4 million. The increase will probably entirely occur in low and middle income countries where road traffic injuries would become one of the major causes of death. Given these numbers, tackling this problem has to become no less of a policy priority as compared with diseases such as diarrhea, malaria, HIV/AIDS and tuberculosis.

In the last four decades, industrialized countries have been able to achieve significant reductions in road mortality. For instance, in the case of France, the reversal of the trend was observed already in 1972. The attention of policymakers to this issue was reflected in the creation of a National Delegate for Road Safety position. In 1973, mandatory seat belt and speed limit laws were implemented. Still in 2002, road safety was President Chirac's top priority. New road-related laws led to the setting of speed cameras, the automatic process of traffic offences and the creation of a probationary license, which led to a 32.5% cut in road mortality in only four years' time (2001-2004). Overall, road mortality decreased by 83%, from 18,000 in 1972 to around 3,000 fatalities nowadays. This reduction was made possible by a constant and strong political will, tackling all dimensions of the problem: from enforcement of traffic rules to the quality of road and health infrastructures.

High and middle-low income countries experience today very different situations with respect to road traffic mortality. Contrary to developed countries, the number of road fatalities has risen substantially in many developing regions. While the number of road traffic deaths decreased in 42 (out of 49) high-income countries between 2007 and 2010, only 41 (out of 100) middle-income states and 5 (out of 33) low-income ones have a similar record (WHO; 2013).[2] Road traffic injuries entail major economic problems, in particular because they primarily affect the economically active population, as does HIV/AIDS. Moreover, providing medical services to those injured im-

[1] India belongs to the middle-income country group.

[2] These statistics correspond to a categorization of countries according to the World Bank Atlas method (WHO; 2013) the middle income group corresponds to countries with a GNI per capita between US$ 1,006 and US$ 12,275.

plies a high burden on national health systems and budgets. Hence, not surprisingly, the WHO estimates global losses due to road traffic accidents to be close to 518 billion USD and likely to cost governments between 1% and 3% of their GDP (Ansari et al.; 2000; Jacobs et al.; 2000; WHO; 2009).[3] In many developing countries this is obviously more than the total amount that these countries receive in terms of development assistance. Cross-country studies (Kopits and Cropper; 2005; Bishai et al.; 2006) suggest that at very low levels of income, road traffic fatalities per population increase with income up to a certain threshold and then fall. This inverted u-shaped relation between the income and number of road casualties can be explained by the fact that growth and development come first with an increase in road mortality caused by a raise in the number of motorized vehicles. Subsequently, once a certain level of wealth has been reached, the country is able, in particular, to invest in road and health infrastructures, to launch awareness campaigns or to enforce traffic rules. Unfortunately, most developing countries are still far away from this stage. Nevertheless, adequate and cost effective actions must be found without delay in order to reverse or at least bend down the observed trend in road mortality in these regions.

0.1 What are the possible levers to reduce road mortality?

The improvement of the quality of road infrastructures plays a key role in the reduction of the frequency and the severity of road traffic accidents. While metropolitan cities are widening in many developing countries, leading to an increasing need of mobility within but also between cities, huge financial resources and time are required to build a safe and comprehensive road network. In many cases, governments' financial shortcomings explain why potholes and unpaved roads are still very common in many regions of the world. Rapid access to health care following a road crash is also crucial to limit the consequences of injuries. In the case of India, the slowness of ambulatory services worsens the road accident problem. According to Hsiao et al. (2013), 58% of all road injury deaths in this country occur on the scene of the collision, either immediately or while waiting for the emergency ambulance to come.

Another lever to reduce road mortality is to prevent individuals from adopting risky behaviors while traveling. In recent years, more and more low- and middle-income countries have started implementing and enforcing road-related legislation to reduce speeding and drink-driving, and increase the use of motorcycle helmets, seat-belts and child restraints. The case of Cambodia is a good example of the efforts some governments are putting to reduce road mortality by changing habits of road users. Indeed, this country passed a law in 2009 requiring motorcycle drivers to wear a helmet. One year later, it increased the police capacity to enforce the law. Finally in 2012, it implemented an awareness campaign, in order to make individuals realize the financial and health-related risks they face when traveling without a helmet. Unfortunately, the low enforcement of traffic rules and the widespread petty corruption in many developing countries (WHO; 2013) often impede the success of road safety legislative measures.

[3] Ansari et al. (2000) report for instance that in Saudi Arabia the impact of road traffic crashes on the health budget is dramatic: at any time, one third of beds in public hospitals would be occupied by road crash victims.

Attitudes adopted by road users may also depend on their perception of road risks and their awareness regarding road injuries. Despite the fact that helmet use is an individual choice, the adoption of head protection may be influenced by social norms, or be the result of a family decision. Let's take the case of a motorcyclist. His or her expectations regarding the financial and health consequences of infringing the helmet mandatory law, as well as of being involved in a road crash if not using a head protection are likely to impact his or her traveling behavior. Considering the cost of a helmet, a household may decide to buy only one such device and subsequently choose which member of the household will benefit from this protection. This choice may depend on age, gender or on the income each household member brings home. Finally, behaviors adopted by other motorcyclists belonging to the same household, the same neighborhood or the same community may also influence individual's conduct, regardless of his or her risk preferences and beliefs.

The environmental, institutional and behavioral dimensions I just presented are all likely to impact road mortality. In this PhD dissertation, I study these different factors and their respective impact on road mortality, taking the case of India. Road traffic accidents represent in this country up to 3% of the GDP (Mohan; 2001). Since the end of the 1980's, the strong urban growth, combined with an accelerated motorization, has led to an important increase in the number of road deaths. Fatalities and injured people constitute there a major public health issue, yet largely neglected. India has seen its road mortality situation worsen over the years: the number of road deaths has more than doubled in twenty years' time going from 56,000 fatalities in 1992 to close to 137,000 in 2013 (figures from the National Crime Record Bureau), corresponding to 10% of all road victims worldwide. In 1950, the number of vehicles was close to zero in India. In fifty years, this figure reached more than 70 million, among which 50 million are motorbikes. I have thus chosen to concentrate my doctoral dissertation on this subcontinent and in particular focus my research on road safety behaviors adopted by motorcyclists.

0.2 An overview of the thesis

My dissertation aims at understanding the environmental, institutional and behavioral determinants of road traffic accidents in a developing country, India. Thanks to rich and original datasets, this thesis aspires to contribute to the growing debate on road safety programs in developing countries. Figure 0.1 presents the articulation of the different chapters, and figure 0.2 reports the different research questions which I tackle in this dissertation.

0.2.1 Environmental and institutional determinants of road mortality

The first chapter of the thesis is a macroeconomic study on the Indian subcontinent. It explores the determinants of road mortality in India. Besides income, the analysis takes into account, as potential explanatory factors, the socio demographic structure of the population, the level of motorization, the traffic mix, the road and health infrastructures as well as the traffic rules enforcement intensity. An original panel dataset built based on information coming from diverse sources and covering 25 Indian states has been used. When analyzing the road mortality dif-

ferential across Indian states and over time, I find that the rise in the motorization level, the urbanization rate, as well as the share of pedestrians and motorcyclists among the road users are the main factors associated with road mortality in India. Among vulnerable road users, women are particularly at risk. Furthermore, the more money the government spends per police officer, the lower the level of mortality is. These findings suggest that India should invest more in road infrastructures, in the strict implementation of road rules and in education programs on road-related risks.

0.2.2 Data collection and measurement issues

Road traffic crashes result from a complex and multidimensional phenomena. The conduct adopted by road users when traveling is one of the key factors often put forward as one of the main cause of the number of fatalities. Many public policies have tried to affect individuals' actions by focusing either on repression (speed cameras, fines for infringing road rules) or prevention (information campaigns, education programs emphasizing road dangers).

Given that in India 70% of motorized vehicles are two-wheelers and that more than half of the road casualties sustain head traumas, I decided to focus my analysis on this particular subgroup. In order to overcome the absence of individual data on road habits, a household survey among motorcyclists in Delhi has been implemented in 2011. Chapter 2 provides a detailed presentation of the sample and questionnaire. Before investigating the influence of individuals' preferences and beliefs on safe conducts in Chapters 4 and 5, I study in Chapter 3 the adequate measurement of risk aversion in the context of a developing country. Besides the measurement of individual's preferences toward risk per se, I consider the implementation issues and in particular the influence of interviewers.

0.2.3 Individual determinants of road safety behaviors

In the two last Chapters of the dissertation, I investigate the respective roles of risk preferences and subjective expectations on helmet use. In Chapter 4, a theoretical model on the influence of risk attitudes on self-protection and self-insurance activities is first adapted to the road safety context. When turning to the empirical analysis, we find that more risk averse drivers are more likely to wear a helmet while there is no significant effect of risk preferences on choice of speed, as predicted by the theory. Moreover, low speed and helmet use appear to be substitutes. As for passengers, they seem to adapt their helmet use to their environment and in particular to the driver's skills. Subsequently, the formation of injury and fine expectations and their impact on helmet adoption are studied in Chapter 5. Knowing someone who experienced a road crash or having been sanctioned by the traffic police modify motorcyclists' subjective expectations. Interestingly, fear of injuries lead to a greater use of helmet on long distance journeys, while police threat rather determines the helmet use on short distance trips. Based on these findings, I advocate for the simultaneous raise of fines prices and enforcement of road rules as well as for information campaigns with a focus on the utility of wearing a helmet also for motorbike trips nearby users' home.

Figure 0.1 : Articulation of the thesis' chapters

Chapter 1: Determinants of road traffic crash fatalities across Indian states
Chapter 2: Presentation of the Road Safety Survey implemented among motrocyclists in Delhi in 2011
Chapter 3: "Tell me, are you risk averse?" The influence of questions and interviewer on risk aversion measurement
Chapter 4: Why do some motorbike riders wear a helmet and others don't? Evidence from Delhi, India
Chapter 5: "Your money or your life!" The influence of injury and fine expectations on helmet adoption among motorcyclists in Delhi

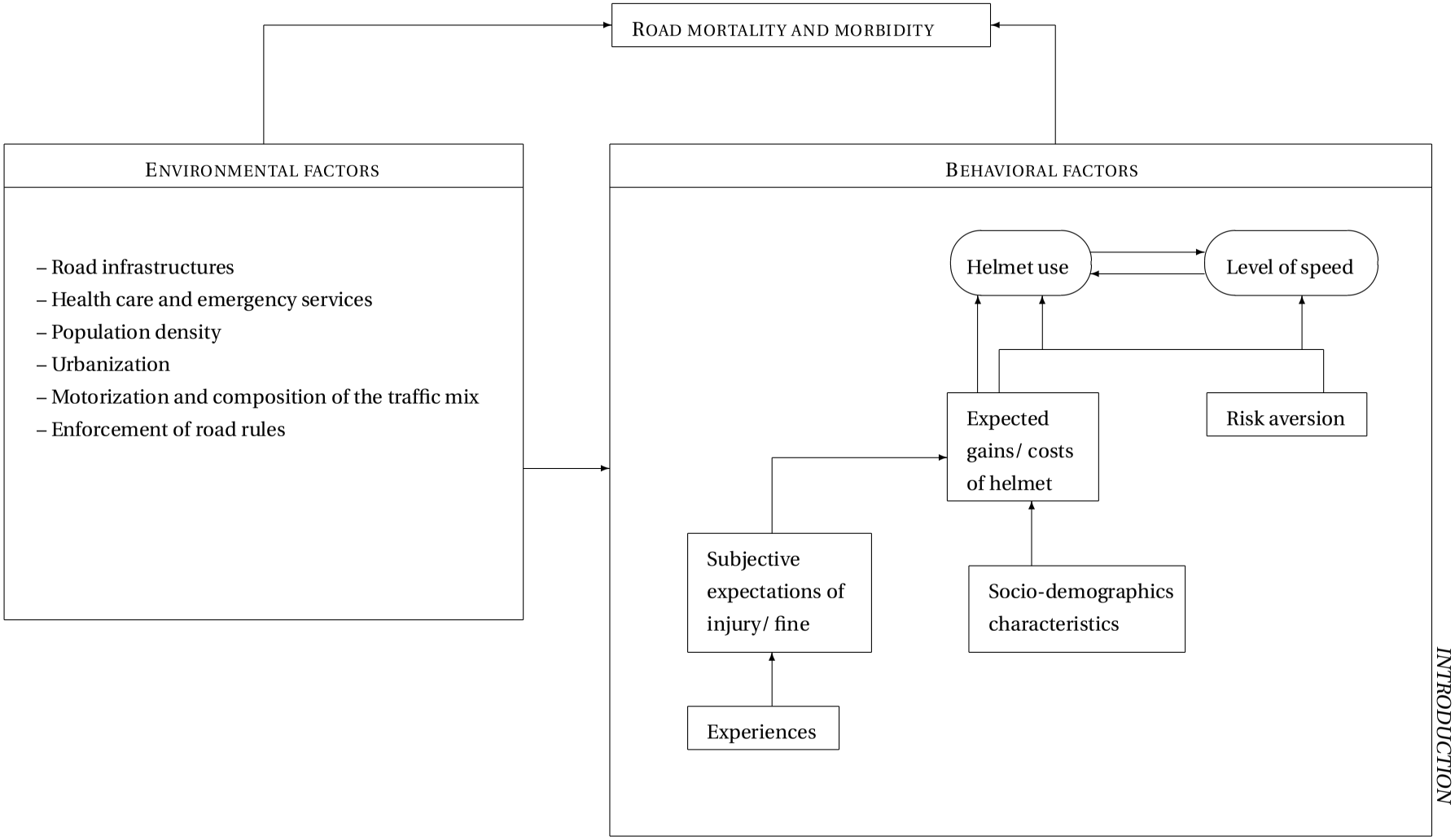
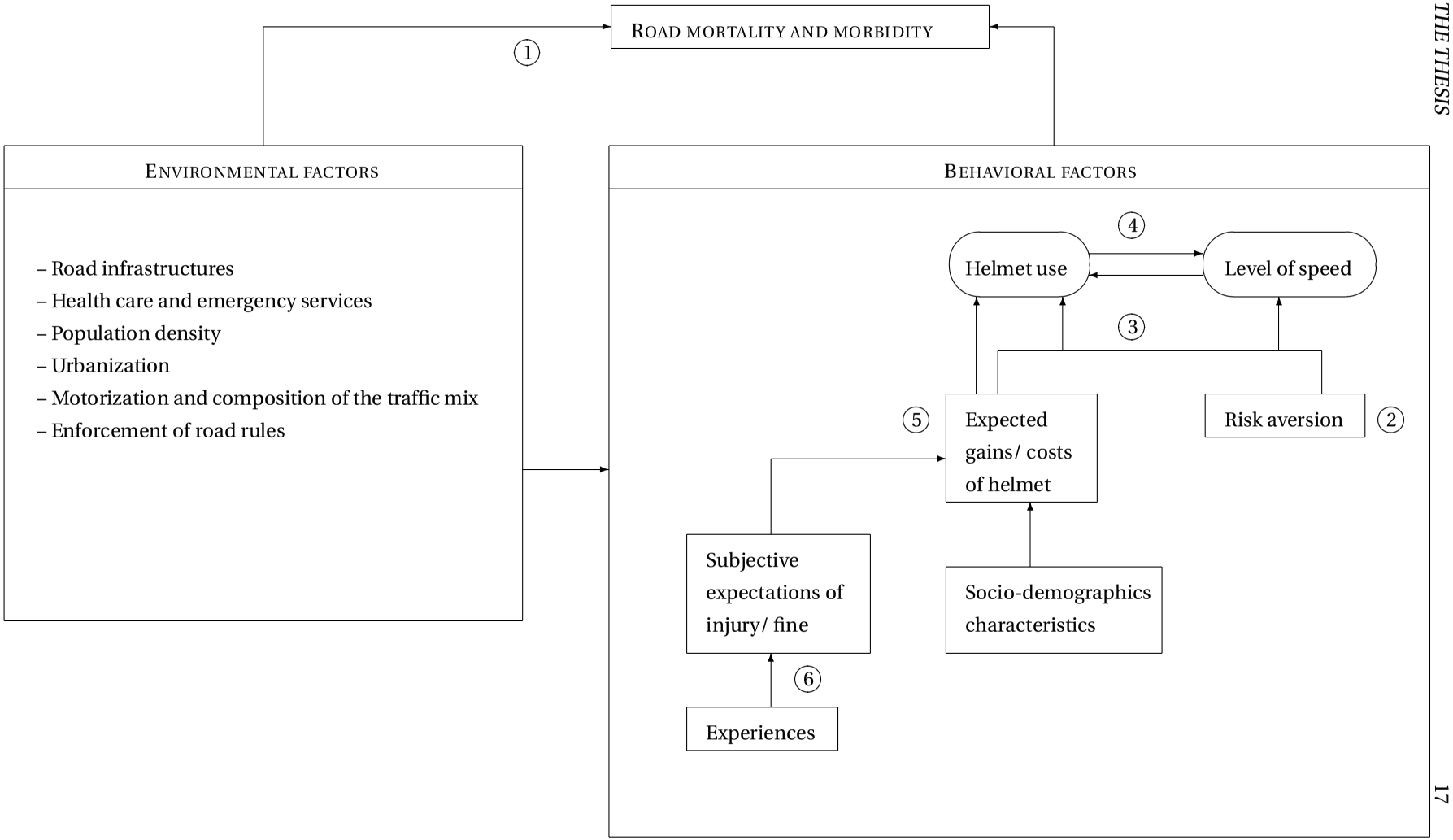


Figure 0.2 : Research questions tackled in the PhD dissertation

Chapter 1: (1) What are the determinants of road mortality in India?
Chapter 3: (2) Do questions and interviewers impact the elicited individual risk aversion?
Chapter 4: (3) Do more risk averse individuals wear more the helmet?
(4) Are helmet use and low speed substitutes or complements?
Chapter 5: (5) Do individuals' experiences modify their subjective expectations?
(6) To what extent subjective expectations influence helmet use decision?



Chapter 1

Determinants of Road Traffic Crash Fatalities across Indian States

This Chapter was written with Michael Grimm (Erasmus University Rotterdam, Passau University and IZA).
It is published in Health Economics, Volume 22, Issue 8, pages 915-930, August 2013.

Abstract

Objective: This paper explores the determinants of road traffic crash fatalities in India. In addition to income, the analysis considers the socio-demographic population structure, motorization levels, road and health infrastructure and road rule enforcement as potential factors.
Methods: An original panel data set covering 25 Indian states is analyzed using multivariate regression analysis. Time and state fixed effects account for unobserved heterogeneity across states and time.
Results: Rising motorization, urbanization and the accompanying increase in the share of vulnerable road users, i.e. pedestrians and two-wheelers, are the major drivers of road traffic crash fatalities in India. Among vulnerable road users, women form a particularly high risk group. Higher expenditure per police officer is associated with a lower fatality rate.
Conclusion: The results suggest that India should focus, in particular, on road infrastructure investments that allow the separation of vulnerable from other road users, on improved road rule enforcement and should pay special attention to vulnerable female road users.

***JEL* classification:** I18, O18, R41.
Keywords: Transportation, traffic safety, vulnerable road users, road rule enforcement, urbanization, India.

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Contents

1.1 Introduction

The World Health Organization (WHO) estimates that, annually, road traffic crashes cause over 1.2 million deaths and more than 25 million severe injuries worldwide (WHO, 2009). In 2020, road traffic injuries are expected to reach third in the ranking of the global burden of disease (Lopez et al.; 2006). Over 90% of the world's fatalities occur in low and middle income countries, putting road traffic fatalities on par with malaria deaths (WHO; 2009). Given that these fatalities are concentrated in the economically active population, reducing the number of road traffic injuries and fatalities could confer large welfare gains to households.

So far, the literature that has examined the causes of road traffic accidents has either focused on the cross-country variation in fatality rates and on the role of aggregate income as one of the major drivers of this variation or relied on small-scale case studies. Cross-country studies that rely on a single year of data (see e.g. Wintemute; 1985; Jacobs and Cuttings; 1986; Söderlund and Zwi; 1995; Van Beeck et al.; 2000) almost all suggest that at very low levels of income, road traffic fatalities per population increase with income up to a certain threshold and then fall again. More recent studies that rely on panel data and thus can control for all time-invariant country-specific characteristics confirm this inverted u-shaped relationship (Kopits and Cropper; 2005, 2008; Bishai et al.; 2006). Moreover these studies have successfully worked out the mediating factors between income and road traffic accident fatalities at different stages of development. Other studies solely focus, as we will do, on the variation across space and time within a single country (Noland; 2003; La Torre et al.; 2007; Traynor; 2008). This may avoid potential problems of parameter heterogeneity, a problem that often arises in cross-country studies. Nevertheless, these latter studies typically focus on richer and highly motorized countries. In this paper we focus on India.

India is an important case as it has one of the highest per capita traffic fatality levels in the world (WHO; 2009). More than 133,000 people died on Indian roads in 2010. Significant differences across states exist, but on average, according to police records, about 85% of all fatalities are men, mainly between the ages of 30 and 59, and more

than 40% are vulnerable road users, i.e. pedestrians or two-wheelers (Mohan; 2009). According to the police, the share of female victims is relatively higher among vulnerable road users than among non-vulnerable ones. Unlike China, fatalities continue to increase. The social costs have been evaluated at 3.2% of GDP, a loss that inhibits economic and social development (Mohan; 2001).

Virtually no low income and less-motorized country has been successful in reducing the number of road traffic crash fatalities and injuries in the recent past. Traffic patterns in these countries are much more complex than those in high-income countries (Mohan; 2002), an issue we will take into account in our analysis. The reasons for this greater complexity are: (i) a large proportion of income-poor road users; (ii) a high proportion of vulnerable road users sharing the road with motorized vehicles; (iii) high population density in urban areas; (iv) a low enforcement of road traffic rules and regulations; and (v) severe limitations on public resources available for roads and other infrastructure. The latter aspect is illustrated in Table 1.1 which shows that Germany, for instance, compared to India had a much higher income level at comparable rates of motorization.

Table 1.1: Same motorization level, different income

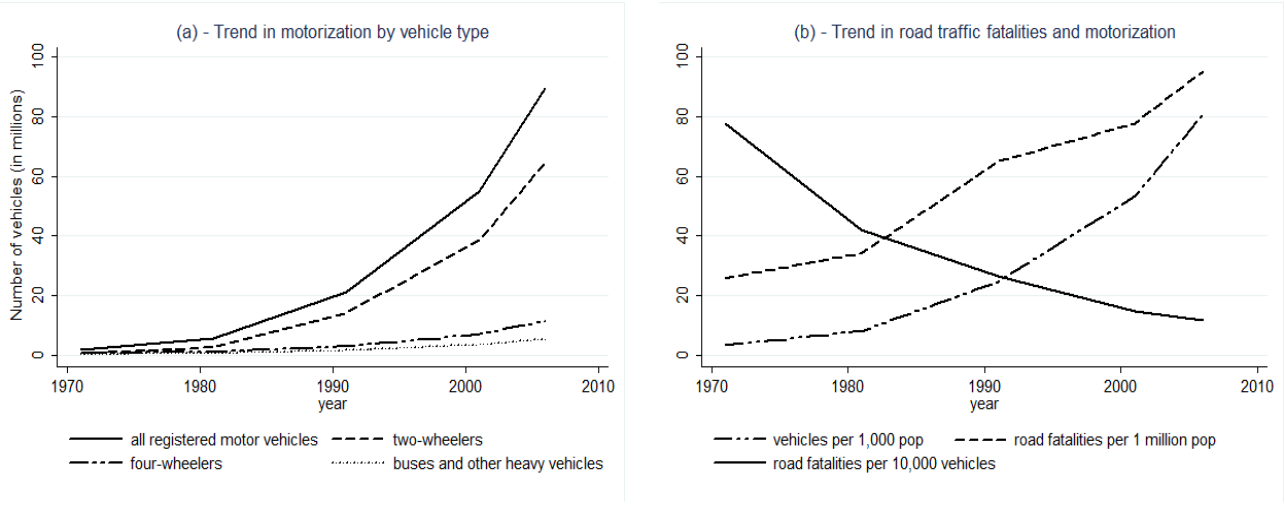
	Year	Motor vehicles per 1,000 population	GDP per capita in 2005 Intl $ PPP
India	2005	73	588
Germany	1960	73	7,092

Source: World Development Indicators, World Bank (2010).

Figure 1.1a shows that in 2006 the number of registered motor vehicles in India was 50 times higher than in 1971. While two-wheelers represented one third of the total number of motorized transport in 1971, today they represent around 70% of the total. Figure 1.1b shows that there is indeed a strong correlation between fatalities per population and the number of vehicles per population, confirming the finding by Bishai et al. (2006) and Kopits and Cropper (2008), that in poor countries the rise of motorization that accompanies income growth is one of the most important forces in the increase in road accident fatalities per population; fatalities per vehicle decline in fact over time.

Using a spline model, Garg and Hyder (2006) find for states below US$750 of net domestic product (NDP) that income is positively correlated with fatalities per population, while for the richest states in the sample the correlation is close to zero and insignificant, i.e. the curve is flat, almost downward sloping, and hence supporting to some extent the hypothesis of an inverted u-shaped relationship. The authors speculate that increased investment in road safety measures and public transport as well as stricter enforcement of road traffic rules enable richer states to reduce road traffic accident mortality. However, none of these hypotheses has been examined empirically. Our study makes an attempt to close this gap by exploiting variations across time and Indian states to disentangle the roles of various factors related to the road accident fatality rate in general and by type of road user in particular.

Figure 1.1: Trends in motorization and road traffic fatalities in India, 1971 - 2006



Source: See Table 1.6.

1.2 Method

1.2.1 Conceptual framework

We focus on four different sets of factors; factors associated with the socio-demographic population structure, motorization level, road and health infrastructure and institutional quality. In addition we include income that may play a role in conjunction with these factors.

Among the socio-demographic factors, we explore gender, education, urbanization, population density and religion, since we assume that these factors influence risk attitude, risk exposure and risk knowledge and via these channels road traffic accident fatalities. Individual income and employment status can be seen as further intermediate variables through which socio-demographic characteristics act on risk attitude, risk exposure and risk knowledge. Income and employment determine the frequency of traveling, the means of transport, the availability of safety devices and the relative costs of physical and human damage.

Motorization should matter through the number of registered vehicles and the vehicle mix. In poorer countries the diversity of vehicles sharing the same road leads to high differences in speed between the various road users, which in turn may increase the number of accidents compared to a country with a more homogenous group of road users. To account for road infrastructure we include some characteristics of the road network. We also consider health care supply as the quality of trauma and medical care may matter for the chances of accident victim survival. Moreover, the quality and accessibility of health facilities may also have an indirect impact on the risk attitude of road users. Regarding the institutional factors, we mainly focus on the enforcement of road traffic rules and regulations.

There are good reasons to believe that income affects road traffic fatalities through all four transmission channels. First, economic development usually leads to increased motorization levels and urbanization. Second, a higher national income will allow the government to invest more resources in the quality and quantity of road and health infrastructure. Moreover, resources allocated to the police may also increase with national income. On the individual level income should matter because, with higher income, road users can also afford more and better safety devices such as better-quality vehicles and helmets. Finally, people's risk attitude and exposure to risky situations is likely to be affected by income. The greater the number of relevant transmission channels that are captured by the empirical analysis, the less we expect income to be significant in our analysis.

Figure 1.2 summarizes the conceptual framework graphically. Our framework is closely related to the systems approach used by the Global Road Safety Forum, an international initiative for global road safety (www.globalroadsafety.org). The systems approach is inspired by the so-called 'Haddon Matrix' which distinguishes three main factors: human, vehicles and equipment and the environment (including the legal framework) that interact over three time windows – pre-crash, crash, and post-crash – to produce or prevent road traffic accident fatalities or injuries.[1]

1.2.2 Data

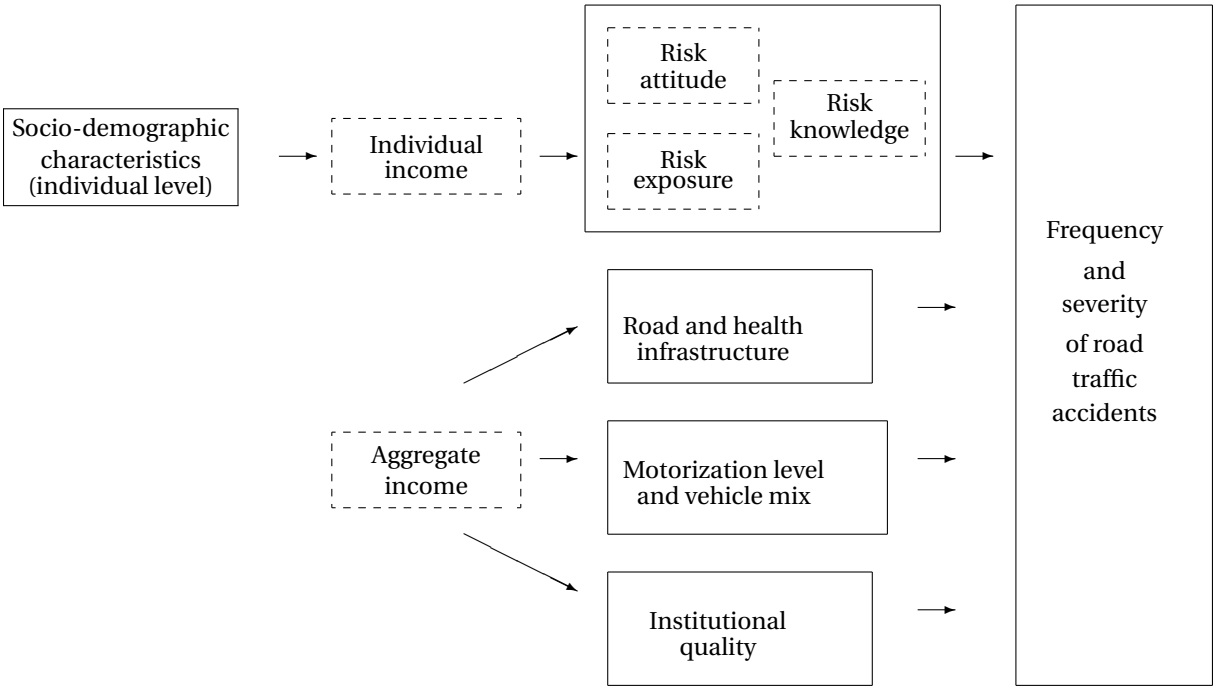
Our data set covers 21 Indian states and four Union Territories (UTs) over the period 1994 to 2006.[2] However, for some of our analysis we stick to the period 1996 to 2006 and 24 instead of 25 state/UT observations as the information regarding other variables is incomplete for earlier years and one particular state. The variables have been drawn from many different sources. The details are given in Table 1.6 (Appendix). The number of road traffic fatalities per population and its components pedestrian, two-wheeler and four-wheeler fatalities are taken from the National Crime Records Bureau (NCRB), i.e. the police. Socio-demographic information is based on census data.[3] However, there is no information available regarding the age structure at the state level. State level income is measured by the state-specific per capita Net Domestic Product (NDP) using 1993 prices published by the National Statistics. Road infrastructure, motorization levels and the vehicle mix were obtained from the Ministry of Road Transport and Highways. Information on road infrastructure is unfortunately missing for many states and years. Information on health care supply, i.e. the number of hospitals and dispensaries, is drawn from the 'Center for Enquiry into Health and Allied Themes' database. We completed this information with the 2001 Census state fact sheets. However, here again the time period covered is a bit shorter than for most of the other variables. Finally, data from the NCRB was again used to compute different proxies of road rule enforcement, i.e. expenditure per police officer, the number of police officers per population and the number of cases under investigation per police officer. We assume that traffic police expenditures are proportional to total police expenditures.

[1] This distinction of factors related to humans, vehicles and roads and enforcement has also been adopted by the World Health Organization (WHO; 2010) and, in a similar form, by the World Bank (WB; 2009).

[2] Before 2000, there were 25 states and 7 Union Territories. We had to exclude three states because these were later split up into several states. We also excluded the UT of Lackshadweep because of its very small size.

[3] To fill in the missing information for years for which no census data is available, we imputed values based on a geometrical extrapolation.

Figure 1.2: Conceptual framework



Source: Own representation.

Under-reporting of road traffic accident fatalities is a potentially important problem in the case of India. Dandona et al. (2008) investigate the magnitude of under-reporting of road traffic accident injuries and fatalities by comparing police data with population-based and hospital-based data. The authors highlight the limitations of

the police data but come to the conclusion that under-reporting of injuries is much higher than of fatalities. Indeed, they show that 77.8% and 98.1% of road traffic accident fatalities that could be found in the population-based and the hospital-based data respectively were reported to the police. Under-reporting of road traffic accident injuries is shown to be much larger, something also acknowledged by Mohan (2009). Adjustments to the data would be possible for specific years using census data or data from the 'Million Death Study' (MHA; 2009), but in the absence of any reliable information that could help to adjust these numbers across states and over time, we refrain from making any corrections. However, most of our analysis relies on fixed effects estimates, which means that at least all state-specific measurement error is absorbed as long as it is roughly constant over time. Visual inspection of the time series state-by-state suggest that this is a plausible assumption for almost all states. Moreover, we conduct various robustness checks of which the results are briefly summarized below. Finally, we would like to highlight that despite WHO efforts to harmonize data, the comparability of road traffic fatality data in cross-country data sets – which have been used many times – is obviously also limited.

Regarding the explanatory variables, it was not possible to find data on all the aspects discussed in our conceptual framework. For instance, there is no variable that would measure the quality of health services on a per state basis for our observation period. Hence, there is a clear trade-off between the level of spatial disaggregation and the length of the observation window on the one hand and the exhaustiveness of the data set on the other.

1.2.3 Empirical specification

To analyze our data, we use a two-way fixed effects model:

$$\ln(fatalities_{st}) = \alpha + \beta_1 \ln NDP_{st} + \beta_2 (\ln NDP_{st})^2 + X'_{st}\delta + \mu_s + \mu_t + \varepsilon_{st}, \tag{1.1}$$

where $\ln(fatalities_{st})$ stands for the log road traffic fatalities per 100,000 population in the State (or UT) s in period t. Alternatively we use pedestrian, two-wheeler and four-wheeler fatalities. NDP stands for net state domestic product per capita in 1993 Rupees (income per capita hereafter), which we introduce in linear and squared form to account for possible non-linearities. The vector X_{st} stands for the set of potential determinants discussed above. Year effects are denoted μ_t. They control for all time-specific effects that are uniform across states such as the general trend in the safety level of vehicles or general changes in traffic regulations. State level fixed effects are denoted μ_s. They account for all the heterogeneity between states that is constant over time such as general weather conditions, the topography and cultural attitudes and norms but also under-reporting as long as this is constant over time. The test statistics that guided the choice of the model are briefly discussed below. We always estimate the model first with income alone and then subsequently introduce all other potential determinants.

1.3 Results

Table 1.2 shows the mean and standard deviation of all variables in our data set, including the within and between state variation. The sample mean fatality rate is 9.7 deaths per 100,000 population (1994 to 2006). Across states this rate varies from about 3 (Assam in 1996) to 21 (Goa in 2006). Over time the mean increased from 7.4 in 1994 to 12 in 2006. For India as a whole, Kopits and Cropper (2005) projected this rate to rise to 24 by 2042. The motorization level also varies substantially across states and time. In 1994 Tripura had 104 (min) vehicles (any motorized vehicle, including two-wheelers) per 10,000 inhabitants, whereas Chandigarh had 4,417 (max). In 2006 the minimum increased to 189 (Arunachal Pradesh) and the maximum to 5,862 (Chandigarh).[4] Figure 1.3 shows that fatalities per population are positively correlated with income. Nevertheless, the slope is smaller for higher levels of income and even starts to become negative, suggesting a turning point similar to what cross-country studies found. This is further discussed below. Conversely, fatalities per vehicle are somewhat negatively correlated with income. In our regression analysis we control for vehicles per population (motorization), hence the estimated effects of the other explanatory variables reflect first of all their effect through fatalities per vehicle.

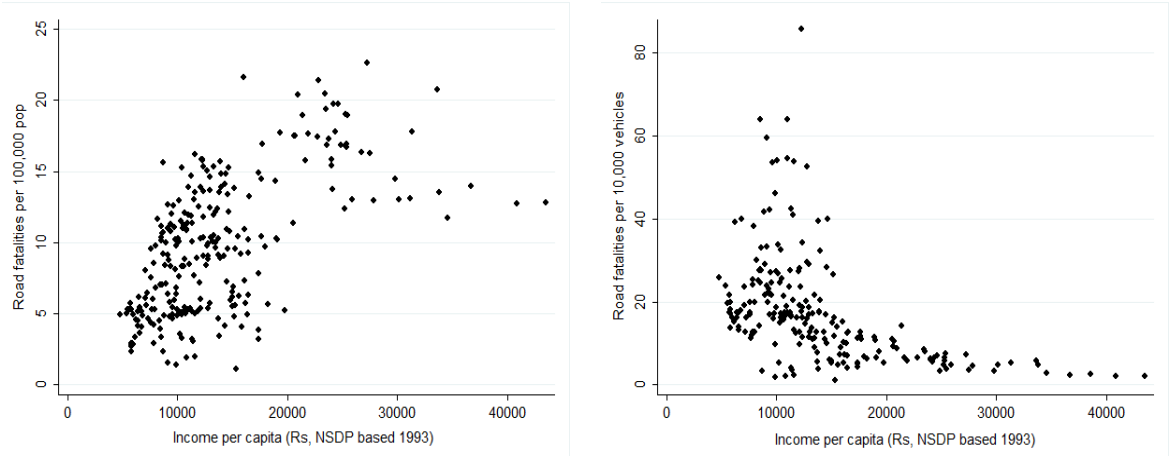
[4] Note that data on motorization is not accounting for exits. This is however not a major problem for our analysis as long as exits are proportional to the stock, which we think is a reasonable assumption.

Table 1.2: Descriptive statistics of variables explored, 1994-2006

	Observations			Mean			Standard Deviation		
Variables	N	n	T-bar	overall	1996	2006	overall	between	within
ROAD TRAFFIC ACCIDENT FATALITIES									
Fatalities per 100,000 pop	245	24	10.21	9.65	8.90	12.19	4.99	4.57	2.09
Pedestrians deaths per 100,000 pop*	199	24	8.29	1.23	1.26	1.28	1.59	1.34	0.89
Two-wheeler deaths per 100,000 pop*	199	24	8.29	2.52	1.89	3.64	2.54	2.41	1.04
Four-wheeler deaths per 100,000 pop*	199	24	8.29	5.53	5.32	6.43	3.00	2.66	1.60
INCOME									
NDP per capita (constant Rs, base year 1993)	245	24	10.21	13,145	10,677	17,894	6,701	6,325	2,835
SOCIO-DEMOGRAPHIC STRUCTURE									
Total population (in thousands)	245	24	10.21	27,600	27,000	31,900	29,100	29,400	2,587
Male ratio (%)	245	24	10.21	51.93	51.83	51.92	1.72	1.77	0.31
Urban population (%)	245	24	10.21	33.35	30.58	36.61	21.31	22.08	1.70
Population density (pop per km^2)	245	24	10.21	1,010	691	1,431	2,251	2,320	337
Literacy rate (%)	245	24	10.21	69.73	64.87	76.53	11.10	9.95	4.82
Hinduism (%)	194	19	10.21	67.50	67.24	65.92	26.08	26.82	2.23
Islam (%)	194	19	10.21	9.53	9.55	9.84	8.89	8.87	1.48
Christianism (%)	194	19	10.21	15.05	14.90	13.13	24.48	25.45	1.32
Buddhism and Jainism (%)	194	19	10.21	2.36	1.60	3.41	5.24	6.71	0.52
ROAD AND HEALTH INFRASTRUCTURE									
Total road length per km^2	139	23	6.04	1.38	1.86	2.14$^\diamond$	2.35	3.89	0.27
Hospitals per 100,000 pop	93	12	7.75	81.54	91.33	57.48$^{\diamond\diamond}$	50.72	40.23	32.05
MOTORIZATION LEVEL									
Vehicles per 1 million pop	245	24	10.21	91,741	57,447	141,022	107,295	110,546	31,835
Two-wheelers (%)	245	24	10.21	66.73	65.74	68.27	15.22	16.20	3.16
Four-wheelers (%)	245	24	10.21	18.45	17.18	20.31	10.51	11.85	2.14
INSTITUTIONAL QUALITY									
Expenditure per police officer (constant Rs, base year 1993)	245	24	10.21	102,843	88,607	97,493	86,666	39,163	77,961
Total cases per police officer	245	24	10.21	3.53	4.35	2.74	4.26	3.54	2.41
Police officers per 100,000 pop	245	24	10.21	294	300	246	225	228	56

Notes: T-bar is the average number of years per state (N/n). This table shows the statistics for the sample most of our analysis relies on. Some variables are not available for all states. Moreover some variables are missing for some states in particular years.
* Information only available for the period 1996 to 2006 (1998 and 2001 missing).
Figures correspond to year 2003 ($^\diamond$) and to year 2004 ($^{\diamond\diamond}$).

Figure 1.3: Income per capita and road traffic accident fatalities per population and vehicle in India, 1994-2006



Source: See Table 1.6.

Table 1.3 shows multivariate regression results for road traffic fatalities per population. In the model in column (1) we only include the log of income and the log of income squared. We then successively introduce state fixed effects (col.(2)), time effects (col.(3)) and all other control variables (cols.(5) and (6)). Column (5) is a simple OLS regression without fixed effects, allowing us to also focus on between-state differences. Column (4) shows, in addition, a regression on a larger sample including, i.e. all states and using also those state-year observations in which one or several of our control variables are missing. Column (7) in turn shows a regression in which we use a balanced panel, using 20 states/UTs observed over 9 years. Prior tests indicated that state fixed effects are indeed required (Preusch-Pagan test) and that at least in those cases where all controls are included fixed effects (FE) are appropriate whereas random effects are not (see results of Hausman tests in Table 1.3). Moreover, modified Wald tests reject the homoskedasticity of our models (not reported), and hence we compute and show robust standard errors.

Table 1.3: OLS and FE regressions of road traffic accident fatalities per population, 1994-2006

Dependent variable: ln (road fatalities per 100,000 pop)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln(NDP per capita, real)	1.757***	2.569***	1.596*	1.677*	2.349***	0.226	0.298
	(0.001)	(0.007)	(0.071)	(0.053)	(0.000)	(0.864)	(0.916)
ln(NDP per capita, real)^2	-0.189*	-0.400**	-0.347**	-0.349**	-0.368***	-0.061	-0.058
	(0.053)	(0.018)	(0.035)	(0.023)	(0.001)	(0.817)	(0.918)
ln(urban population (share, in %))					-0.076	1.961**	2.735**
					(0.519)	(0.016)	(0.048)
ln(population per km^2)					0.031	-1.145	-1.574
					(0.446)	(0.486)	(0.542)
ln(male population (share, in %))					-0.034	0.009	-0.006
					(0.377)	(0.514)	(0.736)
ln(literate population (share, in %))					-0.110	1.428***	2.145***
					(0.720)	(0.004)	(0.006)
ln(police expenditures per officer, real)					-0.121*	-0.132***	-0.178***
					(0.059)	(0.003)	(0.003)
ln(number of vehicles per 1 million population)					0.180*	0.145	0.013
					(0.065)	(0.744)	(0.984)
Percentage of four-wheelers in total motorized vehicles†					-1.005***	-0.006	0.118
					(0.000)	(0.996)	(0.947)
constant	-1.043	-1.720	0.638	0.399	-0.972	-4.185	-5.699
	(0.114)	(0.149)	(0.624)	(0.759)	(0.603)	(0.808)	(0.834)
State fixed effects	No	Yes	Yes	Yes	No	Yes	Yes
Time fixed effects	No	No	Yes	Yes	No	Yes	Yes
Balanced sample	No	No	No	No	No	No	Yes
Hausman test: Prob>chi^2		0.331	0.445	0.600		0.067	0.070
Income turning point							
in 1993 constant Rs	104,391	24,810	9,971	11,052	24,327		
in 1993 international $‡	18,187	4,322	1,737	1,925	4,238		
Observations	245	245	245	323	245	245	180
Number of States/ UTs		24	24	25		24	20
R-squared overall	0.328				0.433		
R-squared within		0.114	0.243	0.229		0.364	0.370

Notes: P-values in parentheses, *** Significance at 1%, ** Significance at 5%, * Significance at 10%.

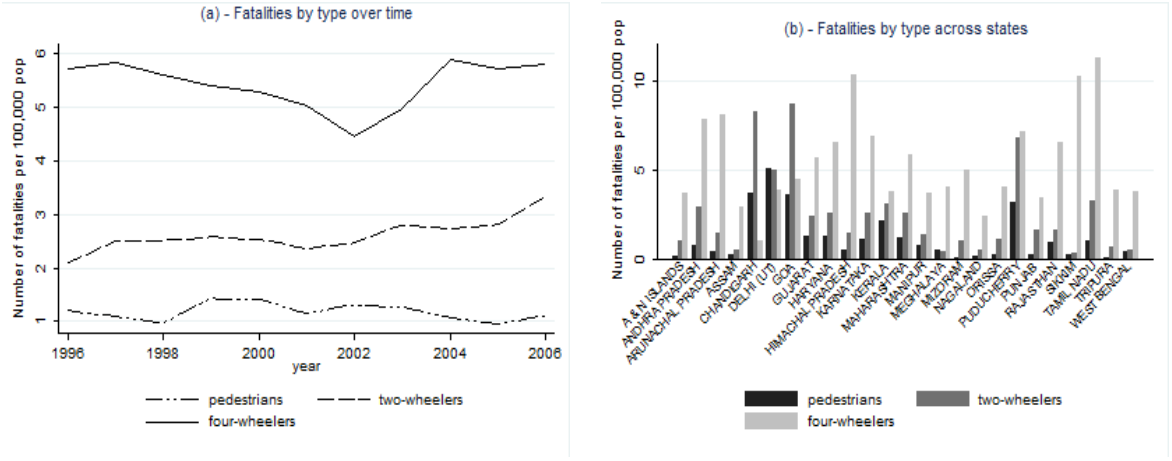
† Four-wheelers covers cars, jeeps, bus, trucks, tractors and tempos. Share of two and three-wheelers is the reference category.

‡ In 1993, one international $ (PPP) corresponded to 5.74 Rs (*Source*: Penn World Tables 6.1).

Column (1) suggests an inverted u-shaped fatalities-income relationship with an estimated turning point, i.e. the income threshold at which fatalities start to decline, of about Rs. 105,000 (or 1993 Intl. $18,000). This turning point is shifted to the left, as state fixed effects and time effects are introduced. If both are considered (col. (3)) the estimated turning point declines to Rs. 9,970 (or 1993 Intl. $1,740). However, the key finding is that the unconditional relationship is concave with an estimated turning point that is situated at the top end of the income distribution in our sample. This can also be seen in Figure 1.5a. Correspondingly, a simple F-test (not reported) does not reject the quadratic form of the income effect. These findings are confirmed if we use the larger sample. If we add further explanatory variables to the model in column (3) and first leave out the state and time fixed effects (col. (5)), the inverted u-shaped fatalities-income relationship is still significant. If we introduce time and state fixed effects together with all control variables (col. (6)), income loses its significance, but we now find a significant positive effect for urbanization and literacy and a significant negative effect for expenditure per police officer. The other enforcement variables turned out to be insignificant and hence, we do not keep them in the model. In column (5) motorization has a significant positive effect on the number of fatalities whereas the share of four-wheelers relative to the share of two-wheelers (controlling for motorization) has a negative effect. These effects still have the same signs in column (6), but are no longer statistically significant once state fixed effects are introduced. If we just rely on the balanced panel, which has 65 fewer observations, the three effects associated with urbanization, literacy and expenditure per police officer are still significant but of an even higher magnitude. We also checked whether multicollinearity poses a problem. Although some of the independent variables do indeed show relatively high pairwise correlation coefficients (e.g. urbanization and population density (0.85), urbanization and motorization (0.86) and income and literacy (0.61), the regression results are surprisingly robust to the inclusion/exclusion of some of these variables.

We now turn to fatalities by road user category. Figure 1.4a shows the trends over time. The number of pedestrian fatalities per population is more or less constant. Fatalities per population of two-wheelers strongly increases and fatalities per population of four-wheelers fell until 2002 and then increased again quite substantially. As mentioned above, almost 50% of all fatalities concern pedestrians and two-wheelers. Figure 4b shows that the relative importance of each of these categories varies significantly across states. Delhi, with more than 2,000 fatalities per year, is the only state in which the fatalities of pedestrians alone dominate the fatality rate with car, truck and bus occupants are least represented.

Figure 1.4: Road traffic accident fatalities by type of road user across time and states



Source: See Table 1.6.

Table 1.4: OLS regressions of road traffic accident fatalities per population by type of road user, 1996-2006

	Pedestrian fatalities per 100,000 pop			Two-wheeler fatalities per 100,000 pop			Four-wheeler fatalities per 100,000 pop		
Dependent variable (in ln)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(NDP per capita, real)	0.272	-0.472	-6.731***	-0.280	0.578	-1.345	6.335***	6.685***	-0.253
	(0.791)	(0.639)	(0.003)	(0.781)	(0.411)	(0.514)	(0.000)	(0.000)	(0.886)
ln(NDP per capita, real)^2	0.285	0.172	1.153**	0.363*	-0.010	0.290	-1.260***	-1.238***	-0.085
	(0.139)	(0.396)	(0.014)	(0.062)	(0.943)	(0.471)	(0.000)	(0.000)	(0.793)
ln(urban population (share, in %))		1.020***	-2.898***		0.082	1.430		-0.279*	-0.023
		(0.000)	(0.005)		(0.655)	(0.133)		(0.066)	(0.972)
ln(population per km^2)		-0.148***	-8.562***		-0.044	-5.444*		-0.002	-2.359
		(0.008)	(0.001)		(0.475)	(0.068)		(0.964)	(0.199)
ln(male population (share, in %))		-0.083***	-0.054*		-0.088***	-0.007		0.002	0.042**
		(0.008)	(0.091)		(0.003)	(0.761)		(0.961)	(0.025)
ln(literate population (share, in %))		1.892***	1.146		0.201	2.392***		-0.860**	0.190
		(0.000)	(0.196)		(0.657)	(0.004)		(0.010)	(0.866)
ln(police expenditures per officer, real)		-0.034	0.436**		-0.262***	-0.270**		0.074	0.050
		(0.841)	(0.041)		(0.009)	(0.040)		(0.503)	(0.582)
ln(number of vehicles per		0.143	-0.823*		0.517***	-0.376		-0.050	-0.502**
1 million population)		(0.519)	(0.091)		(0.002)	(0.475)		(0.613)	(0.047)
Percentage of four-wheelers in total		0.245	-2.496		-2.677***	0.273		-1.422***	-3.431
motorized vehicles†		(0.700)	(0.303)		(0.000)	(0.879)		(0.000)	(0.130)
constant	-2.159	-11.075***	68.261***	-1.056	-3.168	26.038	-6.131***	-2.396	21.987
	(0.101)	(0.002)	(0.001)	(0.414)	(0.196)	(0.298)	(0.000)	(0.254)	(0.174)
State fixed effects	No	No	Yes	No	No	Yes	No	No	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hausman test: Prob>chi^2			0.000			0.130			1.000
Income turning point									
in 1993 constant Rs			18,521				12,353	14,879	
in 1993 international $‡$			3,227				2,152	2,592	
Observations	172	172	172	198	198	198	199	199	199
Number of States/ UTs			24			24			24
R-squared overall	0.516	0.640		0.471	0.733		0.316	0.374	
R-squared within			0.258			0.342			0.173

Notes: P-values in parentheses, *** Significance at 1%, ** Significance at 5%, * Significance at 10%.
† Share of two-wheelers is the reference category. ‡ In 1993, one international $ (PPP) corresponded to 5.74 Rs (*Source*: Penn World Tables 6.1).

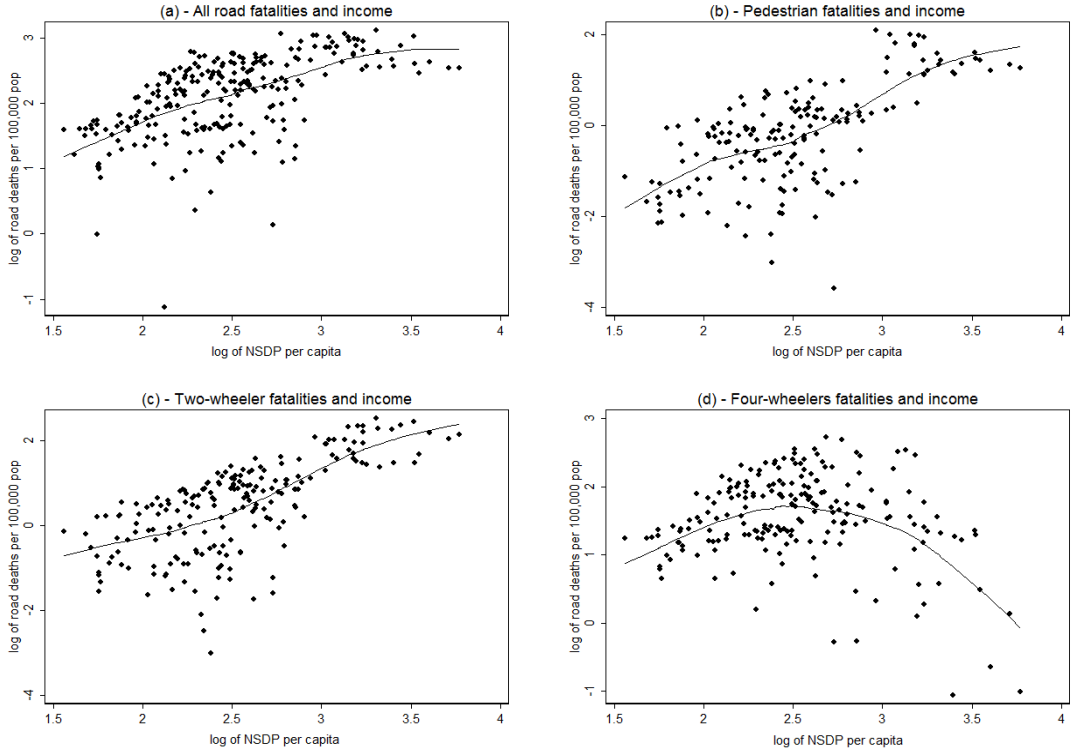
In Table 1.4, we run regressions similar to those in Table 1.3, but instead of using the overall fatality rate per population we use the number of pedestrian (columns (1)-(3)), two-wheeler (columns (4)-(6)) and four-wheeler fatalities (columns (7)-(9)) per 100,000 population. For each type of death, we present a regression with only income and income squared and time effects, a regression with income, all controls and time effects and a regression with income, all controls and with state-fixed and time effects. As can be seen, the inclusion of state-fixed effects in columns (3), (6) and (9) has a huge impact on the size and sometimes the sign of the regression coefficients. They also turn out to be very different from those in Table 1.3. The coefficient associated with population density for example increases if fixed-effects are introduced by a factor of 60 in column (3) and by a factor of more than 100 in columns (6) and (9). The intercept also increases considerably and overall the estimated coefficients are very sensitive to the inclusion and exclusion of certain variables. The Hausman test even rejects the use of fixed-effects in columns (6) and (9). Hence, in what follows we focus uniquely on the pooled OLS estimates, but control for time effects. Regressions using random-effects instead of fixed effects yield very similar regression coefficients to those seen in the pooled OLS results (results not reported in Table 1.4).

The unconditional income effects indicate an exponential growth of pedestrian and two-wheeler fatalities with income and a concave increase of four-wheeler fatalities (Figure 1.5). The turning point for four-wheeler fatalities (conditional on time-effects) is computed in column (7) of Table 1.4. It is situated at about 12,350 Rs. per capita per year (or 1993 Intl. $ 2,150). Figure 1.5 shows that the unconditional turning point for four-wheeler fatalities is significantly lower than the turning point for all categories of fatalities taken together, implying that in the process of income growth four-wheeler fatalities start to decline earlier than pedestrian and two-wheeler fatalities. The regression results suggest further that the pedestrian fatality rate increases with urbanization and slightly decreases with population density (holding urbanization constant). For example a 1% increase of the share of urban residents, increases the pedestrian fatality rate by about 1% (column (2)). A 1% increase in the population per km^2 however, decreases the pedestrian fatality rate by about 0.15%. Moreover, still focusing on column (2), pedestrian fatalities increase with higher literacy and decrease with the share of the male population. Motorization and the share of four-wheelers are both positively associated with pedestrian fatalities, implying that controlling for urbanization and population density, increased motorization and an increased share of four wheelers increase pedestrian fatalities. However, the two latter effects are not statistically significant.

Two-wheeler fatalities strongly increase with the motorization level and, surprisingly decline with the share of four-wheelers. For example an increase in the number of vehicles per population by 1%, increases the two-wheeler fatality rate by about 0.5% (column (5)). Two-wheeler fatalities also decline, quite plausibly, with expenditure per police officer and with the share of males. If for example, expenditures per police officer are increased by 1%, two-wheeler fatalities decline by 0.3%. Lastly, the estimates for four-wheeler fatalities suggest a decline with urbanization and the share of four-wheelers. This seems to suggest that in urbanized areas with a large number of four-wheelers, vehicles are slower and hence, four-wheeler fatalities are less likely. Literacy has a negative effect. Hence, taking all results together, literacy increases pedestrian fatalities, has no impact on two-wheeler fatalities and reduces four-wheeler fatalities. These effects are robust to the inclusion/exclusion of income but not to state

fixed effects.

Figure 1.5: Unconditionnal correlation between road traffic accident fatalities and income, 1994-2006



Source: See Table 1.6.

To see whether differences in religion can explain differences in fatality rates, we use the state fixed effects from Tables 1.3 and 1.4 and regress these on the religious composition in each state/UT, i.e. we treat the religious composition as a quasi fixed factor as these shares change only very slowly over time. In Table 1.5 we only report the regression coefficients, the R^2 as well as a joint F-Test. Note that religious composition is not available for all observations covered by the regressions in Table 1.3. Moreover, as explained above, the results by fatality type need to be interpreted with caution, as we do not have much confidence in the underlying fixed effect estimates. The joint F-test suggests that religion matters. For instance, whereas the proportion of Muslims seems, on average, to increase the fatality rate (although the effect is not significant), the proportions of Christians and in particular of Buddhists and Jains seem to reduce the fatality rate. If these regressions are alternatively run on pedestrian, two-wheeler and four-wheeler deaths, we find very similar results for two-wheelers only. The larger the share of these latter two groups, the lower the fatality rate. In general, religion can explain between 50% and 80% of the total variance in the fixed effects.

Table 1.5: Regression of state fixed-effects on religious distribution (Hinduism is reference category)

Dependent variable state fixed effects of:	All fatalities per 100,000 pop Table 3, col(6)	Pedestrian fatalities per 100,000 pop Table 4, col(3)	Two-wheeler fatalities per 100,000 pop Table 4, col(6)	Four-wheeler fatalities per 100,000 pop Table 4, col(9)
Islam (%)	1,654	24,534	14,123	3,737
	(0,514)	(0,247)	(0,112)	(0,475)
Sikhism (%)	-0,974	11,229	5,548	2,431
	(0,546)	(0,398)	(0,312)	(0,466)
Christianity (%)	-1,655*	-6,683	-5,561*	-1,732
	(0,063)	(0,344)	(0,063)	(0,321)
Buddhism, Jainism and other religions (%)	-3,128	-57,42***	-29,845***	-10,962**
	(0,108)	(0,007)	(0,000)	(0,011)
constant	-0,236	-1,39	-1,231	0,03
	(0,569)	(0,688)	(0,381)	(0,972)
Observations	19	17	19	19
R-squared	0,482	0,621	0,771	0,521
Year used for regression	2004	2004	2004	2004
Joint significance of religion				
F-Test	2,62	4,91	11,75	3,81
Prob > F	0,080	0,014	0,000	0,027

Notes: P-values in parentheses, *** Significance at 1%, ** Significance at 5%, * Significance at 10%.
State fixed effect were extracted from the regressions including time and states fixed effects of Tables 3 and 4.

As discussed in the data section, under-reporting of road traffic accident fatalities is a potential problem in India. According to Dandona et al. (2008) up to 20% of the cases might not be recorded by the police. Comparisons with WHO (2009) data show even larger gaps, but the WHO only provides predictions with the aim of producing coherent cross-country data sets. To be sure that our results are not much affected by measurement error, we conducted various robustness checks. In particular we simulated the impact of under-reporting on our regression results varying both the general magnitude as well as the correlation of under-reporting with income and police expenditure. For plausible ranges regarding the magnitude and these correlations, our results are very robust to under-reporting. Moreover, we have checked that the removal of states where reported data is somewhat erratic and hence systematic under-reporting might be an explanation does also not substantially affect our results.

1.4 Discussion

The role of aggregate income

The weakly concave relationship between road traffic accident fatalities and income is coherent with the inverted u-shaped relationship that other studies using cross-country panel data have found before (see e.g. Kopits and Cropper; 2005; Bishai et al.; 2006). Given India's GDP, we expect most Indian states to still be on the rising branch of this curve. And indeed, the turning point we identify is reached only by the richest states and towards the end of the observation window. If we break down fatalities by type of road users, we find that pedestrian fatalities and two-wheeler fatalities steadily increase with income, whereas four-wheeler fatalities first increase and then decline. This can be seen in Figure 1.5. The effect of motorization on four-wheeler fatalities is in fact weakly negative. This is not surprising in the Indian context, where rising motorization is accompanied by urbanization, increased population density and a steady increase in vulnerable road users, i.e. pedestrians and two-wheelers (see also Nantulya and Reich; 2003; Ameratunga et al.; 2006). Paulozzi et al. (2007) in fact shows that fatalities are highest during a critical transition to motorized travel, when many pedestrians and other vulnerable road users share the roadways with many motor vehicles. This observation is consistent with our findings. Likewise, Kopits and Cropper (2008) emphasize that a higher population density and urbanization results in an increase in pedestrian activity and hence higher pedestrian fatalities (per vehicle). Traynor (2008) shows similar evidence for the state of Ohio (USA). Our results differ in just one respect holding urbanization constant pedestrian fatalities decline slightly with population density. A plausible explanation might be that higher density is associated with a lower average speed of vehicles. Our multivariate analysis suggests that the decline of four-wheeler fatalities is indeed mainly driven by increased urbanization and a higher share of four wheelers in the traffic mix which may slow down the average speed, simply due to the size of four-wheelers as compared to two-wheelers (Table 1.4). Taken together, the estimates suggest that if the urbanization rate increases by 1%, the four-wheeler fatality rate per 100,000 of the population decreases by about 0.3%, whereas the pedestrian fatality rate increases by about 1%. This is an important finding.

Road and health infrastructure

Due to the paucity of available data, the role of road and health infrastructure was difficult to study. We do not find any effect related to the road density (length per km^2) or the quality of roads (results not shown). We believe there are different explanations for this. First, these variables are probably poor measures of road infrastructure and hence are probably better captured by urbanization. Second, better roads may have contrasting effects on road safety. On the one hand they may increase road safety e.g. through the absence of potholes and a better separation of vulnerable and non-vulnerable road users. On the other hand, as Keeler (1994) pointed out, better road infrastructure may also lead to faster driving and thus off-set some of the positive effects of improved health infrastructure. In the literature this is known as the 'Peltzman hypothesis'. Peltzman (1975) theorized that a road user is likely to be concerned with both the time the journey takes and his/her safety. Hence, if roads become safer, the motorist will likely offset the higher level of safety with faster driving, so that some of the enhanced safety is used to provide a faster trip. Such effects might be particularly relevant in a context like India, where the enforcement of road rules is low.

For richer countries, Bishai et al. (2006) identified lower injury severity and better post-injury medical care as one of the main mediating factors that reduce road accident fatalities (see also Jacobs and Cuttings; 1986; Van Beeck et al.; 2000; Kopits and Cropper; 2008). As we mentioned above, we were only able to find scarce and incomplete information on health infrastructure by state and year and hence we could not analyze this relationship quantitatively. However, given that the number of hospitals per population decreased rather than increased over time (Table 1.2), we speculate that the number of hospitals did not, in fact, contribute to the observed drop in fatalities. From our fieldwork we noted that the main issue may not in fact be the general presence or absence of hospitals but rather the poor quality of on-site first aid; many deaths could be prevented by transporting casualties to the medical facility more quickly.

Motorization and vehicle mix

With respect to motorization and the vehicle mix, we find distinct patterns for different categories of fatalities. Pedestrian fatalities seem to increase with the general level of motorization and with the share of four-wheelers, although these effects are not statistically significant in our regressions. For two-wheelers we find a strong positive effect associated with the level of motorization and a negative effect associated with the share of four-wheelers, which in turn suggests that – quasi mechanically – the two-wheeler fatality rate decreases with the share of two-wheelers. For car occupants and other four-wheelers, we find only a weak and, if any, rather negative effect of increased motorization. The share of four-wheelers significantly reduces four-wheeler fatalities, most likely because a higher share of four-wheelers, holding constant the level of motorization, means more congestion and hence a lower average speed as well as a more omogenous vehicle mix which together increase road safety.

Institutional quality

A very robust finding of our analysis is the significant negative impact of expenditure per police officer on road traffic accident fatalities. An increase in expenditure per police officer by 1% induces a decline of the fatality rate by about 0.15%. This is a sizeable effect. Table 1.4 suggests that this effect is mainly driven by two-wheeler fatalities. Looking at this group alone, suggests that an increase in expenditures per police officer by 1% induces an even greater decline of two-wheeler fatalities by 0.3%. We take this as an indication that a better paid and equipped police force is more effective in enforcing road traffic rules and that a higher enforcement rate has a direct effect on the frequency of road traffic accident fatalities, in particular those involving two-wheelers.

Socio-demographic characteristics

The effects related to urbanization and population density have already been discussed together with income and motorization, hence we focus now on the population composition by gender, education and religion. A higher share of women seems to be associated with more two-wheeler and pedestrian fatalities. A 10% increase in the male ratio, increases pedestrian and two-wheeler fatalities by about 0.8% to 0.9%. This is plausible, as women disproportionately walk, since they less often have a driving license and because they travel on average shorter distances as, among other things, their labor force participation is lower. Moreover, and maybe even more importantly, helmet usage is very low among female two-wheelers (drivers and passengers). A representative survey among two-wheelers that we conducted from July to September 2011 in Delhi revealed that 74% of men but only 31% of women regularly wear a helmet.

Quite unexpectedly we find a quite robust positive effect of literacy on the overall fatality rate. This may surprise, as one would assume that general formal education is correlated with, for example, awareness of road traffic laws and regulations, knowledge of traffic signs or offences and related penalties. However, our own experience in the Indian context based on a small survey that we undertook in Delhi in 2010, seems to show that road traffic-related knowledge was, in fact, very low in general and uncorrelated with formal education. In that survey we asked road users about the meaning of road signs such as ‘stop’, ‘no parking’, or ‘pedestrian crossing’. The results were quite surprising. Indeed, out of the ten questions asked, 27% of the 250 persons interviewed could not explain the meaning of any of the presented road signs, and 80% of them had more than six wrong answers. Even professional drivers such as taxi and cycle rickshaw drivers did not perform better on this test. Moreover, Fosgerau (2005) and others have argued that better education and hence a higher income may increase the perceived value of time and decrease the ‘real cost’ of fines (see also Polinsky and Shavell; 1979; Blomquist; 1986; Boyer and Dionne; 1987). Better educated and hence richer individuals may, therefore, drive faster, which will increase their chance of being involved in an accident. In light of this background, it is almost surprising that we find a negative effect of education on four-wheeler mortality (Table 1.4). However, we do not know how robust this finding is, as with state-fixed effects this variable loses significance. If it could be confirmed, it may capture vehicle quality or access to health care, but we think it is safe to say that more micro evidence is necessary to find out how education relates to risk attitude, exposure and knowledge.

Our regression analysis identified religion as an important driver of cross-sectional differences in the fatality rate. Although we do not find very robust differences between Hindus and Muslims, the two main religious groups, we find that the share of Christians and in particular Buddhists and Jains seems to reduce the fatality rate. Jains reject the caste system which may influence their behavior towards vulnerable road users. They also explicitly prescribe a path of non-violence towards all living beings which could also characterize their behavior as road users.

1.5 Conclusion

A strong increase in motorization levels coupled with urbanization are the general drivers of road traffic crash fatalities across Indian states. This is partly due to the increased number of vulnerable road users, i.e. pedestrians and two-wheelers. Some of the richer states can expect that they will soon have reached the turning point after which fatalities per population will decline again with further income growth. To accelerate this process, our analysis highlights the following areas where policy intervention can be particularly effective. First, our study suggests that increased enforcement of road traffic rules can lower road traffic crash fatality rates. In our sample, if mean expenditure per police officer is increased by 10%, the fatality rate is reduced, for instance, by 2%. Second, urbanization strongly increases the road accident fatality rate. This can possibly be best prevented by clearly separating pedestrians and vehicle users, for instance through the construction of sidewalks, traffic lights and properly indicated bus stops. Third, we find a clear female bias in the mortality among vulnerable road users. Hence, awareness campaigns should particularly target women, for instance to promote the use of helmets on motorbikes. Fourth, we find that certain religious groups are less involved in accidents than others. Although we cannot control for the intensity of road use, this suggests that road users behavior may differ across religious groups and that awareness and behavioral change campaigns should be targeted at those groups with more involvement. We think our findings may also apply to other countries, in particular those that are also still in the phase where fatalities per population are increasing, not decreasing, with income. More micro data covering information about road users risk attitude, risk knowledge and risk exposure would further enrich this kind of analysis.

1.6 Appendices

Table 1.6: Sources of data explored

Variables	**Source**	**Years covered**	**States covered**
DEPENDENT VARIABLE			
Road traffic accident fatalities per 100,000 population	calculated based on NCRB, Indian Censuses	1994-2008	UT and statewise
Pedestrian, two-wheeler and four-wheeler fatalities per 100,000 population	calculated based on NCRB, Indian Censuses	1996-2008	UT and statewise
INCOME			
Net domestic per capita at factor costs (thousands 1993 constant Rs)	Central Statistical Organisation	1994-2007	UT and statewise
SOCIO-DEMOGRAPHIC STRUCTURE			
Total population	Indian Censuses 1991 and 2001	1994-2008	UT and statewise
Share of the population that is male (%)	calculated based on Indian Censuses	1994-2008	UT and statewise
Share of the population that lives in urban areas (%)	calculated based on Indian Censuses	1994-2008	UT and statewise
Population per km^2	calculated based on Indian Censuses	1994-2008	UT and statewise
Share of the population that is literate (%)	Indian Censuses	1994-2006	UT and statewise
Religious composition	calculated based on Indian Censuses	1994-2008	UT and statewise
ROAD AND HEALTH INFRASTRUCTURE			
Land size	NCRB	1994-2006	UT and statewise
Roads per km^2	calculated based on transportindia.in	1996-2004	statewise
Number of hospitals per 100,000 population	calculated based on CEHAT, Census 2001	1994-2003	UT and statewise
MOTORIZATION			
Share of registered four-wheelers in total registered motorized vehicles	MORTH	1994-2006	UT and statewise
Number of registered motorized vehicles per 1 million of population	calculated based on MORTH, Census 2001	1994-2006	UT and statewise
INSTITUTIONAL QUALITY			
Police expenditures per officer (thousands 1993 constant Rs)	calculated based on NCRB	1994-2006	UT and statewise
Total cases for investigation per police officer	calculated based on NCRB	1994-2006	UT and statewise
Number of police officers per population	calculated based on NCRB	1994-2006	UT and statewise

Notes: NCRB: National Crime Records Bureau; MORTH: Ministry of Roads Transport and Highways; CEHAT: Centre for Enquiry into Health and Allied Themes.

Chapter 2

Presentation of the Road Safety Survey

Contents

2.1 Motivations

In Chapter 1, we explored the determinants of road traffic crash fatalities at the state level. Besides, quality of road infrastructures, individual behaviors appear to partly explain the road mortality burden as a higher expenditure per police officer is associated with a lower fatality rate and some sub-groups, such as women, seem to be more at risk.

Better prevention could, however, reduce the road crash burden on both household's income and economic growth. Nonetheless, the mechanisms supporting safer behaviors need to be first assessed in order to implement efficient and targeted prevention programmes which could effectively reduce and limit the frequency and severity of road traffic accidents.

The use of helmets has been proven to be really efficient in preventing road traffic mortality. In particular, Liu et al. (2008), based on 53 observational studies, concluded that wearing a standardized quality helmet reduces by 40% and 70% the risk of death and severe injuries respectively. When successful in raising the share of motorcyclists wearing a helmet, such policies have managed to cut down road fatalities at a reasonable cost. This has been the case in Vietnam or Cambodia (see WHO; 2013).[1] In India, helmet use has been made compulsory by the 1988 Motor Vehicle Act, each state being responsible for its implementation. Yet, its enforcement has failed to actually make all motorcyclists use a helmet. Indeed, it is quite common to see a whole family traveling on a motorbike, the driver being the only one wearing a helmet. Is it a financial matter? Helmets are of a relatively low cost when

[1] In 2008, 1,400 less individuals died on Vietnamese roads corresponding to an 11% annual decrease in road mortality. Despite this encouraging result, some problems related to the proper use of helmet still remain. According to a survey implemented in 2008 by the Vietnam Consumer Safety Association, 80% of vietnamese helmets did not met the safety criteria of national standards. In September 2013, a media road safety campaign promoting the use of quality helmet have been launched in Vietnam to tackle this issue.

compared to the purchase of a motorbike, the gasoline expenditures or the financial consequences of road traffic accidents. Nevertheless, the opportunity cost of a helmet may rather correspond to buying completely different consumption goods. If it is the case, households may decide to have only one helmet for all their members. Income earner family members are then likely to be prioritized for the use of this protective device. Do people underestimate road risks? Individuals' lack of awareness of road hazards are likely to partly explain the decision of not using a helmet. Hence, perceived enforcement of road rules, road risk awareness but also opinion regarding the utility of a helmet are factors likely to influence the motorcyclist's decision process regarding safe attitudes while traveling on a motorbike. Furthermore, individual risk aversion, previous experiences of road accident or neighbor's behaviors may also influence motorcyclists' conducts.

Unfortunately, to our knowledge, there is no available database which contains information on road crash and road behaviors at the individual level in India (or in any other developing country). No module related to road habits or safety behaviors is included in Indian national surveys such as the *National Sample Survey* or the *National Family and Health Survey*. Even a simple estimation of the helmet use rate in India is not currently available neither at the national, regional nor local level.[2] Moreover, the police department, which is in charge of collecting data on road accidents, often only gather the information on the circumstances of the crash leaving aside additional characteristics of road users involved in the event. Information on use of safety devices (helmets, seat belts), on risky driving (drunk driving, speeding) and other road factors are sadly missing from police records (Barffour et al.; 2012). Therefore no database links the road traffic crashes with individuals' socio-demographic characteristics, information on risk aversion, awareness and perception of road risks; which all are certainly key to better identify the mechanisms leading to safe behaviors such as the use of a helmet.

2.2 Objectives and expected outcomes of the survey

The absence of data on behaviors adopted by road users, and in particular by motorbike drivers and passengers made the collection of original data necessary to study this topic. Such a survey will allow to (i) document the road habits of motorcyclists in a big city like New Delhi with a particular focus on road safety attitudes; (ii) identify the determinants of safe conducts such as helmet adoption; (iii) suggest relevant policy measures to be implemented and particular subgroups to be targeted. More precisely, based on the information gathered with this survey, we aim at understanding what make two-wheeler users wear a helmet and what prevent them from adopting such behavior. In particular, we will attempt to disentangle the respective roles of individual characteristics (such as income), peers' behaviors, financial incentives or awareness on helmet adoption and other safety behaviors.

[2] Some cities provide figures on helmet use rates, this is notably the case of Bangalore (Gururaj; 2011). As for Banu et al. (2013), they interviewed college youths two-wheeler riders in Delhi. 50% of their respondents declare that they use almost always the helmet while 25% of them use it less than 75% of the times.

2.3 Data collection

Thanks to fundings by the Health chair of Paris-Dauphine University, the International Institute of Social Studies - Erasmus Rotterdam University (ISS - EUR) and the Paris School of Economics (PSE) research fund, we developed an original questionnaire, presented in further details hereinafter. We benefited greatly from advice and feedbacks from Professors at the ISS and PSE.[3] I spent four months from June to September 2011 in New Delhi in order to monitor and supervise the implementation of the survey done by a local firm specialized in data collection, Sigma Research and Consulting.[4] The first year of my PhD has therefore been mainly dedicated to the search of funding, elaboration of the questionnaire and implementation of the survey. Both the questionnaire and the data collection are presented in depth below.

2.3.1 Questionnaire

Informations on road behaviors, risk aversion, road rules enforcement, as well as awareness, road crash experiences, road safety attitudes, motorbike characteristics and insurance coverage were gathered. Moreover, subjective probabilities of injury and police halt if not wearing the helmet and subsequent financial consequences (respectively medical expenditures and fines) were also elicited. This, in addition to many socio-demographic characteristics. Table 2.10 lists the questionnaire's modules and blocks. The english version of the questionnaire is also included in the Appendices.

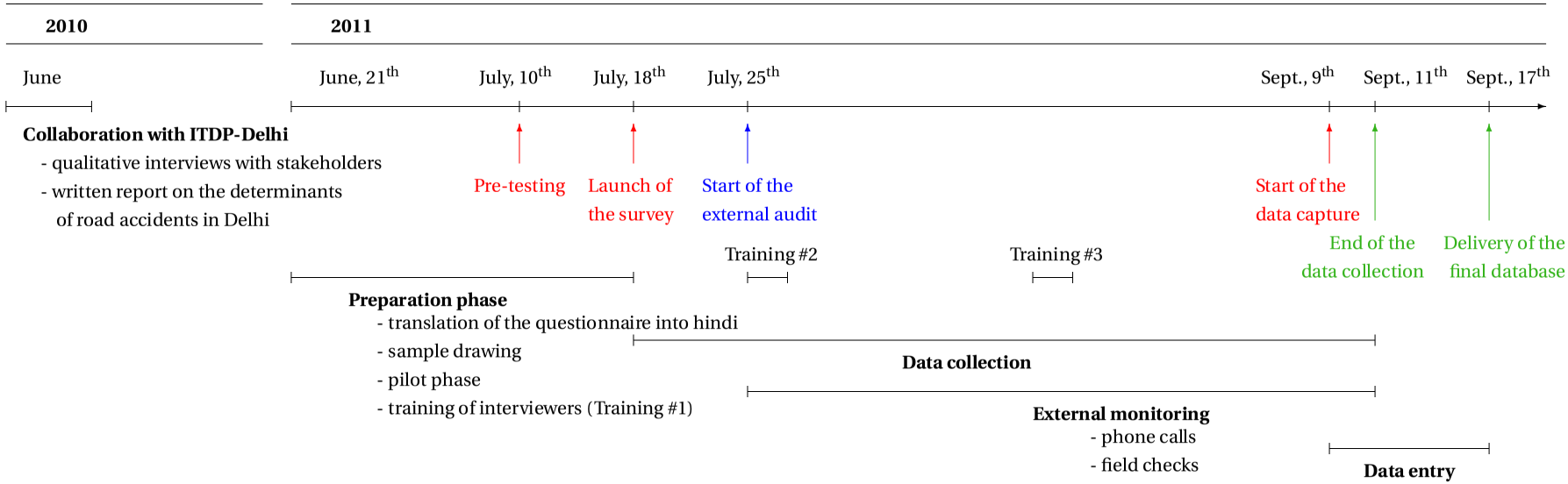
To our knowledge, it is the first time that information on road behaviors, road risk perceptions and risk preferences are all collected in one survey implemented in a developing country.

2.3.2 Implementation of the survey

In the subsequent paragraphs, I briefly summarize the different steps of the survey implementation. The precise timeline is reported in Figure 2.1. We first did a qualitative survey on road safety in Delhi with the collaboration of a local NGO – Initiative for Transportation and Development Programmes (ITDP-Delhi). We subsequently designed and implemented a household survey. I had the great opportunity of participating at each step of the process: from the sample drawing, the pre-testing, the interviewers' training to the supervision and monitoring of the survey and the data entry. Such presence during the field work provided additional insights regarding the quality of the data collected. In particular, interviewers and respondents had some difficulties in understanding some of the survey questions because of differences between Occidental and Indian ways of thinking. These field feedbacks were also of great help in interpreting some results found when analyzing the data.

[3] In particular, the content of the questionnaire has been presented in a seminar at the ISS in March 2011.
[4] http://www.sigma-india.in

Figure 2.1: Field work timeline, from June 2010 to September 2011



Sample drawing

Our study focuses on motorcyclists. Nevertheless, we were not able to base our sample design either on a list of two-wheeler users, or on a list of households owning a motorbike. Instead, we randomly selected households from Delhi's entire population.[5]

We took advantage of the administrative decomposition of the Indian capital city. Delhi is composed of five zones – Central, East, North, South and West – and 70 constituencies. Each constituency contains on average 153 polling booths. These polling booths are gathered by location.[6] These locations correspond to what we called "starting points". Based on a rough calculation, it seemed that 1,000 respondents were a minimum to be reached in order to be able to stratify our sample by religion. According to the 64th round of the *National Sample Survey* (2007-2008), 40% of households are motorbike owners in Delhi. Given this figure and assuming that on average a bit less than two motorcyclists per eligible household would be interviewed; we needed 1,500 households in order to end up with a sample of around 1,000 motorcyclists[7,8]. To reach that number, 10 polling booths corresponding to 10 starting points were randomly drawn in each zone.[9] The size of the sample was also constrained by the duration of each questionnaire and the available budget.

In order to randomly draw the 50 starting points, the following procedure has been adopted. First, in each of the five zones of Delhi, constituencies have been ordered and polling booths numbered. Second, an interval value I corresponding to one tenth of the total number of polling booths have been computed. Then a number N inferior to the value I was randomly drawn. The location of the related polling booth corresponded to the first selected starting point. The second starting point was obtained by adding the value I to the random number N and looking at the corresponding polling booth. The same procedure was followed until 10 locations have been chosen per zone. The interval I ensures a certain geographical distance between the starting points. Indeed, the polling booths attached to one unique location were ranked one after the other. By using this procedure, 47 different constituencies have been selected. In three of them two starting points were drawn. The other 44 selected starting points are all in different constituencies. Table 2.1 reports the number of constituencies and polling booths per zone along with the corresponding values I and the numbers drawn N. The list of constituencies and the exact location of the drawn polling booths are reported in Table 2.11 in the Appendices.

In each starting point, households have been selected following a precise routine: from the address of the polling booth and going in two different directions[10] every fifth household was selected for the interview until 15 households agreed to answer the questionnaire.

In each household the list of all members aged above 15 has been collected.[11] The motorbike status – user or

[5] This will allow us to study the particularities of households with members who use the motorbike compared to others households (cf. section 3 below).

[6] These locations are actually governmental schools where people assigned to each polling booth are supposed to go and vote.

[7] 1,500 households × 0.4 eligible households × 1.8 respondents = 1,080 respondents.

[8] This computation does not take into account households who don't own a motorbike but who have some of their members who use such mode of transportation.

[9] 5 zones × 10 starting points × 2 sides × 15 households = 1,500 households.

[10] Enumerators were told to go either to the left or to the right of the polling booth's location.

[11] Up to a maximum of 8 members.

Table 2.1: Sample drawing

Delhi's zones	Central	East	North	South	West	Total
# of constituency assemblees	9	16	8	14	23	70
# of polling booths	1,440	2,426	1,194	2,074	3,567	10,701
Value I	144	242.6	119.4	207.4	356.7	
Random number N = 1st SP	36	109	69	110	235	
$N + I$ = 2nd SP	180	352	188	317	592	
$N + 2 \times I$ = 3rd SP	324	595	308	525	949	
$N + 3 \times I$ = 4th SP	468	837	427	732	1,305	
$N + 4 \times I$ = 5th SP	612	1,080	546	939	1,662	
$N + 5 \times I$ = 6th SP	756	1,322	666	1,147	2,019	
$N + 6 \times I$ = 7th SP	900	1,565	785	1,354	2,375	
$N + 7 \times I$ = 8th SP	1,044	1,808	905	1,562	2,732	
$N + 8 \times I$ = 9th SP	1,188	2,050	1,024	1,769	3,089	
$N + 9 \times I$ = 10th SP	1,332	2,293	1,143	1,976	3,446	

Notes: SP stands for starting point.

non user, driver and/or passenger – of each household member has been assessed. More precisely, an individual was considered as a motorcyclist if he had traveled at least once on a motorbike in the previous four weeks. A short questionnaire was filled by one member of the family in case there was no motorcyclist in the household; such households were qualified as 'non-eligible'. A longer questionnaire was completed by up to three motorcyclists among the 'eligible' households. A preference for head of household and his spouse has been applied. A Kish grid (Kish; 1965) has been used to select the remaining eligible individuals to be interviewed within each household (cf. instructions to enumerators in the Appendices).

In total, 1,502 households were surveyed. In 545 households at least one member had used a motorbike in the previous four weeks. Up to three users per household, either drivers or passengers, were interviewed. 212 selected individuals refused to answer to the questionnaire, leading to a final sample of 902 motorcyclists. Figure 2.2[12] presents the share of eligible households per constituency[13], along with the average number of motorcyclists, selected individuals and respondents per eligible household per constituency. We note that these numbers vary quite substancially across constituencies. While the variation in the share of eligible households (from 6.7% to 90%) and number of motorcyclists per household (from 1.3 to 4.4 members) may come from the population characteristics of each area, the variation in the refusal rate[14] partly comes from the ability of each interviewer to convince selected individuals to answer the survey.

[12] All maps have been realized using Philcarto software. The map of Delhi's constituencies have first been digilitalized using Phildigit software.

[13] The GPS code of starting points or households have not been collected by the survey firm. Given that for the vast majority of cases there is only one polling booth per constituency we decided to use this unit of desagreggation to represent graphically starting point characteristics.

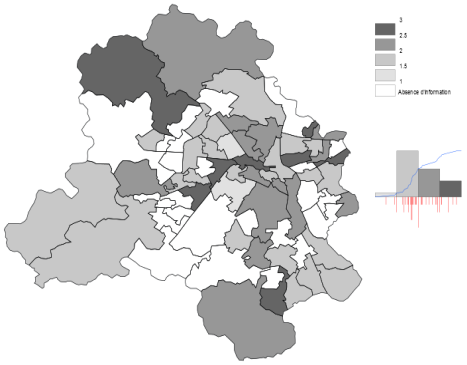
[14] Refusal rate = $\frac{\text{\# of selected individuals - \# of respondents}}{\text{\# of selected individuals}}$

Figure 2.2: Selection of respondents per constituency

(a) share of eligible households

(b) average number of motorcyclists per eligible household

(c) average number of selected people per eligible household



(d) average number of interviewed people per eligible household

Translation of the questionnaire into hindi

The questionnaire has been translated into Hindi, which is the most commonly used language in New Delhi. Of course, such translation may slightly alter the initial formulation of questions. As a further precaution, the most sensitive questions have been extensively discussed and explained to the project manager in charge of the implementation of the survey, so that he could provide all the necessary clarifications to the translator if needed.

Pilot-phase

Three senior interviewers, who later supervised the final survey, were in charge of the pilot-phase. They first attended a one day training where the project manager and myself presented the questionnaire module by module. Mocked tests were then performed. The pilot of the questionnaire was conducted on the 10^{th} of July in Lajpat

Nagar III, South Delhi.[15] Eight households were interviewed. The pre-test was implemented in order to get some sense of how the households would react to the survey, the actual duration of the questionnaire as well as potential misunderstanding of questions. Depending on the interviewer and the number of individuals interviewed per household, the completion of the questionnaire lasted between one and two hours.

Based on these feedbacks, some questions have been modified and a particular focus has been given to certain points during the following training sessions. In particular, the pre-test highlighted that some questions were either not formulated adequatly, too difficult to understand or required that the interviewer made some computation which led to a loss of interest and a rise in the respondent's fatigue. This was in particular the case for the elicitation of the subjective distribution of medical expenditures and fines. In the initial version of the questionnaire, the respondent was first asked about the minimum and maximum amount of medical expenditures and fines, then the inquirer computed three thresholds and asked what was the probability the individual would have to pay less than each of these four limits (the three thresholds and the maximum). This, following the elicitation methodology used for instance by Dominitz and Manski (1997b). Given the enumerator's difficulties in computing the intervals and the subsequent impatience or disinterest shown by respondents, we decided to replace the self-anchored methodology by pre-determined scales.

Training sessions

Training sessions were done in Hindi by the project manager and supervisors who had been trained for the pilot-phase.[16] Before starting the detailed reading of the questionnaire, I personally presented the objective of the survey as well as the institutions involved in the project.

The training was organised as follows. First, the different modules were reviewed. Then each module was read, explained, and role-playing was performed by the trainees. Sections on risk aversion and anticipations of injuries and fines received particular attention due to their complexity. The attitude to be adopted in front of the selected households to convince them to answer the survey and limit the refusal rate was subsequently described. Finally, the process of selection of individuals among the motorcyclist members was presented in depth. In particular, interviewer trainees practiced the Kish matrix which was used to select eligible members.

In addition to the role-playing exercices, a field session has been organised nearby the office (South extension-part II, South Delhi). Each interviewer completed at least one long questionnaire. Subsequently, I personally checked their work and provided them a one-to-one debriefing in order to stress the sections which appeared not to be understood correctly. The training session ended with a summary of the observed difficulties faced by different enumerators. The routine to be adopted for the selection of households as well as the choice of motorcyclists within eligible households was again recalled. A document summarizing all the instructions to be followed during the interviews was distributed to each interviewer (cf. Appendices).

[15] This zone has been chosen due to his location nearby Sigma's office headquarters. No starting point was selected near this area.

[16] Hindi lessons, which I took during the first semester of 2011 at the Ecole Normale Supérieure, allow me to follow roughly speaking the delivery of the training.

Due to an important turn-over of enumerators, new interviewers were actually hired all along the survey implementation in order to be able to complete the survey on time. In total three training sessions have been organised (July 13-16, July 25-26 and August 23-24). Basic information regarding supervisors and interviewers is reported in Table 2.12.

Implementation of the survey

The survey was launched on July 18th. Teams of two enumerators were sent to cover each starting point. To ensure that enumerators followed correctly the household selection routine, they were asked to fill a 'context sheet' with the adresses of selected households, whether they agreed or not to do the survey and if they answered the questionnaire whether they were eligible or not. If the selected motorcyclists were absent at the time of the first visit, a new visit was scheduled. Enumerators were asked to record the date and hour of those appointments in the context sheet. Supervisors were supposed to accompany interviewers who started a new area to make sure the selection of households started from the right location. They were also in charge of checking whether the routine was correctly followed, gathering the questionnaires once completed and keeping track of the survey progress. In total, 17 interviewers and 4 supervisors worked on the survey. The number of long questionnaires completed by each enumerator depends on the date at which s/he started to work and on whether s/he was sent to areas with an important share of motorcyclists. On average each area has been covered by 2.3 interviewers and each enumerator went to 6.7 starting points. The latter interviewed on average 53 motorcyclists. While the presence of other family members during the interview is likely to alter the quality of the data collected (Tourangeau and Yan; 2007), we acknowledge that in the context of our survey neither an isolated interview has been required nor information about which members of the household were present during the interview has been gathered.

External monitoring and supervision

In addition to the internal supervision made by Sigma Research and Consulting, I set up a back-checking and cross-checking of the data collected by the interviewers. To do so, I hired a hindi speaking person, external to the survey firm, who helped me in verifying the quality of the information contained in the questionnaire.

This external audit aimed at controlling whether (i) the households were properly selected, (ii) all eligible households and individuals were recorded and (iii) selected individuals were actually interviewed. More precisely, the verifications were of two types. First, based on the landline or mobile number provided by each interviewed household, phone calls were made to verify their name, address, and the approximative duration of the survey. Partial interviews were also done. In particular we verified whether the household was eligible or not and how many members were motorcyclists and thus were supposed to answer to the questionnaire. Second, we randomly selected a subsample of starting points and went back on the field. By doing so, we were able to check if the routine had been followed; this based on the context sheet interviewers completed. Moreover, by reinterviewing households we verified that individuals from eligible households were indeed asked long questionnaires and not only short ones. Finally, we asked a set of random questions from the survey to respondents in order to later compare them to the answers filled by Sigma's staff. This set of external checks started on the 25th of July, just one week

after the launching of the survey. It turned out to be essential in order to ensure the quality of the data provided by the local firm. Indeed, some interviewers cheated on the eligibility of the selected household or simply filled themselves the questionnaires in order to finish sooner their work. These controls allowed us to detect such falsifications. In several areas the routine was not followed or the right individuals were not interviewed. We therefore decided to cancel the corresponding questionnaires and select new households. The cancellation of some of the starting points translated into some confusion regarding the state of progress of the survey and some delay regarding the expected end of the data collection phase. Extra staff was therefore hired in August to compensate for this extension and ensure that the survey would be completed on time. The data collection ended on the 11^{th} of September.

Data capture

Several meetings were set up with the data programming manager in July and August to discuss the data entry program. We agreed on the precise coding to be used and the presentation of the final data to be delivered.

The data capture was done by an external specialized firm. Before sending the questionnaires to the subcontractor, they were all scrutinized by Sigma's staff. In particular identification codes were added to ease the task of the data entry employees. A specific training session was organized for the latter on September 9^{th}. The questionnaire was presented and the coding explained in depth. Data entry of the first questionnaires started right after the practice.

The data capture has been done using the CS-Pro package. Because of budget constraints, no double entry of the data has been performed. Nonetheless, I checked the correctness of 5% of the questionnaires. A mistake rate of around 1% was found.

Final data was provided to us in *STATA* format by Sigma Research and Consulting on the 17^{th} of September.

2.4 Description of the data

1,502 households were interviewed, out of which 545 had at least one member who had used the motorbike in the past four weeks. Up to three individuals per household could be interviewed: one, two and three individuals have been interviewed in respectively 51%, 32% and 17% of eligible households (cf. Table 2.2), leading to a final sample of 902 motorcyclists.

Table 2.2: Distribution of respondents per eligible household

		% of household	**# of passengers**			
# of respondents	% of households	**# of drivers**	0	1	2	3
1	51.38	0	3.49	16.33	3.49	0.55
2	31.74	1	32.48	21.28	7.16	0
3	16.88	2	6.61	7.52	0	0
observations	*545*	3	1.10	0	0	0

Notes: 27 individuals declare they were both driver and passenger. This explains why 3.49% of households have no driver and no passenger. Those household may have one, two or three uncategorized motorcyclists.

Before describing the socio-demographic characteristics of our sample, I provide evidence of the representativeness of this database. To do so, I first investigate whether our selected households are representative of the Delhi population by comparing them with the 64th National Sample Survey (2007-2008). In a second step, I investigate the similarity of the selected and non selected motorcyclists. Finally, I make sure that individuals who refused to answer the survey are not too different from those who agreed.

2.4.1 Representativeness of our sample

Comparing our sample with the *National Sample Survey*

In order to provide evidence that our survey is representative of Delhi inhabitants, I compare our sample with the data on Delhi provided by the 64th National Sample Survey (NSS-2007). I look at household's and head of household's characteristics of (i) all households, (ii) households who own a motorbike and (iii) other households from the two surveys. When considering households who own a motorbike, we note that they don't differ in terms of religion or social groups (cf. Table 2.3). Regarding the head of household's characteristics, they are more likely to have some tertiary education and are older in our sample than in the NSS. However, distribution of gender, marital status and literacy is similar across samples for these particular households. Therefore, our sample has not been reweighted in the analyses presented in Chapters 3, 4 and 5.

Differences between selected and other motorcyclists

When selecting motorcyclists, a priority was given to the head of the household and his spouse. In other words, in case these individuals did use the motorbike in the previous month, they were automatically selected. The remaining interviewees were then randomly chosen thanks to the Kish grid. Given this feature of the sample design, it is not surprising to see that selected motorcyclists are more often married, more likely to have children and more likely to work and to contribute substantially to the income. The differences in the distribution of highest education degree reached among selected and other motorcyclists can also be explained by the higher and lower level of education of respectively household heads and their spouses (cf. Table 2.4, columns (3) and (4)).

Differences between selected individuals who agreed to answer and those who refused

Table 2.4 (columns (5) and (6)) also compares individuals who answered to the survey and those who didn't. The only significant differences between refusals and consents are gender and status in the household. More precisely, the shares of men and heads of household among individuals refusing to answer to the survey are significantly lower. This may be due to pressure on some women who were actually not allowed by their family to answer the survey.[17] Overall, individuals who did not fill in the questionnaire appear to have similar socio-demographic characteristics as the final respondents; which gives us confidence in the quality and the representativeness of our data.

[17] Such behavior has been reported by a few interviewers in particular in areas with a higher share of Muslims.

Table 2.3: Comparing HH characteristics between NSS-2007 and our Road Safety Survey

	All HH			**Two wheeler non owners**			**Two wheeler owners**		
	NSS	RSS		NSS	RSS		NSS	RSS	
Observations	*(621)*	*(1502)*		*(374)*	*(1045)*		*(247)*	*(457)*	
Variables	Mean	Mean	t-test	Mean	Mean	t-test	Mean	Mean	t-test
HH characteristics									
HH size	4.03	4.94	⋆⋆	3.98	4.76	not	4.11	5.35	⋆⋆
Religion									
Hindu (%)	82.13	82.42	not	81.02	82.20	not	83.81	82.93	not
Muslim (%)	11.92	12.38	not	13.64	12.63	not	9.31	11.82	not
Sikh (%)	4.51	3.99	not	4.01	4.02	not	5.26	3.94	not
Christian (%)	0.97	0.87	not	1.07	0.86	not	0.81	0.88	not
Social group									
ST, SC or BC (%)	39.45	40.55	not	40.91	44.59	not	37.25	31.29	not
Head of HH characteristics									
Age (in years)	41.56	46.70	⋆⋆	41.24	45.70	⋆⋆	42.06	49.00	⋆⋆
Male (%)	92.91	90.48	⋆⋆	93.58	90.05	not	91.90	91.47	not
Marital Status									
Never married (%)	10.14	3.73	⋆⋆	11.76	3.92	⋆⋆	7.69	3.28	not
Currently married (%)	81.80	85.69	not	81.28	85.26	not	82.59	86.65	not
Widowed (%)	7.73	10.05	not	6.68	10.24	not	9.31	9.63	not
Divorced (%)	0.32	0.53	not	0.27	0.57	not	0.40	0.44	not
Education									
illiterate (%)	10.95	18.97	⋆⋆	9.09	22.58	⋆⋆	13.77	10.72	not
> graduation (%)	25.12	28.50	not	26.20	21.82	not	23.48	43.76	⋆⋆

Notes: ⋆⋆ Significant at 5%

Table 2.4: Socio-demographic differences between individuals belonging to eligible households

Within eligible households	**all members**			**motorcyclists**			**selected motorcyclists**		
	motorcyclists (1)	others (2)	p-value	selected (3)	others (4)	p-value	answers (5)	refusals (6)	p-value
observations	*1323*	*832*		*1114*	*209*		*902*	*212*	
Age (years)	34.63	38.22	0.000	36.16	26.46	0.000	36.47	34.84	0.109
Male (%)	64.22	39.90	0.000	65.85	55.50	0.004	67.40	59.43	0.028
Status in the household (%)									
HH head	29.48	18.72	0.000	34.92	0.48	0.000	37.69	23.11	0.000
spouse of HH head	18.14	26.21	0.000	21.36	0.96	0.000	21.51	20.75	0.810
Marital status (%)									
Never married	27.79	31.33	0.079	24.71	44.23	0.000	24.05	27.49	0.298
Married	69.78	62.05	0.000	72.86	53.37	0.000	73.39	70.62	0.416
Divorced	0.53	0.36	0.573	0.36	1.44	0.049	0.33	0.47	0.761
Widowed	1.90	6.27	0.000	2.07	0.96	0.281	2.23	1.42	0.461
Has no children (%)	8.24	6.35	0.108	7.23	13.66	0.002	7.49	6.16	0.504
number of children (#)	1.91	1.97	0.333	1.99	1.26	0.000	1.97	2.09	0.266
Education level (%)									
illiterate	6.71	14.93	0.000	7.26	3.83	0.069	6.95	8.57	0.416
primary education	15.03	22.09	0.000	15.79	11.00	0.076	15.36	17.62	0.420
secondary education	33.94	30.22	0.074	32.49	41.63	0.011	32.96	30.48	0.490
tertiary education	44.32	32.77	0.000	44.46	43.54	0.806	44.73	43.33	0.714
Sector of work (%)									
public	9.98	6.05	0.002	10.86	5.26	0.012	11.31	8.96	0.323
private	22.60	9.44	0.000	23.52	17.70	0.065	23.84	22.17	0.607
self-employed	17.23	7.14	0.000	18.04	12.92	0.072	18.18	17.45	0.804
unemployed	2.65	3.51	0.251	2.33	4.31	0.103	21.51	3.77	0.123
inactive	46.86	73.61	0.000	44.52	59.33	0.000	43.90	47.17	0.390
Contributes to HH income (%)	50.68	22.83	0.000	53.87	33.65	0.000	55.00	49.06	0.119
Share of the contribution (%)									
less than 20%	52.33	79.11	0.000	48.69	72.06	0.000	47.09	55.45	0.029
20 to 40%	9.17	5.92	0.007	7.78	16.67	0.000	7.49	9.00	0.462
40 to 60%	13.67	8.09	0.000	14.48	9.31	0.049	14.77	13.27	0.579
60 to 80%	4.05	1.81	0.004	4.52	1.47	0.042	4.81	3.32	0.349
more than 80%	20.78	5.07	0.000	24.52	0.49	0.000	25.84	18.96	0.037

2.4.2 What are the particularities of motorcyclists?

A first outcome of this survey is to provide information regarding motorbike users. More precisely, I first document on which dimensions households with at least one member using a moto as mean of transportation differ from other families. Given that basic socio-demographic characteristics of all members older than 15 years old have been gathered, I subsequently investigate the differences within motorbike households between motorcyclists and other members and between type of motorcyclists. Table 2.5 displays the socio-demographic differences between

'eligible' and 'non eligible' households on the one hand and between households who own a motorbike and other motorcyclist households on the other hand. Table 2.4 considers only 'eligible' households and compares members according to their motorbike status (users vs. non users). Finally, Table 2.6 compares drivers and passengers who were selected for the interview and accepted to complete the questionnaire.

Comparing 'eligible' and 'non eligible' households

36.3% of households have at least one member who used the motorbike in the past four weeks. From Table 2.5 (columns (2) and (3)) we note that the eligible households are significantly bigger (on average 5.3 members vs. 4.7 individuals). There is no difference in terms of religion distribution, but households with motorcyclist members are less likely to belong to a schedule caste or schedule tribe.[18] Similarly, they are richer than non motorcyclist households. Regarding the characteristics of the household's head, in 'eligible' households the latter is a bit older, less likely to have no child, more educated, more likely to work in the public sector and less likely to work in the private one.

Differences between motorbike owners and other eligible households

84% of 'eligible' households own a motorbike. When comparing households who have a motorbike and those who have motorcyclist members but no motorbike, we observe that the latter are more likely to belong to a low caste and earn less than 10,000 INR per month. The head of household is also more likely to have only primary education and to be unemployed. As for the former households they are more likely to earn more than 20,000 INR per month, their household's heads have also more often tertiary education. Not suprisingly, families who own a motorbike have a higher social status than households with members who use this mode of transport but who don't possess their own vehicle (cf. Table 2.5, columns (4) and (5)).

[18] Schedule castes and schedule tribes are two groups of people who have been historically disadvantaged in India.

Table 2.5: Socio-demographic differences between different type of households

		all households			**eligible households**		
	all	eligible	non eligible	p-value	moto owners	others	p-value
	(1)	(2)	(3)		(4)	(5)	
Characteristics of the HH							
observations	*1502*	*545*	*957*		*457*	*87*	
Household size (#)	4.94	5.31	4.73	0.000	5.35	5.09	0.353
Religion (%)							
hindu	82.42	84.22	81.40	0.168	82.93	91.95	0.034
muslim	12.38	11.19	13.06	0.291	11.82	6.90	0.180
sikh	3.99	3.49	4.28	0.448	3.94	1.15	0.195
Caste (%)							
ST or SC	15.20	10.99	17.58	0.000	10.22	15.12	0.185
OBC	25.76	22.72	27.47	0.044	21.56	29.07	0.128
General	58.46	65.32	54.55	0.000	68.22	55.81	0.026
HH monthly income (%)							
observations	*1254*	*447*	*807*		*368*	*78*	
less than 5,000 INR	29.35	15.44	37.05	0.000	12.77	26.92	0.002
5,000 to 10,000 INR	28.87	24.61	31.23	0.013	22.83	33.33	0.051
10,000 to 15,000 INR	18.82	24.61	15.61	0.000	26.09	17.95	0.131
15,000 to 20,000 INR	11.48	16.11	8.92	0.000	16.85	12.82	0.381
more than 20,000 INR	11.48	19.24	7.19	0.000	21.47	8.97	0.011
Characteristics of HH's head							
observations	*1502*	*545*	*957*		*456*	*87*	
Age (years)	46.61	48.69	45.42	0.000	48.95	47.41	0.334
Male (%)	90.51	92.10	89.61	0.115	91.67	94.25	0.414
Marital status (%)							
Never married	3.74	3.67	3.78	0.921	3.29	5.75	0.266
Married	85.64	86.21	85.31	0.632	86.62	83.91	0.502
Divorced	0.53	0.55	0.52	0.946	0.44	1.15	0.413
Widowed	10.09	9.56	10.39	0.609	9.65	9.20	0.895
Has no children	9.69	4.79	12.51	0.000	4.82	4.65	0.945
number of children	2.17	2.19	2.15	0.610	2.17	2.26	0.586
Education level (%)							
illiterate	19.22	11.50	23.62	0.000	10.84	15.12	0.256
primary education	26.77	17.44	32.10	0.000	13.94	36.05	0.000
secondary education	25.22	30.80	22.03	0.000	30.97	29.07	0.726
tertiary education	28.79	40.26	22.25	0.000	44.25	19.77	0.000
Sector of work (%)							
public	15.98	19.67	13.87	0.003	20.83	13.79	0.131
private	34.49	30.88	36.55	0.026	29.39	37.93	0.114
self-employed	28.61	26.84	29.62	0.252	26.97	26.44	0.918
unemployed	1.40	1.29	1.47	0.771	0.88	3.45	0.051
inactive	17.11	19.85	15.55	0.033	20.61	16.09	0.334
Contributes to HH income (%)	85.48	82.72	87.07	0.022	82.02	86.21	0.345
Share of the contribution (%)							
less than 20%	15.86	19.52	13.77	0.003	20.44	14.94	0.237
20 to 40%	4.02	4.24	3.89	0.744	4.18	4.60	0.858
40 to 60%	15.73	17.31	14.83	0.205	16.48	21.84	0.228
60 to 80%	10.78	9.02	11.78	0.099	9.89	4.60	0.115
more than 80%	53.61	49.91	55.73	0.030	49.01	54.02	0.393

Table 2.6: Socio-economic characteristics breakdown by motorcyclist and gender

	all respondents	**all drivers** [1]	**all passengers** [2]	difference significance [2] -[1]	
Male (%)	67.37	97.02	25,07	0.000	
observations	*901*	*503*	*371*		
	all respondents	**male drivers** [1]	**male passengers** [2]	difference significance [2] -[1]	**female passengers**
Age (%)					
15-19 years old	7.10	7.17	13.98	0.029	4.32
20-29 years old	27.83	30.53	18.28	0.017	23.38
30-39 years old	26.05	25.41	13.98	0.017	32.37
40-49 years old	20.84	20.29	15.05	0.243	25.18
50-59 years old	10.98	11.27	17.20	0.110	8.99
60 years and above	7.21	5.33	21.51	0.000	5.76
mean (in years)	36.47	35.47	42.10	0.000	37.00
observations	*902*	*488*	*93*		*278*
Married (%)	73.39	68.82	69.48	0.898	85.56
observations	*898*	*485*	*93*		*277*
Number of children	1.5	1.33	1.52	0.233	1.86
observations	*893*	*481*	*93*		*276*
Contributes to hh income (%)	55.00	80.94	68.82	0.009	5.78
observations	*900*	*488*	*93*		*276*
Contribution share (%)					
less than 20%	47.09	20.75	35.48	0.002	94.93
between 20 and 40%	7.49	11.20	8.60	0.460	1.09
between 40 and 60%	14.77	19.71	22.58	0.528	3.62
between 60 and 80%	4.81	7.68	4.30	0.248	0.36
more than 80%	25.84	40.66	29.03	0.035	0.00
observations	*894*	*482*	*93*		*276*
Education level (%)					
illiterate	6.95	2.49	7.53	0.013	14.91
primary education	15.36	11.02	27.96	0.000	18.18
secondary education	32.96	33.06	44.09	0.041	31.27
tertiary education	44.73	53.43	20.43	0.000	35.64
observations	*892*	*481*	*93*		*275*
Religion (%)					
Hindu	84.37	83.40	86.02	0.530	86.69
Muslim	11.09	12.09	10.75	0.715	9.35
Sikh	3.44	3.28	2.15	0.566	3.24
observations	*902*	*488*	*93*		*278*
Pray daily	71.24	65.23	74.19	0.093	80.73
Believes fate is in god's hands	88.18	87.47	90.22	0.460	87.27
observations	*897*	*486*	*93*		*275*

Notes: Difference between the number of total respondents and the sum of male drivers and passengers is due to 27 individuals who declare to be both passenger and driver and 24 female drivers.

Differences between motorcyclists and other members of the same household

From Table 2.4 (columns (1) and (2)), we see that motorcyclists are significantly younger, more likely to be male, head of household and married. Motorcyclists are much more likely to have tertiary education. They are also more often income earners; this regardless of the amount of revenue they bring to the family and the sector in which they work (public, private or self-employed). From these observations it seems that being active is the main determinant of motorbike use. We can guess that the use of the two-wheeler is given to workers in priority, the other members of the household, who travel less and for shorter distances, relying rather on other means of transportation if needed. Indeed, respondents who are bread earners are much more likely than those who don't contribute to the household income to report motorbike as their main transport mode (57.8% vs. 48.6%). The latter in turn are more likely than the former to declare that they mainly use the bus (20.7% vs. 13.7%) or travel by foot (11.6% vs. 7.9%).

Differences between drivers and passengers

Table 2.6 shows some basic descriptive statistics of our sample, separated by drivers and passengers. The average age is 35 years for drivers and 38 years for passengers. Almost all drivers are men, passengers are predominantly female (75%). Drivers are typically married and are the main breadwinners in their household. Male passengers contribute much less often to the family revenues and when they do it is for a smaller share. Only 6% of female passengers contribute to total household income. As for the education level, it is relatively high. Almost 50% of all drivers completed middle or high school and 44% have some university education. The education level of passengers is significantly lower, partly reflecting the gender gap in education. The religious composition is similar among drivers and passengers and shows that more than 80% of respondents are Hindus. Muslims and Sikhs represent respectively around 10% and 3% of the sample. 65% of male drivers report to pray daily, they are significantly more among male passengers (74%). Among female passengers this share is, at 81%, even a bit higher. Moreover, when asked whether they believe that their life was in the hand of a superior force, 88% of respondents definitively agreed with this statement.

2.4.3 Content of the survey

Motorbike use and traveling habits

The data collected allows in particular to document why and how motorcyclists use this mode of transport. More precisely, thanks to the information gathered I am able to present their habits (frequency of trips, type of roads, distances traveled, time spent on the road, number of people on the same motorbike), the characteristics of their motorbike (age, price, size) and the related expenditures (insurance, gasoline, maintenance).

Table 2.7 reports the share of households and respondents who own a motorbike, while Tables 2.8 and 2.9 display the characteristics of the vehicle (the one mostly used in case the household owns several motorbikes) and the associated expenses respectively. 84% of eligible households own at least one motorbike.[19] 87% or our

[19] 89% of them have only one motorbike.

respondents belong to such household. While interviewed male drivers and female passengers mostly belong to households who own a motorbike, more than 50% of male passengers actually don't possess such asset. This may explain why they are mainly passenger. The motorbike is half of the time driven by different household members. Regarding the size of the vehicles, they are rather small, only 15% of them are 150 cubic centimeters or bigger ones. The most common type is between 100 and 150 cubic centimeters (55%). 80% of motorbikes have been purchased first hand, average price paid being 46,000 INR.[20]

Table 2.7: Motorbike ownership

	all respondents	**male drivers**	**male passengers**	**female passengers**	**per household**
HH owns a motorbike (%)	87.35	92.61	48.39	90.65	84.01
# of motorbike owned					
no motorbike	12.65	7.39	51.61	9.35	15.99
one motorbike	77.80	84.19	38.71	79.50	76.65
two or three motorbikes	9.54	8.42	9.68	11.15	7.36
observations	*901*	*487*	*93*	*278*	*544*
HH owns a car (%)	27,01	29.61	15.21	26.98	26.90
observations	*896*	*483*	*92*	*278*	*539*

[20] More precisely, the average price for first hand purchased moto is 50,370 INR while it is of 26,280 INR for second hand purchased vehicles. When considering the global average price, it corresponded to 920 EUR in 2011 or 5,500 EUR in PPP 2011.

Table 2.8: Characteristics of the motorbike and related expenditures

	all respondents	**male drivers**	**male passengers**	**female passengers**	**per household**
Characteristics of motorbike #1 among respondents whose HH owns a motorbike					
Moto driven by several drivers	48.91	50.00	40.00	50.60	55.51
observations	*783*	*450*	*45*	*249*	*454*
Size of the motorbike (%)					
less than 100cc	29.45	28.14	30.00	32.58	29.20
From 100 to 150cc	54.52	54.42	57.50	53.39	55.47
above 150cc	16.03	17.44	12.50	14.03	15.33
observations	*730*	*430*	*40*	*221*	*411*
Date of acquisition (%)					
this year	15.02	15.25	8.89	16.47	14.82
one year ago	14.12	12.33	26.67	14.46	15.27
two years ago	18.36	16.82	20.00	19.68	18.14
three years ago	13.61	14.57	11.11	12.45	13.94
four years ago	10.91	11.21	8.89	10.04	10.62
five years ago	7.45	7.62	6.67	7.63	6.86
more than five years ago	20,45	22.20	17.78	19.28	20.35
observations	*779*	*446*	*45*	*249*	*452*
Mode of acquisition (%)					
first hand	81.11	81.17	86.67	79.84	81.11
second hand	15.42	15.25	11.11	16.53	16.22
donation	3.47	3.59	2.22	3.63	2.67
observations	*778*	*446*	*45*	*248*	*450*
Average purchasing cost (in INR)					
mean	46,012	46,884	46,538	44,166	45,827
std. dev.	15,216	16,346	13,167	13,913	15,685
min	10,000	10,000	20,000	10,000	10,000
max	108,000	108,000	72,000	78,000	108,000
observations	*644*	*364*	*39*	*206*	*365*
Technical checks (%)					
yes	91.56	91.28	88.64	92.50	91.14
observations	*758*	*436*	*44*	*240*	*440*
Frequency of checks (%)					
each month	36.67	35.60	28.89	38.77	37.91
every 3 months	41.95	41.96	44.44	41.85	41.86
twice a year	11.50	12.59	13.33	10.57	10.23
once a year or less	9.88	9.56	13.33	8.81	10.00
observations	*739*	*429*	*45*	*227*	*430*

Table 2.9: Motorbike related expenditures

	all respondents	**male drivers**	**male passengers**	**female passengers**	**per household**
Expenditures (in INR) related to motorbike					
in gasoline in the last 30 days					
mean	1,230	1,197	1,209	1,237	1,251
std. dev.	996	964	868	1,020	1,017
observations	*596*	*368*	*29*	*166*	*332*
in lubricant products in the last year					
mean	1,188	1,311	709	982	1,329
std. dev.	2,014	2,358	910	1,339	2,424
observations	*523*	*321*	*28*	*142*	*289*
in maintenance in the last year					
mean	2,061	2,149	1,818	1,841	2,113
std. dev.	3,424	3,297	5,363	2,754	3,556
observations	*526*	*326*	*28*	*140*	*291*
Has a motorbike insurance (%)	81.61	80.92	85.71	82.25	81.57
observations	*745*	*435*	*42*	*231*	*434*
Among those who have an insurance (%)					
public insurance	59.90	62.82	67.65	55.25	63.13
full coverage	79.66	81.32	88.57	75.27	79.82
observations	*595*	*348*	*35*	*182*	*342*

Road safety effort

Respondents reported whether they use a helmet when traveling on a motorbike; this breakdown by type of roads and length of the journeys. We therefore know if each individual wear a helmet when moving within residential areas, or on main roads for long or rather short trips. Helmet ownership, motives for its use and perceived utility of head protection were also elicited.

Driving skills

Questions related to driving skills were included in the survey. Regarding formal training, while 91% of male drivers[21] have a driving license, only 72% and 46% of them took a driving exam or driving lessons respectively. The driving license is issued by the Regional Transport Offices and its obtention is a two-step procedure. First individuals must apply for a learner's license. In addition to some administrative papers,[22] applicants must pay a fee of 360 INR, pass a color blindness exam and a written test on traffic rules and regulations. After 30 days, they can apply for a permanent license, for which a 90 INR fee is charged and a driving road test must be undertaken. This leads to an official total cost of 450 INR. In our sample, 80% of drivers who declare having a license reported the cost of getting it. On average they paid 500 INR or less.[23] Besides formal training, drivers were asked whether they think they drive more carefully and better than other drivers.

Road traffic accidents

Personal and relatives' road traffic accident involvement were reported by motorcyclists. In particular, data regarding the circumstances of the crash, the type of injuries and their severity as well as the legal, financial and job consequences were collected. In addition to these experiences, information on respondents' knowledge of road risks was gathered. More precisely, they were interrogated about the number of annual road deaths and injuries that occured in 2010 in Delhi as well as the type of road users they think were most at risks. The answers provided were then confronted to official figures collected by the National Crime Record Bureau.[24] This comparison allows to identify individuals who underestimate, accurately estimate or overestimate road casualties.

Police enforcement

Respondents were asked whether they already have been caught by the traffic police and if it was the case which was the road rule they infringed. Besides, general enforcement of different traffic offences were elicited along with opinion on the level of corruption among policemen and the possibility of bribing officers to avoid the legal penalty.

[21] 97% of drivers are men in our sample.

[22] Individuals must provide to the administration proof of residence, proof of age, passport size photography and a medical certificate.

[23] Bertrand et al. (2007) implemented a randomized control trial to investigate the influence of corruption in the driving license process in New Delhi. While the official cost of driving license was 450 INR, the average actual cost of getting a driving license was around 1,100 INR among drivers belonging to the "control group". The rather low level of expenditures we find may be partly due to the fact that cost of driving license is likely to have increase over time and the mentioned figure doesn't control for the date at which the drivers got their license.

[24] The National Crime Record Bureau is a governmental agency of India responsible for collecting and alayzing crime data. In particular, it is in charge of putting together all data on road traffic accident transmitted by police local offices.

2.5 Conclusion

To our knowledge, it is the first time that information regarding road habits and safety behaviors of motorcyclists have been collected in a survey in India or in any other developing country. The representativeness of the data collected has been checked by comparing socio demographic characteristics of our respondents with the *National Sample Survey*' ones. The richness of our questionnaire allows me to document, in this thesis, the road habits of motorcyclists, their safety attitudes as well as their previous experiences of police stops and road traffic accidents. Risk aversion and respondents' expectations regarding injuries and fines have also been collected through our survey. These dimensions will be presented in details in the following Chapters.

2.6 Appendices

Table 2.10: Content of the questionnaire

Module 0	**General information**	
	Block 1	Information on the household
	Block 2	Information on the interview
	Block 3	Particulars of field operations
Module 1	**Household characteristics**	
Module 2	**Demographics and other particulars of the household**	
	Block 1	Demographic and economic characteristics
	Block 2	Religious practices and beliefs
Module 3	**Transport**	
	Block 1	Transport habits
	Block 2	Transport habits and helmet use
	Block 3	Insurance and other vehicle expenditures
Module 4	**Risk attitude**	
	Block 1	Self-reported risk aversion
	Block 2	Lotteries
	Block 3	Risk aversion in financial matters
	Block 4	Risk aversion in health
	Block 5	Preference for the present
Module 5	**Road risk awareness and perception**	
	Block 1	Road risk awareness
	Block 2	Overconfidence and driving skills
	Block 3	Situation on the road
	Block 4	Elicitation of subjective probabilities and outcomes
Module 6	**Police enforcement**	
	Block 1	Perception of police enforcement and road rules knowledge
	Block 2	Elicitation of subjective probabilities and outcomes
Module 7	**Accident experience**	
Final questions		

MODULE 0 – GENERAL INFORMATION

M0 – BLOCK 1 – INFORMATION ON THE HOUSEHOLD

Starting point	
Direction	Right 1 Left 2
Household Number	
Zone	
Address	
Name of head of household	
Contact number (cell phone or landline)	
Household unique ID code	

M0 – BLOCK 2 – INFORMATION ON THE INTERVIEW

Interviewer's name					
Date of interview	Day	Month	Year	Time interview	
First visit				start	
				end	
Second visit				start	
				end	

M0 – BLOCK 3 – PARTICULARS OF FIELD OPERATIONS

Senior Investigator's name	Date of survey inspection
Other supervisor officer's name	Date of survey inspection
Remarks by investigator	Comments by supervisor officer

INTRODUCTION

Namaste. My name is ... . I am from Sigma Research, a social research agency. From time to time, we conduct studies on issues related to health, awareness and general issues. Currently, we are carrying out a research study in Delhi to understand behavior related to road.

As part of this study, we are talking to people like you here (name of the area) ... in order to find out the attitude and behavior on the road among road users of Delhi. Your views are important to us. Your participation is voluntary and you are free to stop the interview at any time. Please be assured that the information given by you will be treated as confidential and will only be used for research purposes.

May I begin the interview now ?

Respondent agrees for interview	1	
Respondent doesn't agree for interview	2	→ CLOSE

MODULE 1 – HOUSEHOLD CHARACTERISTICS

Q n°	Questions		
M1	REPORT THE ID CODE OF HH	Code category	HH ID code
Q1	How many persons are there in your household ?		
Q2	To which religion your household belong to ?	Hinduism 1 Islam 2 Christianity 3 Sikhism 4 Other : specify 9	
Q3	To which social group does your household belong to ?	Scheduled tribe 1 Scheduled caste 2 Other backward class 3 General 4	
Q4	Is your dwelling ... ?	Owned 1 Rented 2 Other 9	
Q5	What is the type of your dwelling ?	Independent house 1 Flat 2 Other 9	
Q6	How many rooms does your dwelling have ? (excluding kitchen and bathrooms)		
Q7	In which of the following brackets does the monthly income of the head of the household range ?	Less than 5,000 INR 1 Between 5,000 and 10,000 INR 2 Between 10,000 and 15,000 INR 3 Between 15,000 and 20,000 INR 4 Between 20,000 and 25,000 INR 5 Between 25,000 and 40,000 INR 6 Between 40,000 and 60,000 INR 7 Between 60,000 and 100,000 INR 8 More than 100,000 INR 9	

MODULE 2 – DEMOGRAPHICS AND OTHER PARTICULARS OF THE HOUSEHOLD

M2 – BLOCK 1 – DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

Instructions : List all members of the household who have 15 years old or more

M1B1	Q1	Q2	Q3	Q4	Q5	Q6A	Q6B	Q7
ID code	Name	Age	Gender	Relation to the head	Marital status	Sector of work	Occupation	Number of children living in the household
	THAN 15 YEARS OLD	in years	Male 1 Female 2	Household head 1 Spouse of head 2 Married child 3 Spouse of married child 4 Unmarried child 5 Grandchild 6 Father/ mother in law 7 Brother/ sister/ other relative 8 Servant/ employee/ other non relative 9	Never married 1 Married 2 Widowed 3 Divorced/ separated 4	Public firm or government 1 Private firm 2 NGO 3 Self-employed 4 Unemployed 5 Inactive/ housewife 6 Student 7 Retired 8 Other 9	Unskilled work 1 Skilled work 2 Petty trader 3 Shop owner 4 Businessman 5 Salesman 6 Teaching 7 Supervisory level 8 Junior executive 10 Senio executive 11 Not working 12 Other 9	
1								
2								
3								
4								
5								
6								
7								
8								

M1B1	Q8	Q9	Q10	Q11	Q12	Q13
ID code	Level of education Illiterate 1 Below primary (1-4) 2 Primary (5-6) 3 Middle (7-9) 4 Secondary (10-11) 5 Higher secondary 6 Below graduation 7 Graduation 8 Post graduation 10 Other : specify 9	Contribution to the household income Yes 1 No 0	Share of the contribution Less than 20% 1 From 20 to 40% 2 From 40 to 60% 3 From 60 to 80% 4 More than 80% 5	In the last four weeks, did [NAME] travel by motorbike/ scooter ? Yes 1 No 0 → IF NO THEN SKIP TO NEXT HOUSEHOLD MEMBER	Is [NAME] mainly a driver or a passenger ? Driver 1 Passenger 2 Both 3	In the last four weeks, how often did [NAME] travel by motorbike ? He/ she traveled frequently by motorbike (always or most of the time) 1 He/ she occasionnally travel by motorbike 2
1						
2						
3						
4						
5						
6						
7						
8						

M2 – BLOCK 2 – RELIGOUS PRACTICES AND BELIEFS

Instructions : The following questions are asked to eligible and selected individuals as well as to the head of household of non eligible households

Q n°	Questions			ID code	ID code	ID code
M2B2	REPORT THE ID CODE OF RESPONDENT	Code category				
Q1	How often do you go to place like temple ? READ OUT	Never Less than once a month Once a month Once a week More than once a week	0 1 2 3 4			
Q2	How often do you pray ? READ OUT	Never Rarely Once a week Everyday	1 2 3 4			
Q3	Do you believe your life is in the hands of a superior force ? READ OUT	Yes, definitively Yes, this is quite true No, not really No, definitively not	1 2 3 0			

MODULE 3 – TRANSPORT

M3 – BLOCK 1 – TRANSPORT HABITS

Q n°	Questions				
M3B2	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
	Means of transport	Walk 1			
		Bicycle 2			
	In order of frequency of use, what are the	Cycle rickshaw 3			
	means of transport you usually use ?	Auto rickshaw 4			
		Motorbike 5			
Q1A	FIRST	Car or jeep 6			
Q1B	SECOND	Taxi 7			
Q1C	THIRD	Bus 8			
		Metro 10			
		Other 9			
Q2	Do you use the bus to travel ?	Yes 1			
		No 0			
		If No → SKIP TO BLOCK 2 or END THE INTERVIEW			
Q3	Do you usually use the ... ?	Public bus 1			
	READ OUT	Private bus 2			
		Both 3			
Q4	What is the main reason why you take the	Workplace/ office 1			
	bus ?	Social/ familial gathering 3			
	READ OUT	Entertainment 4			
		Other : specify 9			
Q5	Do you feel unsafe when traveling by bus ?	Yes 1			
		No 0			
Q6A	Would you complain if the bus driver drives	Yes 1			
	too fast ?	No 0			
Q6B	Would you complain if the bus driver stops in	Yes 1			
	the middle of the road far away from the bus	No 0			
	stop ?				

M3 – BLOCK 2– TRANSPORT HABITS AND HELMET USE

Instructions : The following questions are asked to all eligible and selected individuals
Formulation : Please each time consider the last 4 weeks

Q n°	Questions				
M3B2	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
	What are the 2 main reasons why you travel	Workplace/office/school 1			
	by motorbike ?	Delivery man/woman 2			
	READ OUT	Social/ familial gathering 3			
Q1A	FIRST	Entertainment 4			
Q1B	SECOND	Other : specify 9			

Q n°	Questions				
M3B2	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q2	Approximatively, how many km do you travel by motorbike a week ?	kms			
Q3	On average, how long do you travel by motorbike a week ?	minutes			
	How often do you use	Always, almost every trip 1			
	READ OUT	Often, more than half of the			
Q4A	highways ?	times 2			
Q4B	rural roads ?	Sometimes, less than half of			
Q4C	ring roads ?	the times 3			
Q4D	inner cities/ main roads ?	Never or almost never 0			
Q4E	colonies/ market roads ?				
Q5	Type of motorbike user ?	Driver → ASK Q6A 1			
		Passenger → ASK Q6B 2			
		Both 3			
		→ ASK BOTH Q6A and Q6B			
Q6A	How many people travel usually with you on the motorbike when you are a driver ?	I travel alone 1			
		One person 2			
		Two persons 3			
		More than two persons 4			
Q6B	How many people travel usually with you on the motorbike when you are a passenger ?	One person 1			
		Two persons 2			
		More than two persons 3			
Q7A	Do you have a helmet ?	Yes, I have my own helmet 1			
		Yes, but I share it with an other household member 2			
		No, I don't have helmet 0			
		If 1 or 2 → SKIP TO Q8			
Q7B	ASK Q7B ONLY IF ANSWER IS NO IN Q7A				
		It is too expensive 1			
	Which is the main reason why you don't have a helmet ?	It is not elegant 2			
		It is too warm/ not comfortable 3			
	→ SKIP TO Q11	I do not like helmet 4			
		I do not have bike 5			
Q8A	Your helmet is	Full head helmet 1			
	READ OUT	¾ helmet 2			
	SHOW THE PICTURES OF DIFFERENT HELMETS	Half helmet 3			
		Building site helmet 4			
		Other 9			
Q8B	TRY TO SEE THE HELMET CONDITION AND COMMENT	Good condition 1			
		Good condition but some scretches 2			
		Broken but manually fixed 3			
		Completely broken 4			
Q9	Does your helmet have a strap ?	Yes 1			
		No 0			
		If No → SKIP TO Q11			

Q n°	Questions					
M3B2	REPORT THE ID CODE OF RESPONDENT	Code category		ID code	ID code	ID code
Q10	IF YES IN Q9 THEN ASK When you travel, how often do you attach the strap ?	I always attach it I attach it in most cases I sometimes attach it I never attach it	1 2 3 4			
Q11	When you travel to local market/ near by area, do you use the helmet ?	Yes, always Yes, in most cases No, I never use the helmet	1 2 0			
Q12A Q12B	When you travel on main roads, do you use the helmet ? for short trips for long trips	Yes, always Yes, in most cases No, I never use the helmet	1 2 0			
Q13	ASK IF 1 OR 2 CODED IN Q11/Q12A/Q12B Which is the main reason why you use it ?	Safety reason Family wish Community wish Police threat Other : specify	1 2 3 4 9			
Q14A Q14B	ASK IF 0 CODED IN Q11/Q12A/Q12B Would you use regularly the helmet if... (choose no more than 2 options) READ OUT MULTIPLE RESPONSE	Your family asked you to The chief of your (religious) community asked you to The police asked you to Information campaign asked you to No Other : specify	1 2 3 4 0 9			
Q15	Do you think it is useful to wear helmets ?	Yes No If Yes → SKIP TO NEXT BLOCK	1 0			
Q16A Q16B Q16C Q16D	ASK IF NO IN Q15 Would you say that : READ OUT MULTIPLE RESPONSE UP TO 4 RESPONSES	It is never useful It is not useful in highways It is not useful in colonies It is not useful around markets It is not useful during the day	1 2 3 4 5			

M3 - BLOCK 3 – INSURANCE AND OTHER VEHICLE EXPENDITURES

Instructions : The following questions can be asked to only one of the respondents

Q n°	Questions				
M3B3	REPORT THE ID CODE OF RESPONDENT	Code category	ID of the household		
Q1	Does anyone in the household possess a car ?	Yes 1 No 0			
Q2	Does anyone in the household possess a motorbike ?	Yes 1 No 0 If No → SKIP TO MODULE 4			
Q3	How many motorbikes do you currently have ? TOTAL NUMBER OF BIKES IN THE HOUSEHOLD				
	CHOOSE THE 3 MOTORBIKES MOST FREQUENTLY USED AND RANK THEM	Motorbike code	1	2	3
Q4A	Indicate the name of the owner of the motorbike (registration)	NAME			
Q4B	If different, indicate the name of the main user of the motorbike	NAME			
Q5	What is the size of the motorbike ? READ OUT	Less than 50cc 1 Between 50cc and 100cc 2 Between 101cc and 150cc 3 Between 151cc and 250cc 4 Between 251cc and 350cc 5 More than 350cc 6 Electronic bike 7			
Q6	Is the motorbike shared with other persons ?	Yes, other members of the household drive the motorbike 1 No, the person is the only who drives the motorbike 0			
Q7A	When did you acquire the motorbike ? READ OUT	This year 1 One year ago 2 Two years ago 3 Three years ago 4 Four years ago 5 Five years ago 6 More than five years ago 7			
Q7B	How did you acquire it ? READ OUT	Purchase first hand 1 Purchase second hand 2 Donation or gift 3			
Q8	How much did it cost ?	in INR			
Q9	For how much could you sell it currently ?	in INR			

Q n°	Questions				
M3B3	REPORT THE ID CODE OF MOTORBIKE		1	2	3
Q10	Do you think of replacing this motorbike anytime soon ? READ OUT	Yes, this year 1 Yes, next year 2 Yes, in two years 3 Yes, in 3 to 5 years 4 Yes, in 6 to 10 years 5			
Q11	Do you regularly make technical checks on your motorbike ?	Yes 1 No 0 If No → SKIP TO Q13			
Q12	How often do you make technical checks ? READ OUT	Each month 1 Every 3 months 2 Twice a year 3 Once a year 4 Every two years 5			
Q13	Was this vehicle involved in any road accident	Yes 1 No 0 If No → SKIP TO Q15			
Q14	Did this accident lead to material damages ? READ OUT	Yes, material damages on the vehicle 1 Yes, material damages on the other vehicle 2 Yes, material damage on both vehicles 3 No 0			
Q15	During the last 30 days, how much did you spend in gasoline for the motorbike ?	in INR			
Q16	During the 365 days, how much did you spend in lubricants and other fuels for motorbike ?	in INR			
Q17	During the 365 days, how much did you spend in maintenance and reparation of the motorbike ?	in INR			
Q18A	Is your motorbike insured ?	Yes 1 No 0 If No → SKIP TO MODULE 4			
Q18B	Is the insurance company private or public ?	Public 1 Private 2			
Q18C	What is your coverage contract ?	Full coverage 1 Partial coverage 2			
Q18D	How much do you pay in insurance premiums per year ?	in INR			
Q18E	Are you satisfied with this deal ?	Yes 1 No 0			

MODULE 4 – RISK ATTITUDE

M4 – BLOCK 1 – SELF-REPORTED RISK AVERSION

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions	Code category	ID code	ID code	ID code
M4B1	REPORT THE ID CODE OF RESPONDENT				
	People behave differently in different situations. On a risky scale going from 0 (not at all prepared to take risk) to 7 (fully prepared to take risk) How would you describe yourself:	0 1 2 3 4 5 6 7			
Q1A	In general ?				
Q1B	While driving ?				
Q1C	For financial matters ?				
Q1D	Regarding leisure and sport ?				
Q1E	With your health ?				

M4 – BLOCK 2 – LOTTERIES

Instructions : The following questions are asked to all eligible and selected individuals
For each row in the lottery table, the interviewer asks each respondent which option between the safe amount and the lottery he/ she prefers.

Q n°	Questions	Code category	ID code	ID code	ID code
M4B2	REPORT THE ID CODE OF RESPONDENT				
	Do you prefer to receive X amount for sure or to have 50% chance to get nothing and 50% chance to get 12,000	Lottery table – all amounts are in INR			
Q1	INR ?				
Q2					
Q3	SEE INSTRUCTION MANUAL				
Q4					
Q5					
Q6					
Q7					
Q8					
Q9					
Q10					
Q11					
Q12					
Q13					
Q14					
Q15					
Q16					
Q17					
Q18					
Q19					
Q20					

Row	Safe amount	Lottery payoffs P=0.5	Lottery payoffs P=0.5
1	0	0	12000
2	500	0	12000
3	1000	0	12000
4	1500	0	12000
5	2000	0	12000
6	2500	0	12000
7	3000	0	12000
8	3500	0	12000
9	4000	0	12000
10	4500	0	12000
11	5000	0	12000
12	5500	0	12000
13	6000	0	12000
14	6500	0	12000
15	7000	0	12000
16	7500	0	12000
17	8000	0	12000
18	8500	0	12000
19	9000	0	12000
20	9500	0	12000

Safe amount A
Lottery pay-offs B

M4 – BLOCK 3 – RISK AVERSION IN FINANCIAL MATTERS

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions				
M4B3	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1	Imagine you had just won 100,000 INR in a lottery and you can invest this money in a business. It is equally likely that the business goes well or not. If it goes well you can double the amount invested after one year ; if it does not you will lose half of the money you invested. Out of these 100,000 INR, how much would you like to invest in such business ?	Amount in INR			
Q2A	Would you like to take the opportunity of a 50 percent chance of doubling your income and a 50 percent chance of reducing your income by one third ?	Yes 1 No 0 If No → SKIP TO Q2C			
Q2B	Would you take it for a 50 percent chance of reducing your income by one half ?	Yes 1 No 0 If No → SKIP TO Q3A			
Q2C	Would you take it for a 50 percent chance of reducing your income by one fifth ?	Yes 1 No 0			
Q3A	What is the maximum amount you would pay for a lottery ticket with 50 percent chance of winning 500 INR ?	Amount in INR			
Q3B	What is the maximum amount you would pay for a lottery ticket with 50 percent chance of winning 10,000 INR ?	Amount in INR			
Q4	Imagine you are in a situation where you can afford to lend money to one of your friends. Would you do it if he/she asks you to lend him 10,000 INR ?	Yes 1 No 0			
Q5A	With a one percent chance (in other words one chance out of 100) risk of losing 100,000 INR (due to water damage, fire, theft) Would you pay a 1,500 INR premium for full insurance ?	Yes 1 No 0 If No → SKIP TO Q5C			
Q5B	Would you pay a 2,000 INR premium for full insurance ?	Yes 1 No 0 → SKIP TO Q6A			
Q5C	Would you pay a 1,000 INR premium for full insurance ?	Yes 1 No 0			
Q6A	Are you enrolled in Health insurance ?	Yes 1 No 0 If No → SKIP TO Q6B			
Q7A	What is your coverage contract ? READ OUT	Full coverage 1 Partial coverage 2			
Q8A	Did you subscribe for it yourself ?	Yes 1 No 0 If No → SKIP TO Q6B			

Q n°	Questions				
M4B3	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q9A1	What type of insurance ?	Individual 1 Family 2			
Q9A2	How much did you pay in premium last year ?	Amount in INR			
Q6B	Are you enrolled in Health insurance ?	Yes 1 No 0 If No → SKIP TO Q6C			
Q7B	What is your coverage contract ? READ OUT	Full coverage 1 Partial coverage 2			
Q9B2	How much did you pay in premium last year ?	Amount in INR			
Instructions : the following questions will be asked only to one individual in the household					
Q6C	Are you enrolled in dwelling insurance ?	Yes 1 No 0 If No → SKIP TO NEXT BLOCK			
Q9C2	How much did you pay in premium last year ?	Amount in INR			

M4 – BLOCK 4 – RISK AVERSION IN HEALTH

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions				
M4B4	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1	Currently, your general health is : READ OUT	Very good 1 Good 2 Neither good nor bad 3 Bad 4 Really bad 5			
Q2	When you feel sick, would you rather : READ OUT	Go to the doctor/ hospital 1 Try to cure yourself alone 2 Wait and see if it goes better itself 3			
Q3	Would you define yourself as an anxious person ? READ OUT	Yes, definitively 1 Yes, pretty much 2 No, not really 3 No, not at all 0			
Q4	How do you access the medical care ? READ OUT	I can easily get care without paying 1 I can access medical care but with some costs 2 It is difficult for me to access medical care 3			
Q5	Do you think it is worth in order to live longer to deprive yourself of the so-called pleasure of life (such as good food, drinking, smoking, eventful life, etc...) READ OUT	Yes, definitively 1 Yes, pretty much 2 No, not really 3 No, not at all 0			
Q6A	Let's assume that by the age of 20 someone assures you that you will live without any health problem, but in return your life will be shortened. Would you accept this deal ?	Yes 1 No 0 If No → SKIP TO Q7			
Q6B	Till which age do you think you will live ?	years			
Q6C	How many years would you accept to sacrifice ?	years			
Q7	Let's assume now that by the age of 20 someone assures you that you could live a life without any health problem and pass away while sleeping at the age of 85. However, to be eligible you have, at the age of 20, to drink an elixir that can also be fatal. What probability for this to happen would you accept ? READ OUT	I will never take such product 1 I accept to take the product knowing that there is A 30% chance to be harmful 2 A 10% chance to be harmful 3 A 1% chance to be harmful 4			

Q n°	Questions				
M4B4	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q8A	Do you or did you smoke ? READ OUT	Yes, I am currently a smoker 1 Yes, I used to smoke but I quit 2 No, I never smoke 0 If No → SKIP TO Q9A			
Q8B	Since how long or for how long ?	years			
Q8C	How often do (did) you smoke ?	More than 10 cigarettes a day 1 5 to 10 cigarettes a day 2 2 to 4 cigarettes a day 3 One cigarette a day 4 At least once a week 5 At least once a month 6 Less than once a month 7			
Q9A	Have you ever had any alcoholic beverage to drink (more than just few sips) ?	Yes 1 No 0 If No → SKIP TO BLOCK 5			
Q9B	Think back over the last 2 weeks. How many times have you had three or more drinks in a row (more precisely 3 beers or more/ 2 pegs or more) ?	None 1 Once 2 Twice 3 3 to 5 times 4 6 to 9 times 5 10 or more times 6			

M4 – BLOCK 5 – PREFERENCE FOR THE PRESENT

Instructions : The following questions are asked to all eligible and selected individuals

Instructions : For all Q1A to Q1C, please ask questions indicating that it is « given the current condition of the market » (interest rate, etc…)

Q n°	Questions				
M4B5	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1A	Which offer would you prefer ? READ OUT	a payment of 52,000 INR this month 1 a payment of 58,000 INR next month 2			
Q1B	You can receive 5,000 INR now, or wait one year to receive the money. What would be the amount for which you would agree to wait one year ?	Amount in INR			
Q1C	You can receive 5,000 INR now, or wait 5 years to receive the money. What would be the amount for which you would agree to wait 5 years ?	Amount in INR			

MODULE 5 – ROAD RISK AWARENESS AND PERCEPTION

M5 – BLOCK 1 – ROAD RISK AWARENESS

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions			ID code	ID code	ID code
M5B1	REPORT THE ID CODE OF RESPONDENT	Code category				
Q1	In your opinion, how many individuals died through road traffic accidents last year (2010) in Delhi ? READ OUT	Less than 100 people From 101 to 500 people From 501 to 1,000 people From 1,001 to 2,000 people From 2,001 to 5,000 people From 5,001 to 10,000 people More than 10,000 people	1 2 3 4 5 6 7			
Q2	In your opinion, how many persons suffer from severe injuries caused by road traffic accidents which occured last year (2010) in Delhi ? READ OUT	Less than 500 people From 501 to 1,000 people From 1,001 to 5,000 people From 5,001 to 10,000 people From 10,001 to 15,000 people From 15,001 to 20,000 people More than 20,000 people	1 2 3 4 5 6 7			
	Different types of road users die every year in road traffic accidents (pedestrians, bus passengers, auto rickshaw drivers, etc...) In your opinion, out of 100 persons who die from road traffic accidents :					
Q3A	How many are pedestrians ?					
Q3B	How many are motorbike users ?					
Q3C	How many are car users ?					
	MAKE SURE THAT THE SUM IS LESS THAN 100					

M5 -BLOCK 2 – OVERCONFIDENCE AND DRIVING SKILLS

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions				
M5B2	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1	ASK ONLY TO DRIVER OR BOTH Comparing your driving to the other road users, how would you qualify yourself ? READ OUT	I drive more carefully than other drivers 1 I drive as carefully than others 2 I drive less carefully than others 3			
Q2	ASK ONLY TO DRIVER OR BOTH How do you rate your driving skills ? READ OUT	Worse than others 1 Same as others 2 Better than others 3			
Q3A	ASK ONLY TO DRIVER OR BOTH Do you have a driving licence for your motorbike ?	Yes 1 No 0 If No → SKIP TO BLOCK 3			
Q3B	When did you get it ? READ OUT	Past year 1 1 or 2 years ago 2 Between 3 and 5 years ago 3 Between 5 and 10 years ago 4 More than 10 years ago 5			
Q3C	Did you pass a driving exam to obtain it ?	Yes 1 No 0			
Q3D	Did you take motorbike driving training ?	Yes 1 No 0			
Q3E	How much did it cost you to get your driving licence ?	in INR			
Q4	ASK ONLY TO PASSENGER OR BOTH Do you think your driver should drive more carefully ?	Yes 1 No 0			

M5 – BLOCK 3 – SITUATION ON THE ROAD

Instructions : The following questions are asked to all eligible and selected individuals
Instructions : Show the related photos when presenting each of the following situations

SITUATION 1 : Vehicles are coming. There is a little gap and Rashmi is running and crossing the road.

SITUATION 2 : Gupta is on his motorbike, he decides to overtake a car from the left.

SITUATION 3 : Sundar is on his motorbike with his wife, he chooses to overtake a car from the left.

SITUATION 4 : Verma and his family are on their motorbike, in front of them there is one bus and one truck. There is still a small gap between the two vehicles and Verma decides to overtake the two vehicles by engaging in this gap.

Q n°	Questions				
M5B3	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
	In your opinion, which is the level of risk taken by each of these individuals ? READ OUT	Not al all risky 1 Slightly risky 2 Somewhat risky 3 Moderately risky 4 Risky 5 Very risky 6 Extremely risky 7			
Q1	SITUATION 1				
Q2	SITUATION 2				
Q3	SITUATION 3				
Q4	SITUATION 4				

M5 – BLOCK 4 – ELICITATION OF SUBJECTIVE PROBABILITIES AND OUTCOME

Instructions : The following questions are asked to all eligible and selected individuals
Instructions : Show the related photos when presenting each of the following situations

INTERVIEWER : « I will ask you several questions about the chance or likelihood that certain events are going to happen. On a scale going from 0 to 10, I would like you to tell me what you think the likelihood or chance that a specific event will happen is. 1 represents one chance out of 10. If you choose 0, it means that you think the event will NOT happen. As you choose a higher number on the scale, it means that you think the likelihood that the event will happen increases. For example, if you say 1 or 2, it means that you think the event is NOT likely to happen but it is still possible. If you say 5, it means that you think it is as likely that the event will happen that it will not happen (fifty-fifty). If you say 6, it means that the evt is slightly more likely to happen than not happen. Finally, if you say 10, it means you are sure the event will happen.
There is no right or wrong answer. I just want to know what you think. »

SCALE		
	0	It is sure the event will fot happen
	1	The event is not likely to happen but it is still possible
	2	
	3	
	4	It is slightly more likely that the event will not happen
	5	It is as likely that the event will happen than not happen
	6	It is slightly more likely that the event will happen
	7	
	8	
	9	
	10	It is sure the even will happen

Instructions : For questions using the above scale, if the respondent say 10 (or 0), prompt : « Are you sure that this event will almost surely (not) happen ? ». Circle 1 in column « Prompt 0 or 10 », if you prompted the respondent and report his/ her final answer only.

Q n°	Questions				
M5B4	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1A	Imagine I have 5 balls, one is red and four are blue. If you pick one of these balls without looking, how likely it is that you pick the red ball ?	0 to 10 scale			
Q1B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q2A	How likely are you to go to the market sometime in the next two days ?	0 to 10 scale			
Q2B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q3A	How likely are you to go to the market sometime in the next two weeks ?	0 to 10 scale			
Q3B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q4A	How likely do you think it is that you will go out of the house for any reason in the next month ?	0 to 10 scale			
Q4B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q5A	How likely it is that CHRISTMAS will fall in the month of June ?	0 to 10 scale			
Q5B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q6A	Think about the way you generally travel on the motorcycle. Given this, how likely do you think it is that you have an accident in which you get injured ?	0 to 10 scale IF THE RESPONDENT ANSWERS 0 → GO DIRECTLY TO Q7A			
Q6B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1

Q n°	Questions				
M5B4	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q6C	ASK ONLY INDIVIDUALS WHO ANSWERED 1-10 IN Q6A What type of injury do you think is the most likely yo happen ? READ OUT	Broken arm/ hand/ leg 1 Arm/ hand/ leg dismemberment 2 Cerebral trauma 3 Problems related to back bone 4 Other : specify 9			
Q7A	In case you are not wearing a helmet, how likely do you think that you have an accident in which you get injured ?	0 to 10 scale IF THE RESPONDENT ANSWERS 0 → GO DIRECTLY TO MODULE 6			
Q7B	CIRCLE IF PROMPT ANSWER 0 OR 10				
Q7C	ASK ONLY INDIVIDUALS WHO ANSWERED 1-10 IN Q7A What type of injury do you think is the most likely yo happen ? READ OUT	Broken arm/ hand/ leg 1 Arm/ hand/ leg dismemberment 2 Cerebral trauma 3 Problems related to back bone 4 Other : specify 9			
Q8A Q8B Q8C Q8D Q8E Q8F Q8G Q8H Q8I Q8J Q8K Q8L	Thinking about the medical expenditures you would have to pay if you were injured in a road crash right now without wearing a helmet, what do you think is the percent chance that this amount would be ONCE THE RESPONDENT REACHES 100% GO TO MODULE 6 REPORT THE %	Less than 500 INR Less than 1,000 INR Less than 2,000 INR Less than 3,000 INR Less than 5,000 INR Less than 10,000 INR Less than 20,000 INR Less than 50,000 INR Less than 80,000 INR Less than 100,000 INR Less than 150,000 INR Less than 200,000 INR			

MODULE 6 – POLICE ENFORCEMENT

M6 – BLOCK 1 – PERCEPTION OF POLICE ENFORCEMENT AND ROAD RULES KNOWLEDGE

Instructions : The following questions are asked to all eligible and selected individuals

Q n°	Questions				
M6B1	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
	Can you tell us if for the following situations police stops the individuals READ OUT				
Q1A	Non use of helmet by male driver				
Q1B	Non use of helmet by male passenger				
Q1C	Non use of helmet by female driver	Yes, often 1			
Q1D	Drink and driving	Yes, but rarely 2			
Q1E	Non use of seat belt by car driver	No, never 0			
Q1F	Traffic light jumping				
Q1G	Over speeding				
	Out of 100 police arrests, how much do you think concern each of the following behaviors ? FIRST READ OUT ALL CATEGORIES The interviewer has to make sure the answers sum up to 100				
Q2A	Non use of helmet by driver				
Q2B	Non use of helmet by passenger				
Q2C	Drink and drive				
Q2D	Non use of seat belt by car driver				
Q2E	Traffic light jumping				
Q2F	Over speeding				
Q2G	Driving licence verification				
	TOTAL				
	Out of 100 motorbike trips, according to you, what is the number of times :				
Q3A	A male driver who never wears a helmet would be arrested by the police ?				
Q3B	A male passenger who never wears a helmet would be arrested by the police ?				
Q3C	A female driver who never wears a helmet would be arrested by the police ?				
Q4A	When someone is stopped by the police because of infringing the road rules, do you think he usually : READ OUT	Have to pay the fine 1 Can bribe the policeman not to pay the fine 2 Can negociate the amount of the fine 3 Other : specify 9			
Q5	Have you ever been penalized by the police ?	Yes 1 No 0 If No → SKIP TO BLOCK 2			
	For which reasons have you been stopped by the police ? CHOOSE NO MORE THAN 3	Driver's non use of helmet 1 Passenger's non use of helmet 2 Drink and driving 3 Driver's non use of seat belt 4			
Q6A	FIRST REASON	Traffic light jumping 5			
Q6B	SECOND REASON	Over speeding 6			
Q6C	THIRD REASON	Driving licence verification 7 Other reason 9			

M6 – BLOCK 2 – ELICITATION OF SUBJECTIVE PROBABILITIES AND OUTCOMES

Instructions : The following questions are asked to all eligible and selected individuals
Instructions : Recall the respondent that it is the same scale and procedure that the one used in Module 5 – Block4

SCALE		
	0	It is sure the event will fot happen
	1	The event is not likely to happen but it is still possible
	2	
	3	
	4	It is slightly more likely that the event will not happen
	5	It is as likely that the event will happen than not happen
	6	It is slightly more likely that the event will happen
	7	
	8	
	9	
	10	It is sure the even will happen

Q n°	Questions				
M6B2	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q1	Think about the way you generally travel on the motorcycle, what is the likelihood that you will be stopped by the police in the next month ?	0 to 10 scale			
Q1B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q2	If you do not use the helmet at all during the next month, what is the probability the police stop you at least once over the period ?	0 to 10 scale			
Q2B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Q3	According to you what is the likelihood you will be stopped by the police for no reason during the next month ?	0 to 10 scale			
Q3B	CIRCLE IF PROMPT ANSWER 0 OR 10		1	1	1
Instructions : Ask the next question to all individuals who expressed a percent chance greater than zero of being stopped by the police in question 2					
Q4A Q4B Q4C Q4D Q4E Q4F Q4G Q4H Q4I Q4J Q4K	Thinking about the fine you would have to pay if you were stopped right now without wearing a helmet, what do you think is the percent chance that this amount would be ONCE THE RESPONDENT REACHES 100% GO TO Q5 REPORT THE %	Less than 50 INR Less than 100 INR Less than 200 INR Less than 300 INR Less than 400 INR Less than 500 INR Less than 600 INR Less than 700 INR Less than 800 INR Less than 900 INR Less than 1,000 INR			
Q5	Would this money go : READ OUT	To the policeman 1 To the government 2			

MODULE 7 – ACCIDENT EXPERIENCE

Instructions : The following questions are asked to all eligible and selected individuals

Q n° M7	Questions REPORT THE ID CODE OF RESPONDENT	Code category		ID code	ID code	ID code
Q1	Have you ever been involved, either as a person at fault or as a victim, in a road trafic accident ?	Yes No If No → SKIP TO Q13	1 0			
Q2A Q2B	Consider the last 5 years, how many times have you been involved in a road trafic accident : in which people have been injured ? in which there was only material damages ?	INDICATE THE NUMBER OF TIMES				
In case you have been involved in several road accidents, think to the most severe one you had.						
Q3	Were you : READ OUT	A motorbike's driver A motorbike's passenger A pedestrian A biker A car driver A car passenger A bus passenger In a cycle rickshaw In an auto rickshaw Other	1 2 3 4 5 6 7 8 10 9			
Q4	You had this accident with a ... READ OUT	Pedestrian Biker Cycle rickshaw Auto rickshaw Car Taxi Bus Animal Material obstacles Other	1 2 3 4 5 6 7 8 10 9			
Q5	Would you classify this accident as : READ OUT	Light Severe Very severe Fatal	1 2 3 4			
Q6	How long ago did this accident happen ? READ OUT	Past week Past month In the past 6 months Past year In the past 5 years More than 5 years ago	1 2 3 4 5 6			
Q7A	How would you think a police officer would assess the accident ? READ OUT	Other road user's fault I partly caused it My fault	1 2 3			
Q7B	Would you agree with him/ her ?	Yes No	1 0			
Q8	Following this accident, did you ? READ OUT MULTIPLE RESPONSES UP TO TWO RESPONSES	Claimed for compensation Abused the other driver Took legal action Any other action Did not do anything	1 2 3 4 5			

Q n°	Questions				
M7ID	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q9	In this accident, have you been injured ?	Yes 1 No 0 If No → SKIP TO Q12			
Q10A	What type of injuries have you got ? READ OUT MULTIPLE RESPONSES UP TO TWO RESPONSES	Broken arm/ hand or leg 1 Arm/ hand or leg dismemberment 2 Cerebral trauma 3 Problems related to back bone 4 Any other : specify 9			
Q11A	Did your injuries have lasting effects on your professional occupation ? READ OUT	Yes, I had to change/ quit my previous job after this event 1 Yes, I have some difficulties but still do the same job 2 No 0			
Q11B	Did your injuries have lasting effects on your well-being ?	Yes 1 No 0			
Q12	Did this acident modify your attitude on the road ?	Yes, completely 1 Yes, slightly 2 No 0			
Q13	Did some of your family relatives or friends have ever been involved, either as a person at fault or as victim, in a road trafic accident ?	Yes 1 No 0 If No → END OF THE INTERVIEW			
Q14	What is your relation to this person ? READ OUT	Spouse 1 Parent or children 2 Other relatives 3 Close friend 4 Friend 5			
Q15	Were he/ she : READ OUT	A motorbike's driver 1 A motorbike's passenger 2 A pedestrian 3 A biker 4 A car driver 5 A car passenger 6 A bus passenger 7 In a cycle rickshaw 8 In an auto rickshaw 10 Other 9			
Q16	He/she had this accident with a ... READ OUT	Pedestrian 1 Biker 2 Cycle rickshaw 3 Auto rickshaw 4 Car 5 Taxi 6 Bus 7 Animal 8 Material obstacles 10 Other 9			
Q17	Would you classify this accident as : READ OUT	Light 1 Severe 2 Very severe 3 Fatal 4			

Q n°	Questions				
M7ID	REPORT THE ID CODE OF RESPONDENT	Code category	ID code	ID code	ID code
Q18	How long ago did this accident happen ? READ OUT	Past week 1 Past month 2 In the past 6 months 3 Past year 4 In the past 5 years 5 More than 5 years ago 6			
Q19	In this accident, was the person injured ?	Yes 1 No 0 If No → END OF THE INTERVIEW			
Q20	What type of injuries did this person suffer from? READ OUT MULTIPLE RESPONSES UP TO TWO RESPONSES	Broken arm/ hand or leg 1 Arm/ hand or leg dismemberment 2 Cerebral trauma 3 Problems related to back bone 4 Any other : specify 9			
Q21	Did his/ her injuries have lasting effects on his/ her professional occupation ?	Yes 1 No 0			
Q22	Did you provide any financial or time support to this person ? READ OUT	Yes, borrow money 1 Yes, start to work to bring income 2 Yes, provide medical care assistance 3 Yes, other support : specify 4 No 0			

FINAL QUESTIONS BEFORE ENDING THE INTERVIEW

Instructions : These questions can be asked only to the head of the household os his spouse.

Q n°	Questions		
MFID	REPORT THE ID CODE OF HOUSEHOLD	Code category	ID of the household
AIQ1	Would you agree if we come back in a few months to ask you again some questions regarding road transport habits ?	Yes 1 No 0	
AIQ2	Relative or friend name		
AIQ3	Relative of friend's phone number		
AIA4	Relative of friend's address		

Study on helmet use and risk aversion among motorcyclists in New Delhi, India

IMPORTANT INSTRUCTIONS FOR ENUMERATORS

I. Role of Enumerator

The success of the survey depends on the capacity of the enumerator to collect precise information from the interviewed persons.

As an enumerator, your role will include the following tasks:

- Identify all members of the household and start a conversation with;
- Conduct the interview in accordance with the procedures described in this manual;
- Review the whole questionnaire before ending the conversation, make sure that the questions have been answered correctly and that the spaces left for questions that are not supposed to be answered are left blank as indicated in the questionnaire;
- In case information on certain household members is not available at the time of your first visit, return to the household again;
- Check all questionnaires completely before handing them over to the supervisor.

You should never make corrections in the questionnaire (other than small irregularities) without reviewing the content with the interviewee. Besides, you should never copy information obtained during an interview into a new questionnaire.
Establish a rapport with the interviewee: The first impression you make on the interviewee will determine his/ her motivation to cooperate in the survey.

1. Presentation: You should introduce yourself by name and show the interviewee your enumerator id card. Then you should politely ask to speak to the head of the household.
2. First impression: When you approach an interviewee for the first time, you should:
   a) Use a choice of words that will make the person feel at ease;
   b) Begin the interview by greeting the person and smiling, and phrase the questions in a simple manner since using technical jargon might make the interviewed person feel uncomfortable;
   c) Dress appropriately since this is a sign of respect for the interviewed persons, and in order to adequately represent the institution you work for.

IMPORTANT! ASSURE YOURSELF THAT YOU ARE TALKING TO THE HEAD OF THE HOUSEHOLD OR HIS/HER SPOUSE. IF NEITHER OF THEM IS AVAILABLE AT THE BEGINNING OF THE INTERVIEW YOU SHOULD PROCEDE AS OUTLINED IN SECTION III.

Good morning/ Good evening, my name is ..... **(INTRODUCE YOURSELF BY NAME AND SHOW YOUR CURRENT ID-CARD)** ***and I work for Sigma Research and Consulting, a survey company based in New Delhi. We are here to conduct a survey on the transport habits of New Delhi inhabitants.***

This survey is funded by a French institution and will serve as a base for future development projects. In order to develop projects that are adapted to the population's needs and that contribute to the general improvement of transport safety we need precise information. It is necessary to talk to the person who best knows the household and also with members of the household who use regularly a motorbike if there is any in your household.
All the information that you give us is absolutely confidential and will not be passed on to others or used for purposes other than the study at hand.
The questionnaire will take max. 60 minutes.
Are you prepared to participate?

IF HE/SHE ABSOLUTELY DOES NOT WANT TO PARTICIPATE, END THE INTERVIEW.
IF YES, - Terrific! So, we start with the questionnaire.

3. Confidentiality: The interviewed persons should be assured that the information they are giving will be treated confidentially and will not be handed over to unauthorized persons. The given information will be used in order to realize the objectives of the survey and not for any other purposes. None of the individual information will be analyzed. In this context, you should make sure that the questionnaires are completed with the utmost care.
4. Neutrality during the interview: Most of the interviewed persons are polite and have the tendency to give the responses that they think you would like to hear. Consequently, it is very important for you to be absolutely neutral

during the interview; i.e. you must be sure to neither through your tone of voice nor through your facial expressions give the interviewed person the impression that he/ she is giving the right or wrong answer to the posed questions.

5. Make sure to always use the same wording and the same sequence of questions: The wording and the question sequence should be maintained in all interviews. If the person being interviewed does not understand a question correctly, you should read out the question again clearly and slowly. Aside from following the question sequence you should make sure to include the filter questions and follow the instructions in the questionnaire about skipping questions.
6. Act tactfully: In case a person you are interviewing does not show any interest in the interview, seems annoyed or distanced, or, if she/ he contradicts responses given earlier or refuses to respond to questions, you should tactfully animate the person to show interest in the interview.
7. Don't interrupt the interview: You should pose the questions slowly and give the interviewee enough time to reflect upon the question, in order to be sure that he/ she understands what you are asking. If the interviewed person does not have the time to reflect upon the questions and to form his/ her own opinion, the response could be « I'm not sure » or he/ she could give you a wrong answer. If the interviewee takes a longer time to respond, it is not necessary to put him/ her under pressure or to interrupt the interview.

II. Concepts and important definitions

– HOUSEHOLD AND HEAD OF HOUSEHOLD

The household is the unit of observation for certain modules of this survey. It is important to be familiar with how a household is definde, as well as with the exceptions to this definition. A household is a basic socio-economic unit in which the different members who live in the same house or yard, related or not, combine their resources and satisfy their basic needs as a community, under the authority of one person called the head of household.
There are several special types of households which will be treated in the following.

1. All individuals who live alone in a dwelling and provide for their own basic needs (alimentation, rent, clothing, etc.) should be considered as a one-person household. If this is not the case, they should be linked to the local household which provides for their basic needs. In order to do this you should ask the following type of questions: « Where do you normally eat your meals? », « Do you pay the rent yourself? »
2. (Full time) Household servants (maids, boys, etc.) are part of the household where they work.
3. Certain households are collective. A collective household constitutes several people from one institution who are not related to each other but who live in a community for reasons linked to travelling, studying, health, or for work related reasons, etc. This type of household can be found e.g. in hotels, boarding schools, military barracks, prisons, and construction sites. These households should not be interviewed.

– PERMANENT RESIDENTS

Three criteria apply to persons considered as regular/ permanent members of the household:

1. The person should usually live in the household and take his/her regular meals there.
2. The person should respect the authority of the head of household.
3. The person should have been present in the household during at least six of the twelve months prior to the interview. If a person was absent from the household for more than six months of the twelve month period, he or she cannot be considered a member of the household (the head of household is an exception; he/ she remains a member of the household even if he/ she is absent for more than six of the twelve months prior to the interview). If a person is present in the household for less than six months but has the definite intention of staying, he/ she should be considered a household member.

Examples: newborn children are household members, even if they are under six months of age ; newly-wed wives are considered members of the household, even if they have been married for less than six months.

Visitors who are present in the household at the time of the interview should be excluded from the respective household. All persons who do not live in the household normally are considered visitors, i.e. Persons who have been present in the household for less than six months prior to the interview and who do not have the intention of staying for six months.

III. How to act in cases when interviewees are not present

Head of household

The head of household is the key decision maker for the household, and his authority is respected by the other members of the household. It is possible that the principal contributor to the household income is not necessarily the head of household. Since the head of household makes the key decisions, he/ she is the person with the most knowledge on what is going on in the household, and he/ she is often the most appropriate person to direct the questions to. Nevertheless, it is possible that the head of household is not able to respond to all questions posed accurately, e.g. if he/ she is not the principal contributor to household income, or if other household members have their own areas of responsibility. In these cases, other members of the household can assist the head of household during the interview. For example, the older siblings might be better

informed on the level of schooling of the younger household members. In the second part of the questionnaire, three members of the households will be consecutively interviewed. In the **Module 3 – Block 3**, the questions should be asked, if applicable, to the driver and owner of the motorbike.

		MAN (head of household*)	
		present	absent
WOMAN (spouse)	present	case 1	case 2
	absent	case 3	case 4

Note: *The head of household can also be a woman, if for example her husband lives elsewhere or if he is deceased.

Case 1: Direct the questions to the head of household and the other selected members as indicated in the questionnaire.

Case 2: Ask the wife if her husband happens to be close by.
If YES... Ask the questions directed at the wife and look for her husband afterwards.
If NO... Ask, when and if he is available on the days foreseen for the respective survey zone.
If YES... Ask the questions directed at the wife and return at the agreed time.
If NO... Ask whether the wife or another person present is sufficiently informed about the household.
If YES... Ask the questions.
If NO... Interview a replacement household.

Case 3: Ask the husband if his wife happens to be close by.
If YES... Ask the questions directed at the husband and look for his wife afterwards.
If NO... Ask when and if she is available on the days foreseen for the respective survey zone.
If YES... Ask the questions directed at the husband and return at the agreed time.
If NO... Interview a replacement household.

Case 4: Ask the neighbors if you can find the respective household members somewhere nearby or at a later time at their house.
If YES... Look for them at the place indicated by the neighbors or later at their house.
If NO... Interview a replacement household.

In case 2 and 3, if the person to be interviewed is not available, you should follow the same approach with the exception of the first step. You should always take notes on the **Module 0** (e.g. household interviewed or not).

In the case no member of the household is using regularly a motorbike (**Module 2 – Block 1, q.11**), the head of household will be the only person interviewed and the questionnaire will be shorter (restricted to **Module 2 – Block 2 and Module 3 – Block 1**, see the indications on the questionnaire itself).

In the households where at least one member of the household use regularly the motorbike (which therefore makes the household eligible to the second part of the questionnaire), three eligible members have to be selected. The spouse and head of household (if eligible) are automatically selected. In addition, a third individual will be selected among the eligible individuals of the household. In case either the head of household or the spouse are not eligible, two other members of the household will be selected among the pool of eligible members. In the case both head of household and spouse are not eligible, three other members of the household will be selected among the pool of eligible members. In the case there are less eligible members than the number supposed to be interviewed all eligible individuals will be interviewed but you should not replace one respondent with a non eligible member of the household.

IV. Instructions concerning the completion of the questionnaire

THE INSTRUCTIONS DIRECTED AT THE ENUMERATORS ARE WRITTEN IN PARENTHESIS IN CAPITAL LETTERS OR IN ITALIC LETTERS. THEY ARE EXCLUSIVELY DIRECTED AT THE ENUMERATOR AND SHOULD NOT BE READ TO THE INTERVIEWEES.

Example: In order of frequency of use, what are the means of transport you usually use? **[READ ALL THE MODALITIES]**

YOU MUST READ THE QUESTIONS WORD FOR WORD TO THE INTERVIEWED PERSON.

THE RESPONSE CATEGORIES THAT SHOULD NOT BE READ TO THE INTERVIEWEE ARE INDICATED WITH **[DO NOT READ]**. IN THIS CASE YOU SHOULD CLASSIFY THE INTERVIEWEE'S RESPONSES YOURSELF.

(Choose no more than 3 options) INDICATES THAT THE RESPONDENT CAN (BUT IS NOT OBLIGED TO) CHOOSE MORE THAN ONE BUT LESS THAN 3 OPTIONS.

IN CASE THE RESPONDANT DOES NOT WANT TO OR CANNOT RESPOND TO THE QUESTION OR IF THE QUESTION DOES NOT APPLY, WRITE

-1 FOR **"DON'T KNOW"**

-2 FOR **"REFUSED"**

-3 FOR **"NOT APPLICABLE"**

-5 *FOR "IRREGULAR"*

AS INDICATED ON THE QUESTIONNAIRE AT THE BOTTOM OF EACH PAGE.

AT THE BEGINNING OF EACH BLOCK, A NOTE REMINDS YOU WHO ARE THE RELEVANT PERSONS THAT NEED TO BE INTERVIEWED.

Example: **Module 4 – Block 1**: "*The items of this module are asked to all selected individuals of the eligible households*"

DO NOT FORGET TO REPORT THE CORRECT ID CODE OF EACH HOUSEHOLD MEMBER WHEN THEY ANSWER TO EACH OF THE QUESTIONS.

FOR CERTAIN QUESTIONS, SOME FILTERS (*in italic*) HAVE TO BE APPLIED ACCORDING TO THE ANSWER GIVEN BY THE RESPONDENT. YOU HAVE TO CAREFULLY FOLLOW THESE INSTRUCTIONS.

Example: **Module 4 – Block 3**

q.2a	
Would you take the opportunity of a 1 chance out of 2 of doubling your income and a 1 chance out of 2 of reducing your income by one third?	
Yes	**No**
Ask question 2b	*Ask question 2c*

Example: **Module 7**

q.1	
Have you ever been involved, either as a person at fault or as a victim, in a road traffic accident?	
Yes	**No**
	If No, go directly to item 13

V. The questionnaire

Module 1 – Household characteristics

q.1: « How many persons are there in your household? ». c.f. Section II for the definition of household members.
q.7: « How many rooms does your dwelling have? ». This refers to the total number of rooms that can be found in different buildings within the household. The rooms taken into account are bedrooms, dining rooms, and living rooms. However, lavatories, bathrooms, hallways, verandas, and kitchens do not count as rooms.

Module 2 – Demographic and other characteristics of the household

The first step concerning **Module 2 - Block 1** is to establish a list of all the members of the household. Only after this list has been established you can begin to ask the other questions. You can include up to 8 persons over the age of 12 on the list.
In cases in which the household has more members, then you should list the 8 oldest persons. The total number of individuals is already included in **Module 1, q.1 – Household size.**
The person in the first row of the list is always the head of the household. Even if the respondent is not the head of the household, the head of the household will still be listed in the first row (and not the person interviewed). If the head of household is absent during the interview, he/ she will also be listed in the first row.

q.8: The general level of education refers to the highest achieved level. Someone who is currently enrolled in primary school would be listed as having gone to "primary".

Module 3 – Block 1 – Transport habits

q.1: the respondent has to rank by frequency of use the three means of transport he use most often. The enumerator report the code of the number one mean of transport in the first column, the number two in the second column and the number three in the third column.

q.4: only one reason can be provided, it has to be the main purpose of bus trips.

Module 3 – Block 2 – Transport habits and helmet use

q.7: the respondent has to give the 2 main reasons of his/ her motorbike trips and rank them. The enumerator reports the code of the # one reason in the first column, the # two in the second column. If the respondent chose the option "other", the enumerator asks him/ her to specify and report the reason in the "other" column.

q. 11: report the answer made in M**odule 2 – Block 1 - item 12**.

q.12: For driver indicates report the answer in 12a, for passenger in 12b. For individuals that are both ask the question in the two different cases and report the respective answers in 12a and 12b.

q.14: show the card with the different helmet types. If possible kindly ask whether you can see the helmet they are referring too. This may be quite sensitive to introduce so be careful not to make them feel uncomfortable or untrusted.

q.17 and q.18: let the respondent say yes or no and if yes ask whether it is always or not.

Module 3 – Block 3 – Insurance and other vehicle expenditures

q.3: number of motorbikes owned by the household members.

In the following questions of this block (**q.4 to q.18**) every motorbike will be coded starting with the number 1. In other words, if the household members own 3 motorbikes in total, all questions will be asked for each motorbike. The latter being coded respectively 1, 2 and 3.

Module 4 – Block 1 – Self reported risk aversion

In this block, you start with the introductive sentence indicated on the questionnaire and present the scale which goes from 0 for « not prepared to take risks at all » to 7 « fully prepared to take risks »

Module 4 – Block 2 - Lotteries

In this block, you first present the lottery game and ask if the respondent agree to answer to these questions.

In the case the person does not want to answer to lottery questions, indicate this situation by coding all the answers by **-2 (code for REFUSED)**.

If he agrees, then you explain that 20 different lotteries will be presented and that the respondent will have to choose between a safe amount (always the same) and a lottery pay-out for which there is a 50 percent chance to get nothing and a 50 percent chance to get 12,000 Rs. The respondent has to say which option between the safe amount and the lottery he would prefer. You need to make sure the respondent take the lottery seriously and that his/ her answers are honest.

For each row, you ask the respondent if he prefers receiving for sure X Rs or receiving nothing with a 50 percent chance and 12,000 Rs with a 50 percent chance. X varies with each row (cf. Lottery table).

You report the choice of the respondent for each row in the questionnaire.

Example : (row 10) « Between receiving for sure 4,500 Rs or receiving nothing with a 50 percent chance but 12,000 Rs with a 50 percent chance, which of these two alternatives would you prefer? »

Module 4 – Block 3 – Risk aversion in financial matters

item 6 to 9: Insurance coverage questions are asked for two different types of insurance. The enumerator will proceed the following way: questions 6 to 9 will be asked for one insurance type at a time. In other words, the enumerator will first ask items 6A, 7A, 8A, 9A and then pass to the second type of insurance by asking items 6B, 7B, 8B, 9B.

Module 5 – Block 1 – Road risk awareness

q.3a, q.3b and q.3c: the sum of the three answers can be lower but not higher than 100. You have to make sure that it is the case.

Module 5 – Block 4 and Module 6 – Block 2 – Elicitation of subjective probabilities

The objective here is to make the respondent revealing his personal perception of the probability either to be injured (Module 5) or to be stopped by the police (Module 6)

Table 2.11: List of starting points randomly selected

Zone	Code	Constituency	Starting Point address
	101	Sadar Bazar	Sarvodya Kanya School, Lalita Block, Sashtri Nagar
	102	Chandni Chowk	Govt. Girls Sec. School, Kalan Mahal, Darya Ganj
	103	Matia Mahal	Anglo arabic school, Ajmeri gate
	104	Ballimaran	M.C. Pry school, Gali No10, Multani Dhanda
Central	105	Ballimaran	M.C. Pry school, Lahori Gate
	106	Karol Bagh (SC)	Govt. Sarvodaya Bal Vidyalaya, Kaseruwalan, Pahar Ganj
	107	Patel Nagar (SC)	Nagar Nigam Prathmik Balika vidyalaya,West Patel Nagar
	108	Moti Nagar	G.G.S.S School, A Block, Kirti Nagar
	109	Rajinder Nagar	M.C.D. Pry School, J.J. Colony, Inder Puri
	110	New Delhi	N.P. Pry school, Babar Road
	201	Babarpur	M.C.Pry school, Zafarabd extn (Pili Mitti) Ist shift
	202	Ghonda	Govt. Boys Sr. Sec. school No1, C-block, Yamuna Vihar
	203	Gokalpur (SC)	Govt Girls Sec. School, Saboli
	204	Kondli (SC)	MC.D Pry School, Block-16 Kalyanpuri IInd shift
East	205	Krishna Nagar	M.C Pry school, Ram Nagar (single shift)
	206	Mutafabad	D-Block, Dayal Pur E-II, Nehru Vihar
	207	Rohtas Nagar	MC Pry school, Ashok Nagar, Shahdara
	208	Seelampur	M.C. Pry school Sabzi Mandi, Iind shift, Mauj Pur
	209	Shahdra	M.C. Pry School, Circular Road, Jhilmil South Zone, Jwala Nagar
	210	Vishwas Nagar	MC. Pry. school-II, Bhikam Singh Colony
	301	Timarpur	Sarvodaya Bal Vidhyala, Timarpur
	302	Adarsh Nagar	M.C. Pry school, Dhirpur
	303	Rohini	M.C. Pry school, Section-18, Rohini
	304	Rohini	Govt Co-Ed Sr. Sec. School, Section-7, Rohini
North	305	Shalimar Bagh	M.C. Pry school, AG Block
	306	Shakur Basti	M.C.D. Pry basic school, New Multan Nagar
	307	Tri Nagar	M.C.D. Pry school, I-Block, Shakurpur
	308	Wazirpur	Tool Room Training Center Wazirpur, Indl Area
	309	Wazirpur	M.C. Pry Model school, Nimri Colony
	310	Model Town	Guru Nank Sr. Sec. School, Singh Sabha Road

List of starting points - continued

Zone	Code	Constituency	Starting Point address
	401	Jangpura	M.C.D. Pry school, Jeewan Nagar
	402	Malviya Nagar	Central school, IIT Campus
	403	R.K.Puram	M.C.D. Pry Model School, Indian Airlines Colony, Vasant Vihar
	404	Chhatarpur	Acharya Tulsi Sarvodya Vidyalaya, Chhattarpur
South	405	Deoli (SC)	M.C. Pry school, Block-G, Sangam Vihar
	406	Sangam vihar	M.C.D. Pry school, Block-F2, Sangam Vihar
	407	Greater Kailash	M.C. Pry school, Slum-II, DDA flat Kalkaji
	408	Tughlakabad	M.C. Pry school, Sanjay Colony
	409	Badarpur	M.C. Pry school, Jaitpur
	410	Okhla	Govt Boys Sr Sec. School, Noor Nagar
	501	Bawana (SC)	M.C. Pry school, E-5 J.J. Colony, Bawana
	502	Burari	M.C. Pry. school, Mukund Pur
	503	Hari Nagar	M.C.D Pry school, D-1/A, Janak Puri
	504	Kirari	Govt Middle school (Boys), Nithari
West	505	Matiala	AC-34, Matiala, Community Centre, Housing Complex, Kakrolla
	506	Najafgarh	M.C. Pry school, Kair Najafgarh
	507	Narela	M.C. Pry school, Holambi Kalan
	508	Rajouri Garden	Nigam Prarthamik Vidyalaya Rajouri Garden (Main) between F & C Block
	509	Tilak Nagar	M.C.P. Co-Ed, Adarsh Nagar, GG-3, Vikaspuri
	510	Vikaspuri	Govt Girls Sec. School, J.J. Colony, Shiv Vihar

Table 2.12: Information on survey staff

Name	**Gender**	**Age** (in years)	**Education‡**	**Experience** (in years)	**Training session†**	**# of long questionnaires** total	completed
List of supervisors							
Sudhakar Gaur	Male	21	2	5	1		
Ashwini Thakur	Male	35	2	10	1		
Indrajeet Singh	Male	24	2	5	2		
Shikha Prajapati	Female	24	3	8	3		
List of interviewers							
Ajay Shukla	Male	23	2	5	1	64	57
Dhirendra Kumar	Male	26	2	6	1	94	82
Rekha Richard	Female	28	2	4	1	103	66
D.P Singh	Male	37	1	3	1	222	200
Sanjay Kumar	Male	37	2	8	2	8	8
Shiv Shankar	Male	23	3	1	2	83	75
Sham Narayan Mishra	Male	25	2	1	2	154	107
Dharmendra prajapati	Male	22	2	2	3	60	43
Ajay kumar	Male	19	2	4	3	11	7
Shivam	Male	19	2	1	3	22	14
Ananya Dwivedi	Female	20	2	5	3	55	50
Hari Shankar	Male	25	2	2	3	66	49
Anish Kumar	Male	21	1	1	3	99	81
Sunil Chaturvedi	Male	30	3	2	3	13	13
Amiran	Female	22	2	1	2	11	7
Sunita	Female	25	3	1	2	23	23
Ashish	Male	28	2	1	2	26	20

Notes: † Training dates : 1st session = 13 - 16 july 2011; 2nd session = 25 and 26 july 2011; 3rd session = 23 and 24 august 2011.
‡ Education level : 1 = 12th grade; 2 = B.A, B.COM, BSC, BSW and 3 = MSW, MA

Chapter 3

“Tell me, are you risk averse?” The influence of survey design and interviewer characteristics on the measurement of risk aversion in a low income context

Abstract

Using an original dataset collected among motorcyclists in New Delhi (2011), this paper compares three different survey measures of risk attitudes: self assessment, hypothetical lotteries and income prospect choices. The contribution of the paper is twofold. First, I investigate the socio demographic determinants of risk aversion for each of the three suggested measures. While self reported risk attitudes appear to be significantly correlated with both risky health behaviors and labor decisions for all three measures, I find that lotteries differ substantially from the two other measures in important respects. Second, I investigate the influence of interviewers on reported measures of risk aversion. I provide evidence that part of the variance in the elicited preferences toward risk comes from the interviewers themselves. However, this influence does not affect the previous relations between risk aversion and risky conducts once interviewer effects are controlled for. This analysis shows that individual risk preferences can be measured through self assessments in large scale surveys in a developing country context like India. Nonetheless, a careful allocation of interviewers is recommended when implementing surveys in order to be able in the analysis to control for their impact.

JEL Classification: C42, D81, I10, O53.
Key words: Risk aversion, India, Survey design, Interviewer bias.

Contents

3.1 Introduction

Preferences toward risk are a key concept used in economics to explain individual decision making. In the context of low income countries, individuals' risk aversion is often mentioned as a possible explanation for the lack of entrepreneurship or the technological innovation delays maintaining individuals in poverty and impeding growth and development (Cardenas and Carpenter; 2008). However, standard household surveys, such as the World Bank's Living Standard Measurement Surveys, do not ask questions about risk aversion and hence cannot be used to analyze the effect of risk preferences on various economic outcomes. In addition, risk attitude measurement is a difficult challenge which is still debated in the literature. The various existing methodologies include Likert scales (Dohmen et al.; 2011); lotteries (Holt and Laury; 2002); prospect choices on lifetime income (Barsky et al.; 1997); domain specific risk taking scales[1] (Weber et al.; 2002); scores based on the item response theory (Arrondel et al.; 2004); or actual behaviors (smoking, seat-belt use). One key aspect of the debate is whether each individual has

[1] Such scales measure both risk attitudes and perceived riskiness.

one unique preference toward risk or whether his or her risk aversion varies depending on the domain considered. Dohmen et al. (2011), Barseghyan et al. (2011) and Einav et al. (2012) provided evidence against the stability hypothesis of risk preferences across contexts. Furthermore, based on evidence from the safety literature, Wilde (1998) documented the fact that individuals do not try to minimize risk but rather target a certain level of risk and adapt their behaviors accordingly. Some compensation may thus appear with respect to the risk individuals are willing to take in different domains. The degree of substitution between domains, the role of risk perceptions but also the formulation of questions make the measurement of risk aversion and the study of its influence on risky behaviors quite complex.

Along with this growing literature on the measurement of risk preferences, empirical research has compared many of these risk aversion methods, both in developed and developing countries (see Binswanger; 1980; Dohmen et al.; 2011; Anderson and Mellor; 2008; Ding et al.; 2010; Hardeweg et al.; 2012). This strand of research aims at investigating which measure, if any, predicts individual risk behavior better. Moreover, it intends to see whether questions easily implementable in a survey are indeed able to capture individuals' preferences toward risk. Finally, the cultural context may modify the impact of the elicited risk aversion parameters on risky decisions. In particular, religious beliefs, like fate, widespread in developing countries may change the influence of risk aversion on risky conducts. Therefore, one measure which has been proven to predict behaviors in one country may not be appropriate in another context. It is therefore interesting to replicate the comparison of risk aversion variables obtained with various methodologies in different regions of the world.

Besides the measurement issue *per se*, the interviewer him or herself may modify the respondents' responses regarding risk aversion, in particular in a face to face interview. Indeed, the interviewer may systematically shift the answers toward one direction, as a result of his or her own observable and unobservable characteristics (such as his or her survey skills, understanding of the questionnaire, ability or own risk aversion). Indeed, the interviewer's socio demographic characteristics have been shown to alter the respondent's answers in particular when sensitive questions are asked (see Tourangeau and Yan; 2007, for a review). Social desirability and positive self image are some of the reasons why individuals may not disclose their true opinions and conducts. Finally, the influence of the enumerator may vary from one respondent to the other. For instance, a male may tend to reveal different risky behaviors and preferences toward risk if it is a woman rather than a man who is interviewing him (see Flores-Macias and Lawson; 2008; Lutz and Lipps; 2011).

In this paper, I aim at contributing to the debate on risk aversion measurement through the use of an original dataset collected among motorcyclists in Delhi in the year 2011. Methodologies widely used in the literature (self assessment of risk aversion, hypothetical lotteries and income choice prospects) were included in the survey. I first explore to what extent the information collected differs across methodologies and domains. To do so, I look at the share of risk averse individuals in each type of measure and at correlations between the different risk aversion variables. It seems that lotteries differ substantially from other measures regarding the information they actually capture. In a second step, I study the socio demographic determinants of individuals' risk aversion and test if they

are the same as the ones mentioned in the literature. Subsequently, I investigate whether the different survey measures are appropriate in the Indian context. More precisely, I study if the various risk preference parameters are good predictors of work sector choices and risky health behaviors, even after controlling for cultural specificities such as religious beliefs. I find that self reported risk aversion predict well the choice of working in the private sector and risky behaviors in health matters. Results found when using the hypothetical lotteries can either be interpreted as evidence for a risk compensating effect across domains or as evidence that such methodology is not adequate in the Indian context (may be partly because of the absence of financial incentives). As for the measure based on the income prospect choices, it is associated with smoking and drinking behaviors but not with the occupational decisions. Finally, I analyze whether interviewers alter the answers provided by the respondents. I first look at the share of variance explained by the interviewers' characteristics. Subsequently, I go back to the analysis of risky conducts. Once interviewers' characteristics are controlled for, a more context specific relation between risk attitudes and risky health behaviors is detected, which is in line with Ding et al. (2010)'s or Wölbert and Riedl (2013)'s findings.

The remainder of the paper is organized as follows. Section 2 presents some conceptual considerations on risk aversion measurement and interviewer bias. Section 3 introduces the data and presents the various methodologies used to measure risk preferences. In Section 4, I report the empirical results regarding accuracy of risk aversion measures in the Indian context and information consistency across survey methods. I also document there the interviewers' influence on the quality of the data collected and on the subsequent analysis made. Section 5 concludes.

3.2 Conceptual considerations

3.2.1 What do we want to capture?

Preference toward risk corresponds to an individual specific characteristic which supposedly plays a role in the agents' decision process under uncertainty. This parameter is usually assumed to be exogenous, i.e. innate and immutable. If a person can choose between two different situations which are identical regarding their expected outcomes but which differ with respect to the probability of realization of the final state, a risk averse individual will derive more utility from the case without uncertainty. In an expected utility framework, such definition is reflected in the concavity of the utility function. Applied researchers aim at capturing this individual characteristic to be able to predict whether a person would engage in risky conducts or not.

3.2.2 How can we measure risk aversion?

Although risk aversion is a fundamental element in standard decision theories, experimental research has provided little guidance as to how risk attitude should be modeled. Instead, many different methodologies have been used to

proxy or capture individual risk preferences and study their impact on individual decisions. Anderson and Mellor (2008) pointed out the wide range of risk aversion measures used in the literature ranging from actual behaviors[2] to hypothetical choices or self reported attitudes. In the following paragraph, I present some of these elicitation methods.

Holt and Laury (2002) developed a lottery choice experiment which allows them to measure the degree of risk aversion over a wide range of payoffs, going from a few dollars to several hundred ones. More precisely, in their setting each agent was supposed to choose between two lottery options. The risk aversion being there seen as the fact of avoiding a high variation in the outcomes. The series of paired lottery choices is structured so that the crossover point from the high risk lottery to the low risk lottery can be used to infer the degree of risk aversion of the individual. In other words, by knowing the lottery for which the individual switches from one option to the other, the authors computed the constant relative risk aversion parameter and categorized respondents into either risk averse, risk neutral or risk prone subgroups. The comparison of two lotteries may appear quite complicated for certain populations. That's why, in order to ease the understanding of the proposed alternatives, Hardeweg et al. (2012), for example, confronted Thai farmers with 20 choices between an increasing safe payment and a fixed lottery. This simplified method was also implemented by Dohmen et al. (2010) or Guiso et al. (2013) in developed countries and by Vieider, Chmura, Fisher, Kusawaka, Martinsson, Thompson and Sunday (2014) in developing ones. De Palma et al. (2011) also offered a series of choices between a lottery and a sure payoff when investigating individual and couple behaviors under risk. In prospect theory, the weighting probability function is a key parameter in elicitating individual risk aversion. Varying the probability that each option occurs, instead of the amount of the payoffs, allows to capture such information (see Abdellaoui; 2000; Bleichrodt; 2001).

Barsky et al. (1997) used questions introduced in the Health and Retirement Study (HRS) where interviewees were offered job opportunities leading to different lifetime income outcomes. Yes/no questions and a two step procedure are adopted in that questionnaire. The questions separate respondents into four distinct risk preference categories, depending on the answers provided in the two questions.[3] The categories can be ranked by degree of risk aversion without having to assume a particular functional form. Nonetheless, this survey measure has been criticized on the ground that individuals may value their current job for reasons other than the income flow associated with it and therefore might be reluctant to switch jobs even for high expected increases in income.

Likert scales have also been included in surveys. In the German Socio Economic Panel (G-SOEP), for example, respondents were asked to assess their risk aversion in general and in specific domains (such as career, health, finance, or leisure) using an 11 point response scale. Despite the easiness of its implementation, critics highlighted that, because of the generality of the formulation, it is rather difficult to know exactly to what each individual is referring to when replying to the question. More over individuals may use differently the extent of the scale. This thus implies some difficulties when comparing answers between individuals.

In order to counteract this issue, summated rating scales have been developed to measure risk attitudes. This methodology is based on specific and factual questions involving risk taking in different situations. Spector (1992)

[2] Viscusi and Hersch (2001) and Hakes and Viscusi (2007) used respectively smoking status and seatbelt use.

[3] A more precise classification (with more categories) can be made by introducing an additional yes/no question.

summarized the criteria of a good score along with the methodology to be followed in order to compute it and verify its quality. He emphasized that each item composing the score should be clear, precise, non ambiguous and as concrete as possible. Arrondel et al. (2004) implemented a risk attitude score based on this item response theory in the PATER survey.[4] They asked a large set of questions in domains such as consumption, finance, labor, health or family matters and with respect to different time horizons. Hence, unlike qualitative scales or hypothetical questions, they introduced specific and contextualized items. The score built by Arrondel et al. (2004) is based on more than 50 items. In the end, a single score is computed assuming that individuals do not have different risk aversion in different areas but a single one which is just better captured by precise questions. This method certainly permits to better measure the global level of individual risk aversion but requires more time to be collected. Furthermore, items must be adapted to the local context. An important testing phase is therefore needed.

As for Weber et al. (2002) and Blais and Weber (2006), they introduced a series of specific questions to estimate individual risk tolerance. More precisely, they elaborated a risk taking scale (DOSPERT scale) to assess both conventional risk attitudes (reported level of risk taking) and perceived risk attitudes (willingness to engage in a risky activity as a function of its perceived riskiness) through scales going from 1 to 7[5] in five specific domains: (i) ethical, (ii) financial (gambling and investment), (iii) health/safety, (iv) social, (v) recreational.[6,7] The idea behind the second scale is that the different behaviors adopted by the same person in two situations might be due to differences in risk perceptions related to the two contexts. In the same way, differences in perceived riskiness may lead two individuals with the same degree of risk aversion to adopt different conducts in a given situation. The combination of risk preferences and risk perceptions may thus better predict an individual decision choice. Nevertheless, this methodology mixed the drawbacks of both the summated rating scale and the qualitative scales. On the one hand, it requires asking a lot of questions and adapting them to the local environment. On the other hand, the qualitative answers may limit the comparison between individuals.

3.2.3 What measurement issues do we face?

In this section, I highlight the measurement issues applied researchers have to consider when designing and implementing a survey aimed at capturing risk preferences.

How should one measure risk aversion?

Given the various methods developed to measure risk aversion, some of which have been presented in the previous subsection, survey designers are facing the dilemma of which measure they should introduce in their questionnaire. Methodologies differ by the number of questions to be asked and by the incentives that can be provided

[4] PATER for “Préférences et Patrimoines face au TEmps et au Risque” (“preferences and wealth in relation to time and risk”).

[5] For the risk taking scale, 1 corresponds to “Extremely unlikely” and 7 to “Extremely likely”. For the risk perception scale, 1 corresponds to “Not at all risky” and 7 to “Extremely risky".

[6] A total of 30 questions, six in each domain, are asked to the respondents.

[7] Arrondel et al. (2004) also investigated more contextualised risk aversion by building subscores for each domain.

to ensure that honest replies are obtained.[8] But do all these methods lead to the same information? Or, is one measure able to capture the individual risk aversion better than others? Does the cultural context alter the predictive power of such indicators? Several studies investigated some of these issues by comparing the accuracy and consistency of elicited risk aversion parameters obtained through different methodologies. Researchers discussed the relevance of experimental versus survey measures. Collecting evidence of the accuracy and the performance of each method is crucial and of particular interest for survey designers. Survey questions are often more easily extendable to large samples such as national households surveys; while incentivized lottery experiments are only implementable at a reduced scale. If survey measures appeared to provide information on individual risk aversion as good as the one obtained with experimental methods; gathering data on risk preferences could be greatly facilitated. Moreover, only a limited number of questions on risk preferences can usually be introduced in a questionnaire due to budget and time constraints. Knowing which elicitation method provides the best measure of the individual's risk aversion could optimize the data collection on risk preferences. I report below the results found by this strand of the literature.

Binswanger (1980) measured attitudes toward risks in rural India using both survey questions to elicit certainty equivalents and experimental gambling with real payoffs. He highlighted inconsistencies between the two methodologies used and argued that the interview method is the one subject to bias. Anderson and Mellor (2008) investigated the relation between risk preferences measured by lotteries and five health behaviors. They argued that survey questions or hypothetical questions are likely to be biased or noisy, while paying one out of ten of the lottery questions ensure an incentive compatible measure of individual risk attitudes. Nevertheless, the authors didn't actually compare their risk experimental measure with self reported risk aversion which limits the strength of their argument.[9] In another paper, using again U.S. data, the same authors compared the information provided by lotteries and the one obtained through hypothetical gamble questions on inheritance and job choices.[10] While the two measures have been associated with many risky behaviors in finance, insurance, health or career choices, Anderson and Mellor (2009) showed that different methods and formulations did not provide the same individual risk aversion level. The classification of individuals in different risk aversion groups based on questions regarding inheritance was more correlated to the risk aversion derived from lotteries than the classification based on job choices. As to Ding et al. (2010), they interviewed 220 students from the University of Beijing. Respondents were presented with an incentivized lottery, hypothetical reservation price of different lottery tickets as well as self assessment risk taking questions in general and in five domains. The risk measure with the best prediction score was the general risk attitude variable. The survey lottery questions had virtually no predictive power for the risky behaviors the authors selected, and the real money experiment only had some power to predict rock climbing. Moreover, their results showed evidence of domain specificity: significant correlations of drinking and rock climbing with risk taking in leisure, of smoking with risk taking in health, of exam preparation with risk taking in

[8] It is common in the experimental literature implementing lotteries, to draw randomly one of the questions and pay the respondents according to the result of the lottery and the choice they previously expressed.

[9] Wölbert and Riedl (2013), using monetary incentives, actually found that lotteries were not correlated with non financial risky behaviors.

[10] The hypothetical gamble questions are similar to the two yes/no questions used by Barsky et al. (1997).

education and of buying stocks with risk taking in finance. Nevertheless, these correlations were not always very large. Based on the analysis performed by Dohmen et al. (2011) on a German sample, Hardeweg et al. (2012) tested the validity of a simple survey item on risk attitude by comparing it to a related field experiment. Using a sample of more than 900 participants from rural Thailand, they compared three different measures: a survey item based on a Likert scale, lottery questions and a hypothetical investment question. Results indicated that the self assessed measure better predicted the purchase of lottery tickets and self employment than the experimental measure or the hypothetical investment question. The authors therefore argued for the use of simple survey measures given that they simultaneously provided useful information on risk attitude and were easily implementable.

In this paper, I focus on survey measures and compare risk attitudes obtained through various methodologies and in different domains. For this purpose, I take advantage of an original dataset collected among motorcyclists in New Delhi in 2011. While previous research on risk aversion measurement in developing countries focused on specific groups such as rural farmers or students (see Hardeweg et al.; 2012; Ding et al.; 2010; Vieider, Chmura, Fisher, Kusawaka, Martinsson, Thompson and Sunday; 2014), the dataset I use covers a large and heterogenous urban population. Thanks to information on religious beliefs and practices, I am also able to verify that cultural background does not change the results found on the influence of risk aversion on risky behaviors. To summarize, this analysis provides additional evidence on the adequate measurement of risk aversion in general and in a developing country in particular.

Do interviewers influence the measurement of risk aversion?

Reliability of survey data is one main concern for empirical researchers. The ability of collecting the 'true' value of the individual's characteristics and behaviors is the absolute prerequisite to the quality of the data collected and the confidence one can have regarding the conclusions subsequently made. Error reporting for non sensitive questions may lead to less precise estimates by increasing their variance.[11] On the contrary, if individuals decide to modify their response rather deliberately, error reporting may lead to biased estimates. Such misreporting is likely to occur for sensitive questions related for instance to politics, racism, risky conducts or gender issues. Social desirability, positive self image, defensive attitudes toward intrusive questions, expected consequences from revealing certain health related information are different reasons why respondents may alter their true response when answering to the interviewer. Interviewers may be more or less efficient in reducing this misreporting. In case a same individual provides a different answer to different interviewers asking him the same question, interviewer effects are taking place. Tourangeau and Yan (2007) highlighted that self administered surveys, the absence of family members during the interview and encouragement to tell the truth are different strategies which help improving the quality of the collected data.

Certain characteristics of interviewers, such as gender and ethnicity, are likely to move respondents' answer

[11] Non responses and reporting errors may appear in non sensitive questions because of difficulties respondents might face in understanding the questions, or in finding a response category in which his response fit.

toward a certain direction. Studies on political attitudes, citizen's duties, voting and racial issues looked at the influence of interviewer's race on provided answers (see Lutz and Lipps; 2010, for a review). Huddy et al. (1997) or Flores-Macias and Lawson (2008) showed that the gender of interviewers influenced replies to questions related to abortion or women's rights. In particular, Flores-Macias and Lawson (2008) took advantage of two gender sensitive questions included in the first wave of the Mexico 2006 Panel Study.[12] They found that male respondents were more likely to report feminist views if interviewed by a woman. As for Catania et al. (1996), they examined items on same gender sexual activity, condom use, number of sexual partners, extramarital sexual activity, sexual violence and sexual problems. They investigated in particular the influence of interviewer' gender. They showed that for most of the items gender matching provided better quality data. This conclusion is challenged by the results reported in McCombie and Anarfi (2002). These authors found, using a survey on AIDS issues in Ghana, that all respondents were more likely to report higher use of condom, "no need to worry about AIDS" and that there was a cure for AIDS to female interviewers. Very young women respondents were more likely to tell men that they had prior sexual activity.

Davis et al. (2010) stressed the importance of interviewer bias in public health surveys where information on risky conducts such as alcohol consumption, drug use, unprotected sexual intercourses are likely to be underreported in particular because of the social norms and low acceptance of such behaviors. Several studies showed that the true information is sometimes rather disclosed to female or male interviewers depending on the nature of the question. For instance, female interviewer collect higher physical abuse, while illicit drug use was higher among male interviewers' sample (Fendrich et al.; 1999). Cosper (1972) found that in addition to perceptible characteristics like age, gender, education, interviewer attitudes may actually influence the behavior respondents declare to adopt on sensitive issues like drinking behavior. For instance, religious interviewers made respondents report less alcohol consumption than non religious ones.

In our face to face survey, respondents were asked about several risky behaviors and about their risk preferences. In addition to potential overreporting of safe conducts,[13] the interviewer might impact the answers respondents give regarding their risk aversion, and this in different ways. Young respondents may want to show off in front of a young interviewer, men may want to present themselves as courageous or reckless in front of a female interviewer. Therefore, the interaction between interviewee and interviewer characteristics might play a role in the misreporting of answers. Moreover, the interviewer's experience in survey work, his or her ability and own risk aversion may impact the way he or she administers the risk aversion questions and systematically orientates interviewees' answers toward one particular direction. To my knowledge, no study has looked at interviewer effect on individual risk aversion survey responses. In this paper, I fill the gap by bringing evidence that interviewer's characteristics indeed explain some of the elicited risk preferences' variance. I then study whether relations between risk attitudes and risky behaviors hold when controlling for interviewer effects.

[12] (i) whether or not abortion should be legal in case of rape ; (ii) among a battery of other items, whether women's rights should be a urgent priority for the next President.

[13] Stulginkas et al. (1985) provided in particular evidence of overreporting of helmet use.

3.3 Data

3.3.1 General presentation of the survey

In this paper, I take advantage of information on risk preferences introduced in a survey on road habits of motorcyclists which has been implemented in Delhi in 2011. Besides socio demographic characteristics, information regarding their job occupation and different risky health behaviors (smoking, drinking) were collected. We also attempted to measure individual risk aversion using different methodologies already developed in the literature. Further details on the measurement of individuals' risk attitudes are presented below.

The following sampling design was adopted: (i) New Delhi was divided into five zones, (ii) in each zone, ten polling booths were randomly drawn, (iii) the locations of these polling booths represented the starting points from which every fifth household was selected for the interview. Around each polling booth, 30 households were interrogated. In total 1,502 households were interviewed. In 545 households at least one member had traveled by motorbike in the past four weeks. Up to three drivers or passengers per household could answered the survey. On average, two individuals per household were interviewed; leading to a final sample of 902 motorbike users.

3.3.2 Interviewers characteristics

17 enumerators worked on the survey. Information regarding their gender, age, education level and experience in survey work has been gathered. Table 3.1 provides descriptive statistics on these socio demographic characteristics along with the interviewers' work load. 76% of them are men, on average they are 25 years old, hold an undergraduate degree and have a bit less than three years of experience in survey work. The number of questionnaires done by each interviewer varies for two main reasons: (i) the presence of motorcyclists in the areas they were sent to and (ii) their starting day.[14]

On average, each area has been covered by two interviewers and each of them went to seven areas.

Table 3.1: Characteristics of interviewers

observations: 17	mean	std. dev.	minimum	maximum
Male (=1)	0.76	0.44	0	1
Age (in years)	25.29	5.42	19	37
Education (Categories (1, 2, 3))†	2.06	0.56	1	3
Experience (in years)	2.82	2.16	1	8
Number of questionnaires done	66	58	8	222

Notes: The education variable takes 3 values: 12^{th} grade (1), undergraduate (2) and master (3).

[14] Indeed, three training sessions have been organised due to an important turnover and delays in the completion of the project.

3.3.3 Measures of risk aversion

Several methodologies to measure risk aversion have been included in the survey. In order to be able to compare the different risk aversion variables, I restrict my sample to individuals who answered to all risk aversion questions. I base my analysis on three elicitation methods (self reported risk aversion, hypothetical lotteries and income prospect choices) as they are more commonly used in the literature and missing observations for some alternative measures[15] considerably reduce the number of respondents for whom I have the complete information.

Respondents were first asked to self assess their risk aversion in general and in four specific domains (on the road, in sport or leisure, in health and in finance). They were offered to use a scale going from 0 “I am not ready to take risks at all" to 7 “I am fully ready to take risks". Hereinafter I refer to these measures as the self reported risk aversion (SRRA) variables. In addition to domain specific variables, I compute the average of the five SRRA measures. In a second step, interviewees were offered to choose between a fixed lottery, where they had a fifty percent chance to win either 12,000 INR or nothing, and a safe amount, starting at 0 and increasing by 500 INR up to 9,500 INR. The number of times the individual opt for the safe amount is the variable used in the analysis. The lottery questions are based on Holt and Laury (2002) but simplified as in Hardeweg et al. (2012). No financial incentives were provided along with the lottery questions. This choice has two motives. First, the objective here is to compare elicitation measures implementable in large surveys, where experimental design is hardly feasible. Second, monetary incentives would have substantially increased the needed budget to collect our data. Finally, following Barsky et al. (1997), questions regarding income prospect choices have been asked. These were organized in a two step procedure which leads to create four different risk aversion group.

A detailed presentation of the wording used in the questionnaire and the variables built can be found in the Appendices.

3.4 Empirical Analysis

As previously mentioned, I consider in my analysis only the individuals who answered to all three measures of risk aversion. This leads to a restricted sample of 675 observations. Table 3.2 displays the socio demographic information of my sample. 70% of the respondents are men, they are on average 36 years old. 20% of them are illiterate or only reached primary education while 47% attended some tertiary education. 30% of the interviewed individuals belongs to families with less than 10,000 INR per month.[16] 17% of them are members of households who earn more than 20,000 INR per month. Unfortunately an important share of the respondents did not agree to provide information on household income. In order to keep these observations in the analysis I introduce income information through dummies and include a “no answer” category. A comparison between the characteristics of individuals who answered to all three risk aversion measures and the full sample can be found in the Appendices

[15] Willingness to invest in a risky business, to pay for a lotto ticket or to take a product which may be beneficial or detrimental for the respondent’s health were also collected in the survey.

[16] 10,000 INR corresponds to 183 EUR in 2011 or 1,092 EUR in PPP 2011.

(Table 3.14).

Table 3.2: Socio demographic characteristics of respondents

	observations	%/mean
Male (=1)	*674*	69.73
Age (in years)	*675*	36.06
Education level	*666*	
3 category variable†		2.26
Illiterate or primary education		20.42
Secondary education		32.88
Tertiary education		46.70
Household monthly income	*675*	
Less than 10,000 INR		31.41
Between 10,000 and 20,000 INR		34.07
More than 20,000 INR		17.63
Did not answered		16.89
Religious beliefs and practices		
Believes his life is in god's hands (=1)	*672*	87.50
Prays daily (=1)	*671*	72.72

The purpose of the empirical analysis is two fold. First, to study the impact of survey design on the measurement of risk aversion in a low income context. Second, to explore the influence of interviewer's characteristics on the elicited preferences toward risk and on their relation with risky behaviors.

Regarding the first objective, a "good" measure of risk aversion must be in line with the economic theory and predict risky conducts. In addition, according to the empirical evidence, elicited parameters are expected to be associated with some individual socio demographic characteristics, such as gender, age, level of education or income. I investigate whether every risk attitude variable included in the survey satisfies these criteria. Furthermore, I compare the prediction power of the three different survey methodologies and explore the existence of domain specific risk aversion. One concern regarding the latter aspect is the difficulty to distinguish between the fact that risk preferences really differ across domains and the fact that some methods may not be able to capture this particular personal characteristic and lead to the construction of noisy measures. Different cases, which are described below, may be found in the data.

Case 1 : Risk aversion is not domain specific

If the levels of individual risk aversion defined in different domains are similar for a same person and if regardless of its domain, the risk aversion measure is positively correlated with the fact that the individual engages in a risky

behavior.

Case 2 : Risk aversion is (partly) domain specific
If a risk aversion measure defined in a given domain doesn't predict a risky behavior adopted in another domain or doesn't predict it as well as a risk aversion measure defined in the same domain as the risky conduct.

Case 3 : Evidence of risk compensation across domains
If a risk aversion measure defined over a specific domain is negatively correlated with the risk taken by the person in another domain.

Case 4 : Risk aversion is noise
If one or several risk aversion measures defined over the same domain do not predict the risky behavior in that domain.

Hereinafter, I start by studying if the different risk aversion measures elicited in the survey provide similar information regarding the level of risk aversion of each respondent. I then investigate in which way the risk parameters are associated with specific risky behaviors related either to finance matters or health issues. This analysis shed therefore some additional light on the context specificity of risk aversion and the relevance of the different survey methodologies.

3.4.1 Do survey measures capture the same information on individuals?

Evidence that risk aversion differs across domains and methods would be obtained if I find that the different measures are not highly positively correlated with one another.

Table 3.3 presents the distribution of the risk aversion measures. Given the proposed ladder for the self assessment of risk preferences, one can define as risk averse any individual who has a score superior to 4, i.e. in the middle of the scale (cf. Ding et al.; 2010). As for the lottery question, the neutrality point corresponds to choosing the safe choice from 6,000 or 6,500 INR onwards.[17] A risk averse person is therefore someone who chose at least nine times the safe amount. By looking at the median, we note that most of the respondents are risk averse and this for almost all measures.[18] There exists some heterogeneity across measures though. While at least 75% of individuals are categorized as being risk averse with the lotteries, they are less than 50% when looking at self assessment of risk aversion in finance, in sport or with the income choice measure. Among SRRA questions, the highest share of risk averse individuals is obtained with the question related to health and in general.

[17] Indeed, the expected gain of the lottery is 6,000 INR. A risk neutral agent is thus indifferent between playing a lottery with a 6,000 INR expected gain and getting 6,000 INR for sure. Therefore he may opt for the safe amount at 6,000 INR or still choose the lottery at that point but switch for the safe amount the next time, i.e. for a safe amount of 6,500 INR.

[18] While a risk aversion tendency is always found in developed countries, Vieider, Lefebvre, Bouchouicha, Chmura, Hakimov, Krawczyk and Martinsson (2014) pointed out that it is not the case in developing regions.

Table 3.3: Descriptive statistics of our risk aversion measures

	Observations	Mean	Standard Deviation	Median	perc. 25th†	Minimum	Maximum
Self reported risk aversion							
in general	*675*	5.15	1.77	6	4	0	7
on the road	*675*	5.00	1.95	5	2	0	7
in sport or leisure	*675*	4.18	2.37	4	4	0	7
in health	*675*	5.13	2.24	6	4	0	7
in finance	*675*	4.47	2.22	4	3	0	7
average*	*675*	4.79	1.55	4.8	3.6	0	7
Lottery questions	*675*	13.31	5.34	13	9	0	20
Income prospect choices	*675*	2.47	1.32	2	1	1	4

Notes: ∗ 'average' is the average of the five SRRA measures.
† 'perc. 25th' stands for the 25th percentile. In the case of SRRA in general, less than 25% of individuals report a risk aversion lower than 4.

To further investigate the consistency of my different risk aversion measures, I look at the pairwise correlations. From Table 3.4, we note that all the risk aversion measures are positively and highly correlated with one another, with the notable exception of the correlation between SRRA in finance and risk preferences derived from lotteries. Moreover, correlation coefficients between lotteries and other variables are quite small in magnitude (less than 0.10) and only two of them are significant (SRRA in sport and income prospect choices). SRRA measures are more correlated with each other[19] than with the measures based on the other methodologies. The income choice measure is more correlated with the SRRA in finance while the risk aversion derived from lottery questions is more correlated with the former variable. In addition, I perform Pearson Chi^2 test.[20] I find that all p-values are inferior to 0.001. Nevertheless, the Pearson Chi^2 statistics is much lower when the lottery question is one of the two measures considered.

These results reveal thus a higher correlation within both methods and domains. However, the use of a different scale across methodologies may partly explain the greater correlation found across self reported risk aversion measures.

To summarize, I find that my various risk aversion measures differ to varying extents from one another. Even if lottery questions seem to provide really different information on individuals, risk aversion measures in financial matters appear closer to one another. This is also the case within the self reported methodology. These pieces of evidence suggest that risk aversion measures define through different methods or in different contexts differ from one another. We can thus invalidate *Case 1*.

[19] Dohmen et al. (2011) also compared self reported risk aversion in different domains. They found that risk attitudes were not perfectly correlated across contexts and that the pariwise correlation coefficients were around 0.5, which is similar to the results I obtain.
[20] The Pearson Chi^2 test is a test of independence between two variables. In my case, rejecting the null hypothesis means that the two different risk aversion measures are related to each other.

Table 3.4: Pairwise correlation between our risk aversion measures

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Self-reported risk aversion								
in general	(1)	1.000						
on the road	(2)	0.585***	1.000					
in sport or leisure	(3)	0.222***	0.343***	1.000				
in health	(4)	0.246***	0.347***	0.548***	1.000			
in finance	(5)	0.332***	0.499***	0.631***	0.408***	1.000		
average*	(6)	0.610***	0.733***	0.782***	0.718***	0.799***	1.000	
Lottery questions	(7)	0.018	0.013	0.085**	0.036	0.025	0.051	1.000
Income prospect choices	(8)	0.174***	0.261***	0.316***	0.243***	0.329***	0.367***	0.175***

Notes: Pairwise correlation coefficients are computed over the restricted sample of 675 observations.
$*$ 'average' is the average of the five SRRA measures. ***, ** and * stands for 1%, 5% and 10% significance respectively.

3.4.2 Are personal characteristics of respondents related with risk attitudes?

To further investigate the accuracy of my different survey measures in the Indian context, I investigate whether gender, age, education and income are correlated with the individual's level of risk aversion. Indeed, numerous studies mainly conducted in developed countries, found that men as well as younger, more educated and wealthier individuals[21] are less risk averse (see Outreville; 2013, for a recent review). I therefore here tease out the correlations between socio demographic characteristics and risk attitudes for the case of India and compare whether these fit the evidence found for other countries.

Again I consider the restricted sample of respondents for which I have all answers for the three methodologies of risk aversion measurement: self assessment, hypothetical lotteries and job income choices. As dependent variables, I consider each of my risk aversion measures. I run ordered logit estimations for the self reported risk aversion measures in different domains and the job income choices (8 and 4 ordered values respectively). As for the average of SRRA measures, I perform an ordinary least square regression. Finally, given that I consider the number of safe choices made in the series of lottery questions, I use a negative binomial model for this particular risk attitude measure.[22] Table 3.5 shows the coefficients obtained with the different specifications used. Similar results are found when using ordinary least square estimations. Results vary from one dependent variable to the other. A gender effect (male being less risk averse) is found with SRRA on the road and in finance. An age effect (older individuals being more risk averse) is found for SRRA in general, on the road, in sport as well as with lotteries. An education effect (more educated individuals being less risk averse) is detected for SRRA in sport, in health, in finance and for income prospect choices. Finally, the income gradient (wealthier individuals being less

[21] For instance, Tanaka et al. (2010) showed the existence of a negative relation between income and risk aversion in the Vietnamese context.
[22] The Pearson goodness-of-fit test results indicate that the distribution of the number of safe choices significantly differs from a Poisson distribution, according to the p-value of 0.000.

risk averse) appears only for job income choices. Income and the two other risk aversion measures in finance are not significantly correlated, even if these coefficients are negative. It is interesting to note that the average of SRRA measure is significantly correlated with gender, age and level of education.

All in all, the same relations between socio demographic characteristics and risk attitudes as the ones already presented in the literature are found with this Indian sample.

Table 3.5: Determinants of risk aversion measures

	Self reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Specification	ordered logit	ordered logit	ordered logit	ordered logit	ordered ologit	ols	negative binomial	ordered logit
Male (=1)	-0.208	-0.369***	-0.198	0.055	-0.322**	-0.291**	-0.055	-0.176
	(0.145)	(0.139)	(0.164)	(0.155)	(0.150)	(0.123)	(0.035)	(0.161)
Age (in years)	0.017***	0.016***	0.020***	0.008	0.006	0.014***	0.003***	0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.001)	(0.005)
Education level (3 groups)	-0.102	-0.170	-0.296***	-0.212**	-0.171*	-0.194**	-0.006	-0.374***
	(0.107)	(0.104)	(0.096)	(0.096)	(0.102)	(0.081)	(0.021)	(0.100)
Household monthly income, *ref:* Less than 10,000 INR								
From 10,000 to 20,000 INR	-0.197	-0.050	-0.162	-0.087	-0.145	-0.157	-0.018	-0.325*
	(0.190)	(0.177)	(0.180)	(0.171)	(0.181)	(0.153)	(0.041)	(0.184)
More than 20,000 INR	-0.353	-0.048	-0.029	-0.222	-0.070	-0.158	0.041	-0.073
	(0.216)	(0.227)	(0.216)	(0.234)	(0.225)	(0.188)	(0.047)	(0.224)
Pseudo R^2/R^2	0.015	0.011	0.016	0.011	0.014	0.072	0.003	0.020
Observations	*665*	*665*	*665*	*665*	*665*	*665*	*665*	*665*

Notes: Robust standard errors are reported in parentheses. ***, ** and * stands for 1%, 5% and 10% significance respectively.
* 'average' is the average of the five SRRA measures.

3.4.3 Do survey measures predict risky conducts adopted by respondents?

In this survey, respondents were asked about both the sector in which they work and their conducts relative to different health behaviors. From Table 3.6, we see that respectively 23% and 11% of individuals work in the private and public sectors, while 20% declare being self employed and 44% inactive.[23] Moreover, 13% of the interviewees smoke and they are 16.5% to drink alcohol. These various decisions appear, in the literature, to be linked to individuals' risk preferences. In particular, Dohmen et al. (2011) showed that smoking habits were associated with a higher willingness to take risks. As for Bonin et al. (2007), they found that more risk averse individuals are more likely to work in occupations with low earning risks.[24] Cramer et al. (2002) highlighted that self employment is

[23] Only 34% of the inactive respondents are men. 75% of them are between 15 and 25 years old.
[24] Both studies used self assessed risk aversion from the German Socio Economic Panel data.

considered a more risky occupation than being an employee and obtained a negative relation between risk aversion and entrepreneurship. Yet, in the specific context of India, where public jobs are scarce, occupation may not always result from the individual's choice.

Table 3.6: Risky behaviors adopted by respondents

	Sector of work choices		
	Private sector	Public sector	Self-employment
Mean (%)	23.41	11.26	19.56
Std. dev.	42.37	31.63	39.69
Observations	*675*	*675*	*675*
	Health risky behaviors		
	Smoking	Drinking	Smoking or/and drinking
Mean (%)	12.93	11.88	16.51
Std. dev.	33.58	32.38	37.16
Observations	*673*	*648*	*648*

I thus look at the predictive power of my different risk aversion measures on the probability of being self employed and of working in the private or the public sectors, as well as on the probability of smoking, drinking, and engaging in at least one of these two activities. Table 3.7 reports the result of probit estimations for the different measures of risk attitudes. I also count the number of risky activities the individual declare to adopt. This variable can take three values (0, 1 or 2). I therefore use negative binomial estimations to study the influence of risk aversion on this counting dependent variable. Socio demographic controls are always included in the regressions and robust standard errors are considered.

When looking at choice of sectors, self reported risk aversion on the road, in sport, in finance and the average of the different SRRA are significantly and negatively correlated with working in the private sector. For instance, a marginal change of the self assessed risk attitudes in finance decreases by 2.4% the probability of working in the private sector (marginal effects not reported in Table 3.7). As expected, more risk averse individuals are less likely to work in the private sector. No significant relation between the public sector and risk aversion is found, this for any of the risk attitudes considered, except for the SRRA in health. In this latter case, a more risk averse individual is less likely to work in the public sector, which contradicts previous research on occupational choice. Nonetheless, when restricting the sample to individuals who contribute to the household income,[25] this coefficient is no longer significant and I find that SRRA in finance and sport are positively correlated with the probability of working in the public sector (cf. Table 3.15 in the Appendices). Finally, the average of the SRRA measures is positively and significantly correlated with being self employed. Similar results are found with SRRA in health and

[25] i.e. 56% of respondents, which corresponds to a sample of 372 persons.

finance when restricting the sample to income contributors. In other words, the more risk averse individuals are the more likely they will work in the public sector or be self employed. The unexpected positive relation obtained between self employment and risk attitudes might be refined when taking into account the Indian context where opportunities to get a safer job in the public sector are scarce and informal sector represent an important share of the labor market. Private sector work and self employment won't under these circumstances necessarily result from the preferred choice of less risk averse individuals. We note that neither lottery questions nor income choice prospects appear to be associated with the occupational choices in the expected way. Moreover, the preference toward risk based on the lotteries are positively correlated with the probability of working in the private sector. According to *Case 4*, one is inclined to conclude that lottery questions are not able to capture the preferences toward risk. Nevertheless, in the case of occupational choices, a reverse causality issue may appear. More precisely, once revenues are secured through a safe public sector job with a monthly salary, individuals may be more willing to take risk in finance and in hypothetical lotteries (see *Case 3*).

In order to further explore the opportunity issue previously mentioned, I introduce interaction terms between risk aversion and both education and caste. Indeed, I expect that more educated individuals have more opportunities and then their occupational choice is likely to result more from their preferred choice. As for individuals belonging to a high caste, I expect them to have more opportunities, even if the effect of caste may be balanced by the existence of positive discrimination national schemes. When introducing these interaction terms in the self employment regressions, the coefficient of risk aversion becomes negative for all measures and is significant for the income prospect choice variable. The level of education seem to reduce the effect of risk aversion on the probability of being self employed. Individuals belonging to a schedule caste or tribe are less likely to be working in the public sector. However, the magnitude of this effect is lowered by the individual's level of risk aversion. The more risk averse a low caste person is, the more likely he will work in the public sector. This result may reflect the effort these persons may actually put to take advantage of the positive discrimination policy implemented by the State (cf. Table 3.16 in the Appendices).

Regarding health behaviors, all the SRRA measures as well as the job income choice variable are highly and negatively correlated with the probability of smoking or drinking. For instance, a marginal change in the average individual's self reported risk aversion decreases by respectively 3.8% and 2.9% the probability of smoking and drinking. Notably, the risk aversion variable derived from the lottery question is unexpectedly positively correlated with the probability of engaging in any of the risky health behaviors considered. Again, a first interpretation of these results could be that in the context of India, the latter methodology is not appropriate to measure individuals' preferences toward risk, as such measure is not able to predict risky behaviors while other risk attitudes in finance are (see *Case 4*).[26] Nevertheless, if one starts from the premise that lottery questions are the gold standard, such results may rather invalidate other elicitation methods and reflect a risk compensation effect across domains (see *Case 3*). In other words, individuals who already take risk with their health by smoking or drinking may be less

[26] I acknowledge that the irrelevance of the lottery measure might come from the absence of incentives provided to respondents. Nonetheless, the budget constraints usually faced by large scale survey designers and the purpose of this study to derive achievable recommendations justify the choice we made to only include hypothetical lotteries in the questionnaire.

willing to play with their money. In any case, the observation made, when looking at descriptive statistics, on the inconsistency between the information provided by the lotteries and the one given by the other risk attitude variables is confirmed.

Additionally, it is interesting to see if one particular risk aversion measure has actually a better predictive power than others. This kind of analysis will allow me to conclude on the existence of domain specificity of risk preferences (see *Case 2*). Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), Pseudo R^2 and Log-likelihood are reported in Table 3.7. All these statistics provide information regarding the quality of each statistical model and enable me to compare the predictive power of different risk aversion measures on a same dependent variable.[27] More precisely, the lowest AIC, BIC and Log likelihood values and the highest Pseudo R^2 indicate the best model. When considering labor choices, self assessed risk aversion in finance is the variable which seems to be the most relevant. Job income choice measure, SRRA on the road and the average of the five SRRA variables are the measures with the highest power of explanation of risky health behaviors. Similarly to Ding et al. (2010), I find that the SRRA in health and in sport perform quite well for cigarette and alcohol consumption respectively. Nevertheless, unlike them I don't find that SRRA in general is the best predictor. The average score of self reported risk aversion in general and in the four specific domains introduced in the survey is actually among the two SRRA measures with the lowest AIC, BIC and Log likelihood scores and the highest Pseudo R^2 for all risky health behaviors. Finally, lotteries seem also to be quite a good predictor of smoking behaviors even if the relation found contradicts the results obtained with other measures of risk aversion in finance and rather reflect some risk compensation effect.

To summarize, on the one hand, in echo to results found in Germany (Dohmen et al.; 2011) but also in China or Thailand (Ding et al.; 2010; Hardeweg et al.; 2012), self reported risk aversion in different domains, and in particular the average score, appear to provide appropriate information on individual risk aversion as they really well predict risky conducts. On the other hand, in our specific context, hypothetical lottery questions may not capture a parameter correlated with the risky behaviors adopted by individuals. Several reasons might explain this finding, going from understanding issues to cultural norms (20% of the respondents said they prefer the zero amount to the lottery[28]). However, we acknowledge that an alternative explanation may be put forward. Indeed, such results would be also found if individuals decide to compensate the risk they take in a certain domain by adopting a safer conduct in another area or if they are more willing to take risk in finance in case they have a secured financial situation. In these cases, we would conclude that lotteries actually well capture the risk preferences of individuals and some context specificity and risk compensation effects would be detected with our data. Finally, while SRRA in finance is more strongly related to labor decisions, results found with health risky behaviors do not really allow us to conclude on the existence of context specificity (see *Case 2*) as SRRA on the road and in sport explain better smoking and drinking habits than SRRA in health.

[27] This comparison can be done if the sample of respondents does not vary and with a fixed set of controls.
[28] Nonetheless, similar findings are reported by De Palma et al. (2011).

Table 3.7: Influence of risk aversion on risky behaviors

	Self reported risk aversion						Lottery questions	Income prospect choices
	in general	on the road	in sport	in health	in finance	average*		
Probability of working in the private sector†, *observations = 665*								
Coefficient	-0.008	-0.060**	-0.070***	-0.023	-0.095***	-0.102**	0.020*	-0.073
Robust SE	(0.032)	(0.029)	(0.027)	(0.027)	(0.027)	(0.041)	(0.011)	(0.045)
Log-likelihood	-309.31	-307.28	-305.64	-308.95	-302.84	-305.72	-307.82	-308.05
Pseudo R^2	0.146	0.152	0.156	0.147	0.164	0.156	0.150	0.150
AIC	634.62	630.55	627.29	633.91	621.67	627.43	631.65	632.10
BIC	670.62	666.55	663.29	669.90	657.67	663.43	667.65	668.10
Probability of working in the public sector†, *observations = 665*								
Coefficient	-0.005	0.036	0.034	-0.053*	0.041	0.017	-0.011	-0.035
Robust SE	(0.041)	(0.035)	(0.032)	(0.029)	(0.030)	(0.044)	(0.013)	(0.052)
Log-likelihood	-197.58	-197.13	-196.99	-196.06	-196.81	-197.52	-197.29	-197.38
Pseudo R^2	0.157	0.159	0.159	0.163	0.160	0.157	0.158	0.158
AIC	411.16	410.27	409.99	408.12	409.63	411.04	410.58	410.76
BIC	447.16	446.27	445.99	444.12	445.62	447.04	446.58	446.76
Probability of being self employed†, *observations = 665*								
Coefficient	0.047	0.041	0.023	0.037	0.048	0.072*	-0.012	-0.036
Robust SE	(0.037)	(0.032)	(0.028)	(0.028)	(0.029)	(0.041)	(0.012)	(0.049)
Log-likelihood	-266.59	-266.63	-267.14	-266.67	-266.00	-265.94	-266.97	-267.19
Pseudo R^2	0.192	0.192	0.190	0.192	0.194	0.194	0.191	0.190
AIC	549.17	549.27	550.27	549.35	547.99	547.89	549.94	550.38
BIC	585.17	585.26	586.27	585.35	583.99	583.89	585.93	586.38
Probability of smoking†, *observations = 663*								
Coefficient	-0.126***	-0.218***	-0.096***	-0.092***	-0.100***	-0.236***	0.088***	-0.164***
Robust SE	(0.033)	(0.034)	(0.029)	(0.026)	(0.030)	(0.049)	(0.014)	(0.054)
Log-likelihood	-224.25	-208.48	-224.90	-225.13	-224.63	-215.53	-211.70	-225.31
Pseudo R^2	0.130	0.191	0.127	0.126	0.128	0.164	0.179	0.126
AIC	464.51	432.96	465.81	466.27	465.25	447.06	439.40	466.62
BIC	500.48	468.93	501.78	502.24	501.23	483.03	475.38	502.59
Probability of drinking†, *observations = 638*								
Coefficient	-0.116***	-0.134***	-0.098***	-0.064**	-0.103***	-0.194***	0.034***	-0.266***
Robust SE	(0.034)	(0.033)	(0.030)	(0.028)	(0.030)	(0.045)	(0.013)	(0.059)
Log-likelihood	-205.53	-202.48	-205.13	-208.09	-204.77	-201.17	-207.08	-198.69
Pseudo R^2	0.125	0.138	0.127	0.114	0.129	0.144	0.119	0.154
AIC	427.07	420.96	426.26	432.19	425.54	418.33	430.15	413.38
BIC	462.73	456.62	461.93	467.85	461.20	454.00	465.82	449.04
Probability of smoking or/ and drinking†, *observations = 638*								
Coefficient	-0.122***	-0.170***	-0.107***	-0.091***	-0.104***	-0.222***	0.057***	-0.202***
Robust SE	(0.033)	(0.032)	(0.028)	(0.027)	(0.028)	(0.044)	(0.013)	(0.052)
Log-likelihood	-250.12	-241.78	-248.97	-251.11	-249.54	-242.01	-246.21	-247.96
Pseudo R^2	0.133	0.162	0.137	0.130	0.135	0.161	0.148	0.141
AIC	516.25	499.55	513.95	518.21	515.07	500.02	508.43	511.92
BIC	551.92	535.22	549.61	553.88	550.74	535.68	544.09	547.59
Number of risky activities in which the individual is engaged‡, *observations = 638*								
Coefficient	-0.185***	-0.262***	-0.152***	-0.136***	-0.157***	-0.333***	0.094***	-0.332***
Robust SE	(0.045)	(0.041)	(0.041)	(0.038)	(0.044)	(0.064)	(0.019)	(0.079)
Log-pseudolikelihood	-361.78	-351.80	-361.55	-362.96	-361.54	-353.87	-357.13	-358.52
Pseudo R^2	0.092	0.117	0.093	0.089	0.093	0.112	0.104	0.101
AIC	741.56	721.60	741.11	743.93	741.08	725.73	732.27	735.05
BIC	781.69	761.72	781.23	784.05	781.20	765.86	772.39	775.17

Notes: Gender, age, education level (3 category variable) and household monthly income (dummies) are controlled for in all regressions.
†Probit estimations. ‡Negative binomial estimation. Dependent variable can take values 0, 1 or 2. * 'average' is the average of the five SRRA measures.
***, ** and * stands for 1%, 5% and 10% significance respectively.

3.4.4 Do cultural specificities bias the influence of risk aversion?

Religion definitively punctuates the daily life of Indians. For instance, in my sample, 87% of the respondents believe their life is in god's hands. They are 73% to pray daily. These religious beliefs and practices are, to some extent, likely to prevent individuals from engaging in prevention activities. However, these individual characteristics would bias my previous estimates if and only if they are correlated with risk aversion. In order to check the existence of a potential omitted variable bias, I look at the pairwise correlation coefficients between the religious variables and the risk aversion parameters. No significant correlations are found. Furthermore, I include religious beliefs and practices in the set of explanatory variables of individuals' preference toward risk. Believing that one's life is in the hands of god reduces only the self reported risk aversion parameters, while praying every day is significantly negatively correlated only with the self reported risk aversion in the health domain and with the income choice prospect measures. Moreover, when including religious beliefs and practices in the regressions, similar results are found regarding the relations between the various risk attitudes and the different risky decisions, with the exception of the income choice variable which now is negatively and significantly correlated with working in the private sector. As for fate and praying activity, they are positively correlated with risky health behaviors. In other words, individuals who believe that their life is in the hands of god or who pray on a daily basis are more likely to smoke and drink. When looking at labor choices, individuals who pray daily are more (less) likely to work in the private (public) sector. Respondents who believe in fate are more likely to evolve in a private firm. Despite differences in religious practices between India and developed countries, the influence of individual risk aversion on risky conducts doesn't seem to be altered (Tables not shown).

3.4.5 Do interviewers influence the individuals' risk aversion?

Till now I did not account for a potential interviewer bias. Nonetheless, both risky behaviors and attitudes might be influenced by observable and unobservable characteristics of the interviewers. In this subsection, I thus turn to the question of the impact of interviewers on sensitive or hard to measure variables. I first estimate the influence of interviewers on risk aversion responses provided by respondents. More precisely, I study whether enumerators explain a significant share of the variance in the elicited risk preferences across individuals. I then investigate whether certain characteristics impact in a specific direction the data collected. Moreover, I explore the interaction between respondent and interviewer characteristics. Finally, I go back to the analysis made previously and investigate whether my results regarding the influence of individual risk aversion on risky behaviors still hold after controlling for interviewer effects.

Information on interviewer's gender, age, education and experience in survey work have been collected. Unobservable characteristics of the individual, such as survey ability or own risk aversion, are also likely to influence the collected information on risk attitudes. The former is captured through two performance indicators: the missing and refusal rates. As for the latter, it could have been interesting to administered a risk aversion questionnaire

to all enumerators. Unfortunately, this has not been done. Nonetheless, econometric methods can help me in accounting for the influence of unobservables. First, clustering standard errors at the interviewer level allows to correct for autocorrelation of residuals. In other words, this adjusts for the fact that one same interviewer measures risk preferences of different interviewees. Second, including interviewer dummies control for variables specific to each interviewer that could affect both the independent and dependent variables.

Figure 3.1 presents the refusal and missing rates of each of the 17 enumerators who worked on the data collection. The former corresponds to the share of selected motorcyclists who did not agree to answer the survey while the latter corresponds to the share of my risk aversion measures (SRRA, lotteries and income choices) that are missing among the individuals interviewed by each enumerator. We note that these performance indicators vary substantially from one interviewer to the other but also that an enumerator who is good at convincing individuals to answer the survey may not be so effective when fulfilling the questionnaire.[29] Younger interviewers faced a higher refusal rate which possibly reflects the difficulties they had in convincing respondents to answer to the survey. An unexpected experience effect is found as the missing rate is positively and highly correlated with the number of questionnaires completed. Nonetheless this is likely to be driven by one unique interviewer who has completed almost 20% of the questionnaires. The other socio demographic characteristics don't seem to play a significant role in the performance of interviewers (cf. Table 3.8).

Table 3.8: Pairwise correlation between performance and characteristics of interviewers

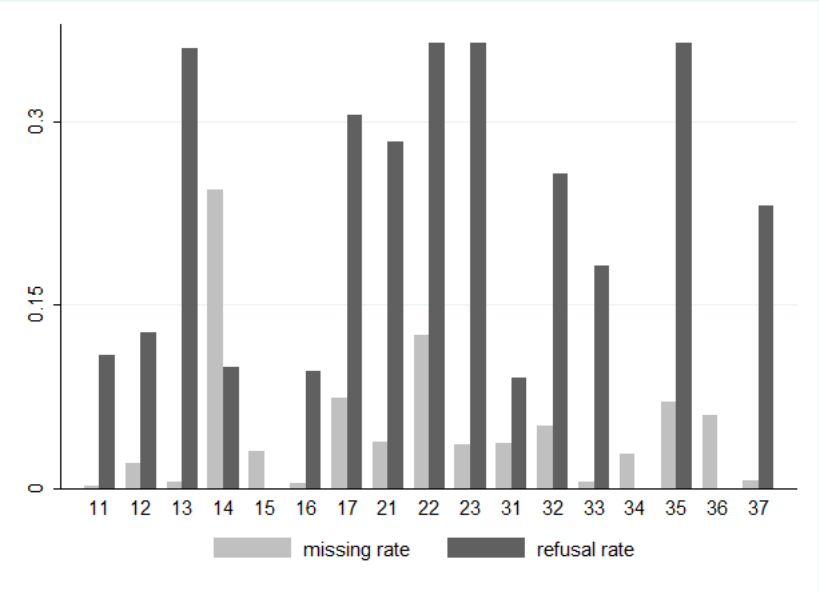
Interviewer characteristics	refusal rate		missing rate	
Male (=1)	-0.056		0.058	
Age (in years)	-0.491	**	0.337	
Education (3 groups)	-0.311		-0.390	
Survey experience (in years)	-0.331		-0.028	
Training				
session 1	-0.069		0.179	
session 2	-0.136		-0.105	
session 3	0.191		-0.052	
Number of questionnaires	0.002		0.490	**

Notes: ** stands for 5% significance.
Remark: Interviewer socio-demographics (gender, age, education and experience) are not correlated with one another.

Subsequently, I consider interviewers' socio demographic attributes as well as the two performance indicators in order to study the potential interviewer effects on the elicited preferences toward risk. As already mentioned, the performance indicators allow me to partly capture the ability of each enumerator to do survey work.

[29] Pairwise correlation coefficient between refusal and missing rates is indeed not significant and rather small (0.049).

Figure 3.1: Performance of interviewers



Notes: the refusal rate corresponds to the share of eligible individual who refused to answer to the survey, the missing rate corresponds to the average share of risk aversion questions (SRRA, lotteries and income choices) which were not fulfilled.

Influence of interviewer's observable characteristics on risk aversion

Table 3.9 shows some evidence that interviewers' characteristics explain partly the observed variance in the risk attitudes revealed by interviewees. The likelihood ratio tests are statistically significant meaning that including the interviewer's socio demographic characteristics and his/ her performance indicators add to the explanatory power of the model. This, for all my measures of risk aversion. Table 3.10 reports the coefficients of interviewer's characteristics and performance when adding these variables to the specifications made in Table 3.5. Following Dijkstra (1983) and Davis et al. (2010), I clustered standard errors at the interviewer level. It appears that the attributes of the interviewers have different impacts depending on the risk aversion measure considered. In particular, a more educated interviewer collects significantly higher risk attitudes with lotteries. Experience in survey work also increase the level of risk aversion elicited with SRRA on the road, in health and with income prospect choices. This may reveal a capacity to explain better to respondents the possible alternatives.[30] As mentioned previously, refusal and missing rates may not catch the same skills. The former tend to capture the interviewer's unability to convince people to answer to the survey (due to shyness, lack of confidence, but also, in the Indian context, differences in

[30] Nonetheless, I acknowledge that this interpretation is somewhat speculative. The only certain conclusion one can make on the basis of such result is that interviewers do influence in some way the answers provided by respondents. Whether certain characteristics of the survey staff induce better quality information is beyond this empirical analysis.

social status or caste). As for the latter, it is more likely to reflect the interviewer's degree of seriousness or his (her) understanding of these more complex questions. While the missing rate is postively correlated with self assessed risk aversion in sport, in health, in finance and with income prospect choices; the refusal rate is positively correlated with SRRA on the road, in sport, in health, with lotteries and with income prospect choices.

Table 3.9: Variance of risk aversion explained by interviewer

	Self reported risk aversion							
	in general	on the road	in sport	in health	in finance	average*	**Lottery questions**	**Income prospect choices**
Specification	ordered logit	ordered logit	ordered logit	ordered logit	ordered ologit	ols	negative binomial	ordered logit
Socio-demographics	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer characteristics†	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer performance‡	yes	yes	yes	yes	yes	yes	yes	yes
Log-likelihood	-1132.36	-1144.49	-1242.93	-1100.22	-1209.75	-	-2061.71	-780.14
Pseudo R^2 / R^2	0.027	0.043	0.036	0.041	0.033	0.173	0.031	0.063
Observations	*665*	*665*	*665*	*665*	*665*	*665*	*665*	*665*
Comparing models with and without interviewers' controls								
LR chi2(6)	28.48	77.88	52.88	68.03	48.70	76.97	117.27	70.99
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Comparing models with and without interviewers' performance indicators								
LR chi2(2)	9.40	45.96	14.58	37.20	26.25	42.25	9.36	33.14
p-value	0.009	0.000	0.001	0.000	0.000	0.000	0.000	0.000

Notes: † Interviewer characteristics: gender, age, education level and survey work experience. Ordered logit coefficients are reported.

* 'average' is the average of the five SRRA measures. OLS estimation is run for this dependent variable.

‡ Interviewer performance: refusal and missing rates. ∗ LR stands for Likelihood ratio.

Table 3.10: Interviewer effect on risk aversion measures

	Self reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Specification	ordered logit	ordered logit	ordered logit	ordered logit	ordered ologit	ols	negative binomial	ordered logit
Respondent socio-demographics	yes	yes	yes	yes	yes	yes	yes	yes
SE clustered at the interviewer level	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer characteristics								
Male (=1)	0.677	0.661	-0.174	0.824	0.194	0.601	-0.042	-0.225
	(0.606)	(0.477)	(0.466)	(0.548)	(0.523)	(0.451)	(0.074)	(0.527)
Age (in years)	-0.023	-0.058	-0.026	-0.115	-0.075	-0.059	-0.015	-0.089*
	(0.062)	(0.048)	(0.038)	(0.071)	(0.049)	(0.044)	(0.010)	(0.050)
Education (3 categories)	-0.271	0.027	-0.339	0.462	-0.085	-0.027	0.259***	0.452
	(0.258)	(0.243)	(0.258)	(0.346)	(0.258)	(0.273)	(0.032)	(0.305)
Survey experience (in years)	0.157	0.330***	0.092	0.374**	0.149	0.230*	-0.001	0.315*
	(0.118)	(0.105)	(0.149)	(0.151)	(0.148)	(0.119)	(0.013)	(0.170)
Interviewer performance								
Missing rate	0.850	4.492	5.284**	9.666**	8.577**	6.876**	0.673	7.319**
	(4.082)	(3.175)	(2.677)	(4.892)	(3.700)	(2.941)	(0.688)	(3.696)
Refusal rate	2.518	5.644***	2.477*	4.354*	2.821	3.448**	0.495*	4.438**
	(2.118)	(2.077)	(1.471)	(2.464)	(1.975)	(1.589)	(0.289)	(2.110)
Pseudo R^2 / R^2	0.028	0.043	0.036	0.040	0.033	0.173	0.031	0.063
Observations	*665*	*665*	*665*	*665*	*665*	*665*	*665*	*665*

***, ** and * stands for 1%, 5% and 10% significance respectively.

Matching interviewer and respondent characteristics

I further investigate the influence of interviewers on the level of risk aversion declared by respondents by looking at how shared characteristics impact elicited parameters. I consider two different individual characteristics: being a male or a female and being younger or older than 30 years old. I perform ordinary least square regressions to ease the interpretation of the results and introduce variables indicating whether the gender and the age of enumerators and respondents match. Table 3.11 presents the results obtained. Similar results are found when using the same specifications as in Tables 3.5 and 3.10. The net effect of (i) being interviewed by a man for a female and for a male, (ii) being interviewed by a young person for an old and a young respondent are also reported. We note that self reported risk aversion variables are not significantly influenced by the gender matching (except for SRRA in general for which male respondents interviewed by a man appear as more risk averse). On the contrary, for lottery questions and the income choices, female respondents declare significantly lower levels of risk aversion if interviewed by a man. More precisely, the lottery elicited risk aversion decrease then by 2.8 (i.e. half one standard deviation). As for the impact of age, a young person interviewed by one of his peers declares a significantly lower level of risk aversion with the self reported risk aversion questions in general, on the road and in sport. The impact of interviewer's age is even stronger for lotteries. In that case a young interviewer elicit significantly higher levels of risk aversion when questionning old respondents and significantly lower levels of risk aversion when interviewing young ones. As an example, old respondents interviewed by a young interviewer end up with 4.1 more safe choices while young respondents in the same situation end up with 1 safe choice less (i.e. 77% and 18% of one standard deviation respectively). Yet, it is difficult to give any advice regarding the optimal matching, i.e. which interviewer should interview which interviewee. Indeed, a young respondent may want to appear reckless in front of one of his peers but he may also prefer to pretend to be more careful in front of an older interviewer.

Table 3.11: Effect of gender and age interviewer-interviewee interactions on risk aversion measures

	Self reported risk aversion							
	in general	on the road	in sport	in health	in finance	average*	**Lottery questions**	**Income prospect choices**
Male (=1)	-1.275**	-0.640***	-0.380	0.257	-0.428	-0.493***	-0.3147*	-0.506***
	(0.468)	(0.129)	(0.539)	(0.382)	(0.246)	(0.122)	(1.633)	(0.101)
Male interviewer (=1)	0.041	0.213	-0.609	0.369	-0.088	-0.015	-2.884***	-0.866***
	(0.329)	(0.284)	(0.690)	(0.768)	(0.560)	(0.431)	(0.967)	(0.240)
Male x Male interviewer	1.166**	0.174	0.299	-0.265	0.080	0.291	2.923	0.534***
	(0.493)	(0.241)	(0.591)	(0.415)	(0.309)	(0.183)	(1.271)	(0.161)
Young (less than 30 years) (=1)	0.240***	-0.383***	-0.960***	0.190	-0.201**	-0.223**	-0.166	-0.026
	(0.055)	(0.086)	(0.161)	(0.188)	(0.083)	(0.088)	(0.568)	(0.124)
Young interviewer (less than 30 years) (=1)	0.152	0.253	-1.138**	-0.246	-0.727	-0.341	4.115***	0.219
	(0.226)	(0.295)	(0.501)	(0.356)	(0.424)	0.307)	(1.125)	(0.270)
Young x Young interviewer	-0.656***	-0.047	0.477*	-0.458	0.011	-0.134	-0.791	0.003
	(0.152)	(0.171)	(0.263)	(0.292)	(0.157)	(0.130)	(0.638)	(0.141)
Education level (3 categories)	0.006	-0.123	-0.334**	-0.324	-0.160	-0.187	-0.276	-0.263**
	(0.118)	(0.117)	(0.142)	(0.237)	(0.145)	(0.123)	(0.437)	(0.108)
Household montly income, *ref:* Less than 10,000 INR								
From 10,000 to 20,000 INR	-0.193	-0.088	-0.057	-0.017	-0.113	-0.094	-0.687	-0.065
	(0.141)	(0.173)	(0.288)	(0.287)	(0.323)	(0.138)	(0.534)	(0.173)
More than 20,000 INR	-0.252	-0.094	0.204	-0.284	0.030	-0.079	0.086	0.305
	(0.302)	(0.388)	(0.279)	(0.397)	(0.384)	(0.266)	(0.509)	(0.276)
R^2	0.082	0.040	0.074	0.051	0.062	0.081	0.118	0.077
Observations	*665*	*665*	*665*	*665*	*665*	*665*	*665*	*665*
Influence of the interviewer on risk aversion depending on the respondent's gender and age								
Male enumerator interviewing								
a female respondent	0.041	0.213	-0.609	0.369	-0.088	-0.015	-2.884***	-0.866***
	(0.329)	(0.284)	(0.690)	(0.768)	(0.560)	(0.431)	(0.967)	(0.240)
a male respondent	1.206*	0.388	-0.310	0.104	-0.008	0.276	0.039	-0.332
	(0.588)	(0.445)	(0.456)	(0.502)	(0.538)	(0.436)	(1.882)	(0.301)
Young enumerator interviewing								
an old respondent	0.152	0.253	-1.138**	-0.246	-0.727	-0.341	4.115***	0.219
	(0.226)	(0.295)	(0.501)	(0.356)	(0.424)	0.307)	(1.125)	(0.270)
a young respondent	-0.415**	-0.429**	-0.484**	-0.268	-0.189	-0.357***	-0.957**	-0.022
	(0.158)	(0.149)	(0.208)	(0.205)	(0.153)	(0.099)	(0.395)	(0.087)

Notes: OLS estimations with SE clustered at the interviewer level. ***, ** and * stands for 1%, 5% and 10% significance respectively.

3.4.6 Do interviewers alter the relation found between risk attitudes and risky behaviors?

When investigating the influence of risk preferences on risky behaviors without taking into account a potential interviewer bias, I might obtain either biased results or incorrectly conclude that a significant (or not significant) relation exists between risky behaviors and some risk attitudes. Indeed, the interviewer's socio demographic characteristics but also his or her way of asking questions may both influence the preference toward risk revealed by the respondent and his or her declared behavior. If this is true, I would face an omitted variable bias.

Controlling for interviewers' observable characteristics

Results presented in the previous subsection actually provide evidence that interviewers' characteristics indeed explain some part of the observed variance in risk attitude variables. In order to control for this omitted bias, I first introduce interviewers' characteristics and performance indicators in my empirical analysis. Table 3.12 displays the same regressions as Table 3.7, adding interviewers' observable characteristics as explanatory variables and clustering standard errors at the enumerator's level.

The significance of the relation between smoking and SRRA in general, in sport, in finance and income prospect choices vanishes following the introduction of information on interviewer's characteristics. When looking at drinking habits, coefficients for SRRA in sport, in health, in finance and lotteries are no longer significant. In both cases, for the variables which remain significant the corresponding coefficient is of smaller magnitude and the level of confidence is bigger. For example, the marginal effect of self reported risk aversion in health on the probability of smoking goes from -1.5% to -1.1%. As for the unexpected positive influence of lottery questions on risky health behaviors, it remains significant for all my measures of risky health behaviors, except the probability of drinking. The other relations between risky health conducts and risk preferences remain similar. When comparing the respective influence of SRRA in health and in finance, the latter variable is either not significant or significant at a much lower level than the former one. The introduction of interviewers' characteristics thus reveals some context specificity of risk aversion (*Case 2*). Regarding the choice of the sector of work, self assessed risk aversion on the road, in sport, in finance and the average of SRRA in all domains are now significantly and positively correlated with the likelihood of working in the public sector. This is also the case of the influence of lottery questions which now is correlated in the expected way with public sector choice. The size of the marginal effects of SRRA in finance and the SRRA score on the probability of working in the private sector both increase by 0.2 percentage points.

Controlling for interviewers' unobservable characteristics

Despite the introduction of the performance indicators, other enumerators characteristics, which plausibly influence the information collected on risk aversion, remain uncaptured (such as interviewer's own risk aversion, for instance). To deal with this issue, I introduce interviewer dummies instead of the information on observable characteristics and perform again my empirical analysis.[31] Table 3.13 reports the results found with this last spec-

[31] When estimating probit regressions, fixed effects cannot be introduced in the specifications. Nonetheless, when running the linear probability models with interviewer fixed effects, as robustness checks, really similar results as the ones presented hereinafter are obtained.

ification. The only measures which still explain significantly the risky health behaviors adopted by respondents are the SRRA in general, on the road, the average of SRRA measures and the income prospect choices. The lottery question appears to be significantly correlated with risky conducts in the same unexpected way as previously. Regarding the labor decisions, SRRA in finance remains significantly associated with the likelihood of working in the private sector. Finally a negative relation between income choices and entrepreneurship is now detected. Information regarding the significance of interviewer dummies is provided in the Appendices, Table 3.17. The number of questionnaires filled in by each interviewer varies quite substantially. When restricting the sample to those enumerators who interviewed at least 50 persons (7 out of the 17 interviewers), the average of SRRA appears to be significantly correlated with labor decisions and all the risky health behaviors I consider. Other results remain overall similar (see Table 3.18 in the Appendices).

I end this analysis by acknowledging that for a certain number of respondents the interviewer effect and the geographical area specificities cannot be disentangled. On average, when considering my restricted sample, each interviewer covered six different areas and each location was visited by two enumerators. However, 11 starting points out of the 50 were covered by only one enumerator and one of them only surveyed one zone.

Table 3.12: Table 3.7 – controlling for interviewers' observable characteristics

	Self-reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Socio-demographics	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer characteristics†	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer performance‡	yes	yes	yes	yes	yes	yes	yes	yes
Probability of working in the private sector†, *observations = 665*								
Coefficient	-0.007	-0.057	-0.069***	-0.040	-0.105***	-0.116**	0.004	-0.078
Robust SE	(0.030)	(0.041)	(0.024)	(0.028)	(0.034)	(0.051)	(0.012)	(0.065)
Pseudo R^2	0.186	0.191	0.195	0.189	0.205	0.197	0.186	0.190
Probability of working in the public sector†, *observations = 665*								
Coefficient	-0.019	0.089*	0.050*	0.003	0.084**	0.085*	0.021**	0.079
Robust SE	(0.033)	(0.052)	(0.026)	(0.028)	(0.035)	(0.046)	(0.011)	(0.073)
Pseudo R^2	0.257	0.265	0.262	0.257	0.268	0.262	0.261	0.260
Probability of being self-employed†, *observations = 665*								
Coefficient	0.068*	0.039	0.029	0.030	0.055	0.083	-0.018	-0.066
Robust SE	(0.040)	(0.038)	(0.034)	(0.032)	(0.039)	(0.055)	(0.014)	(0.064)
Pseudo R^2	0.211	0.208	0.208	0.208	0.212	0.212	0.209	0.209
Probability of smoking†, *observations = 663*								
Coefficient	-0.114	-0.183***	-0.029	-0.089***	-0.045	-0.164**	0.085***	-0.088
Robust SE	(0.073)	(0.066)	(0.038)	(0.033)	(0.040)	(0.080)	(0.020)	(0.081)
Pseudo R^2	0.306	0.337	0.294	0.305	0.296	0.313	0.332	0.297
Probability of drinking†, *observations = 638*								
Coefficient	-0.115**	-0.079*	-0.055	-0.042	-0.062	-0.130**	0.022	-0.211***
Robust SE	(0.053)	(0.044)	(0.038)	(0.029)	(0.044)	(0.060)	(0.016)	(0.063)
Pseudo R^2	0.274	0.269	0.265	0.263	0.267	0.273	0.264	0.285
Probability of smoking or/and drinking†, *observations = 638*								
Coefficient	-0.118**	-0.128**	-0.061*	-0.087***	-0.066*	-0.169***	0.048***	-0.147**
Robust SE	(0.059)	(0.056)	(0.035)	(0.033)	(0.038)	(0.065)	(0.016)	(0.067)
Pseudo R^2	0.274	0.282	0.265	0.271	0.267	0.281	0.275	0.271
Number of risky activities in which the individual is engaged‡, *observations = 638*								
Coefficient	-0.147*	-0.187***	-0.065	-0.092***	-0.080*	-0.216**	0.073***	-0.199***
Robust SE	(0.076)	(0.062)	(0.048)	(0.033)	(0.046)	(0.085)	(0.024)	(0.073)
Pseudo R^2	0.211	0.222	0.204	0.207	0.205	0.216	0.216	0.211

Notes: Gender, age, education level (3 category variable) and household monthly income (dummies) are controlled for in all regressions.
† Interviewer characteristics: gender, age, education level and survey work experience. ‡ Interviewer performance: refusal and missing rates.
†Probit estimations. ‡Negative binomial estimation. Dependent variable can take values 0, 1 or 2. * 'average' is the average of the five SRRA measures. Standard errors are clusterted at the interviewer level. ***, ** and * stands for 1%, 5% and 10% significance respectively.

Table 3.13: Table 3.7 – controlling for interviewers' unobservable characteristics

	Self-reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Socio-demographics	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer dummies	yes	yes	yes	yes	yes	yes	yes	yes
Probability of working in the private sector†, *observations = 640*								
coefficient	0.032	-0.040	-0.042**	-0.016	-0.082**	-0.075	0.009	-0.034
robust SE	(0.029)	(0.044)	(0.019)	(0.025)	(0.036)	(0.053)	(0.014)	(0.069)
Pseudo R^2	0.211	0.212	0.212	0.210	0.219	0.213	0.210	0.210
Probability of working in the public sector†, *observations = 613*								
coefficient	-0.054	0.065	0.021	-0.018	0.055	0.031	0.005	0.005
robust SE	(0.034)	(0.058)	(0.024)	(0.027)	(0.037)	(0.048)	(0.010)	(0.078)
Pseudo R^2	0.276	0.277	0.274	0.274	0.277	0.274	0.274	0.273
Probability of being self-employed†, *observations = 650*								
coefficient	0.062	0.040	0.023	0.023	0.048	0.079	-0.017	-0.135**
robust SE	(0.044)	(0.039)	(0.037)	(0.032)	(0.040)	(0.060)	(0.016)	(0.061)
Pseudo R^2	0.237	0.235	0.234	0.234	0.236	0.237	0.235	0.241
Probability of smoking†, *observations = 619*								
coefficient	-0.095	-0.148**	0.012	-0.026	-0.009	-0.102	0.123***	-0.043
robust SE	(0.072)	(0.064)	(0.044)	(0.024)	(0.036)	(0.078)	(0.015)	(0.087)
Pseudo R^2	0.407	0.425	0.400	0.400	0.399	0.405	0.462	0.400
Probability of drinking†, *observations = 622*								
coefficient	-0.106**	-0.041	-0.036	0.018	-0.044	-0.083	0.034**	-0.217***
robust SE	(0.047)	(0.041)	(0.045)	(0.032)	(0.050)	(0.058)	(0.017)	(0.080)
Pseudo R^2	0.336	0.328	0.328	0.327	0.329	0.330	0.333	0.344
Probability of smoking or/and drinking†, *observations = 628*								
coefficient	-0.111**	-0.098*	-0.041	-0.039	-0.046	-0.131**	0.067***	-0.124
robust SE	(0.056)	(0.055)	(0.037)	(0.027)	(0.031)	(0.058)	(0.014)	(0.076)
Pseudo R^2	0.344	0.344	0.335	0.334	0.335	0.342	0.358	0.339
Number of risky activities in which the individual is engaged‡, *observations = 638*								
coefficient	-0.196**	-0.130**	-0.017	-0.007	-0.037	-0.127*	0.094***	-0.185**
robust SE	(0.053)	(0.048)	(0.046)	(0.044)	(0.048)	(0.073)	(0.023)	(0.090)
Log-likelihood	-262.40	-261.56	-265.14	-265.20	-264.92	-263.66	-256.37	-262.86

Notes: Gender, age, education level (3 category variable) and household monthly income (dummies) are controlled for in all regressions.
† Probit estimations. ‡ Fixed effect negative binomial estimation. Dependent variable can take values 0, 1 or 2. * 'average' is the average of the five SRRA measures. Standard errors are clusterted at the interviewer level. ***, ** and * stands for 1%, 5% and 10% significance respectively.

3.5 Conclusion

In this paper, I am interested in the elicitation of individual risk aversion through surveys in general and in the context of India in particular. More precisely, I wonder if risk aversion parameters as measured in developed countries are appropriate when investigating risky conducts adopted by a population with a different cultural background.

For this purpose, I take advantage of an original dataset implemented among motorcyclists in Delhi in 2011. I compare three different survey measures of risk attitudes (self reported risk aversion, hypothetical lotteries and income prospect choices). I first show that all measures are positively and highly correlated with one another but that this is rather the case within methodologies and within domains. In a second step, I detect the gender, age and education effects on the level of risk aversion usually observed in surveys conducted in developed countries. Subsequently, I investigate the predictive power of these different individual risk aversion measures on the job occupation and health decisions. Most of my elicited risk preferences appear to well predict risky health behaviors. This is in particular the case of the average of SRRA variables. Regarding the labor decisions, when restricting to the sample of income contributors SRRA in finance is the variable with the stronger effect. The unexpected positive relation observed between self reported risk aversion measures and entrepreneurship may be specific to the Indian context where public job opportunities are scarce and occupation may not always reflect the preferred choice of the individual. As for the lottery questions, the results found are puzzling and may be interpreted either as evidence of risk compensation between domains or as incapacity to capture the desired characteristic. Finally, while religious practices and beliefs increase the likelihood of engaging in risky health behaviors, they do not modify the influence of risk preferences on individuals' conducts. The elicitation of risk aversion measures through surveys in developing countries appears thus possible.

Besides the choice of the elicitation methodology, the potential influence of enumerators in a face to face interview is a measurement concern applied researchers face when collecting hard to measure parameters such as individual risk aversion. In this article, I provide evidence that part of the variance in elicited risk aversion comes from the interviewer himself or herself. Moreover, it seems that each measure is impacted differently by interviewers' characteristics. However, the relation between risk aversion and risky behaviors hold when including observable characteristics of interviewers in the regression. When interviewers dummies are introduced most of the significance of coefficients vanishes. Such results might be partly driven by the limited heterogeneity between respondents interviewed by the same person and living in the same neighborhood. But the adoption of risky health behaviors are still correlated positively with lotteries and negatively with self reported risk aversion. This argues in favor of previous conclusions on the reliability of risk aversion measures still hold despite the more or less important effect of interviewers.

To sump up, this work supports the capacity of self assessed risk aversion to pick up the individual risk aversion in countries like India. Besides, I emphasize the influence of interviewers in the elicitation of risk attitudes through face to face interviews. In addition to enumerators' instructions during the training sessions, a way to ensure that such potential bias can be controlled for in the empirical analysis is to carefully allocate enumerators during the implementation of the survey. In particular, one needs to make sure that several interviewers cover each local

area and that all of them work in different zones in order to be able to disentagle interviewer and locality effects. Moreover, the allocation of the work load should be spread into a high number of interviewers to avoid that one enumerator drives the information collected and the analysis subsequently undertaken. Finally, investigating further and with a dedicated research design the influence of interviewers' risk aversion on the elicited preferences toward risk of interviewees could be of great interest for future research.

3.6 Appendices

Appendix A. Risk aversion measures

Self reported risk aversion

Based on the methodology used in particular in the German Socio-Economic Panel (G-SOEP), risk aversion in general and in four domains (on the road, in sport or leisure, in health and in finance) have been assessed using a 8 level scale.[32] The formulation used in the questionnaire was the following: *"People behave differently in different situations. On a risky scale going from 0 (not at all ready to take risk) to 7 (fully ready to take risk), how would you describe yourself [in each domain]?*

To build my risk aversion measures, I inverse the scale so that the lowest value correspond to risk lover and the highest value to the most risk averse individuals.

The following variables were created:

- ⋆ `srra_[domain]_8`: can take 8 different values, increasing with risk aversion.
- ⋆ `srra_score_8`: is the average of the level of risk aversion in each domain, $\frac{\sum_{i=1}^{5} \texttt{srra\_[domain]\_8}}{5}$.

Remark on the formulation used

1. Regarding the **introductory sentence**: The purpose of the introductory sentence was to limit the social desirability bias by telling respondents that no "correct" answer exists for this series of questions. I acknowledge that an unintended effect could be that individuals feel then obliged to provide different answers to the different domains proposed. It is unfortunately not possible to disentangle the true variation of risk aversion across domains and the induced one. However, when looking at the data collected, 28% of the respondents provided no more than two different answers. They are 14% to give a different answer to each of the SRRA question. No difference in terms of gender, age, income or caste is observed between individuals who gave a different answer to each domain and the others, the former are yet on average more educated.

2. Regarding the **scale offered**: Dohmen et al. (2011), Hardeweg et al. (2012) or Ding et al. (2010) use a scale going from 0 to 10, where 0 means "unwilling to take risks" and 10 means "not at all **prepared** to take risk". One may argue that by using this formulation, respondents may be induced to report their behaviors rather than their risk attitudes, which in turn can be problematic when testing whether risk aversion measures predict risky conducts. The word used in the hindi translation of our questionnaire ("paiyaare") is closer to "ready", which is less misleading.

[32] In the literature (Dohmen et al.; 2011; Ding et al.; 2010, for instance), a scale going from 0 to 10 is most commonly used.

Lottery questions

I adapted the Holt and Laury (2002) procedure in order to derive the individual's constant relative risk aversion parameter. Holt and Laury (2002) captured individual risk preferences through differences in volatility; more precisely, they offered 10 decisions between two lotteries which differ in the variation of gains. The safe choice being the lottery with the smallest gap between its two outcomes. The complexity of such task, in particular for individuals with low math skills, have been raised by Dohmen et al. (2010), Hardeweg et al. (2012) or Vieider, Lefebvre, Bouchouicha, Chmura, Hakimov, Krawczyk and Martinsson (2014). More precisely, a set of 20 choices between an increasing safe amount and a fixed lottery was presented to respondents. if choosing the lottery the individual has a 50 percent chance of winning 12,000 INR and a 50 percent chance of receiving nothing. The safe amount was increasing by 500 INR from 0 to 9,500 INR. The point at which subjects switch from the lottery option to the safe choice can be used to classify individuals from according to their degree of risk aversion. 27 individuals provided inconsistent answers. More precisely, they switched from safe amount to lottery. I thus exclude these observations from the analysis.

The following variable was created:

⋆ `safe_choice`: can take 21 different values, indicates the number of times the person has chosen the safe amount.

Income prospect choices

This measure is based on the hypothetical income prospect choices developed by Barsky et al. (1997). All respondents answer to a first 'yes/no' question. According to their response, a second question is asked by the interviewer.

(qA) *"Would you take the opportunity of a 50 percent chance of doubling your income and a 50 percent chance of reducing your income by one third?"*

(qB) if answer to (qA) is 'yes': *"Would you take the opportunity of a 50 percent chance of doubling your income and a 50 percent chance of reducing your income by one half?"*

(qC) if answer to (qA) is 'no': *"Would you take the opportunity of a 50 percent chance of doubling your income and a 50 percent chance of reducing your income by one fifth?"*

I create the following variable:

⋆ `ra_gamble_4`: 4 categories, increasing with risk aversion, takes value 1 if the individual would gamble on his income despite a risk of reducing his income by one half; 2 if he agrees to take the job opportunity if the risk of reducing his income is of one third but not of one half; 3 if the risk of reducing his income is of one fifth but not of one third; 4 if he won't take the job opportunity even for a risk of one fifth only.

Appendix B. Comparing individuals from restricted and full samples

Table 3.14: Socio-demographic characteristics of respondents - restricted, missing, full samples

Sample	All answers	Missing	p-value	Full
Observations	*675*	*227*		*902*
Male (%)	69.73	60.35	0.009	67.37
Age (years)	36.06	37.67	0.118	36.47
Married (%)	71.98	77.53	0.102	73.39
Education				
Illiterate (%)	6.31	8.85	0.194	6.95
Tertiary education (%)	46.7	38.94	0.043	44.73
Education (3 groups)	2.26	2.11	0.012	2.22
Low caste (SC/ST, %)	36.43	28.77	0.039	34.54
Household monthly income				
below 10,000 INR	31.41	31.72	0.931	31.49
10,000 - 20,000 INR	34.07	28.19	0.102	32.59
above 20,000 INR	17.63	15.42	0.444	17.07
Contribute to income (%)	55.87	52.42	0.367	55.00

When comparing individuals who answered to all three risk aversion measures and those who didn't, it appears that the former are more likely to be men, educated but also to belong to a low caste. No significant difference is detected regarding income.

Appendix C. Effect of risk aversion on occupational choice decisions

Table 3.15: Influence of risk aversion on risky behaviors - sample of income contributors

	Self reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Probability of working in the private sector†, *observations = 372*								
Coefficient	-0.063	-0.089**	-0.087***	-0.020	-0.127***	-0.147***	0.023*	-0.044
Robust SE	(0.040)	(0.035)	(0.030)	(0.033)	(0.033)	(0.047)	(0.014)	(0.053)
Pseudo R^2	0.090	0.098	0.101	0.086	0.118	0.106	0.091	0.086
Probability of working in the public sector†, *observations = 372*								
Coefficient	-0.012	0.036	0.059*	-0.049	0.063*	0.039	-0.009	0.008
Robust SE	(0.046)	(0.039)	(0.034)	(0.033)	(0.033)	(0.049)	(0.015)	(0.058)
Pseudo R^2	0.078	0.079	0.086	0.083	0.085	0.079	0.078	0.077
Probability of being self-employed†, *observations = 372*								
Coefficient	0.045	0.045	0.035	0.052*	0.067**	0.093**	-0.013	-0.008
Robust SE	(0.041)	(0.036)	(0.029)	(0.031)	(0.031)	(0.046)	(0.013)	(0.053)
Pseudo R^2	0.029	0.030	0.029	0.032	0.036	0.035	0.028	0.027

Notes: Gender, age, education level (3 category variable) and household monthly income (dummies) are controlled for in all regressions.
†Probit estimations. ***, ** and * stands for 1%, 5% and 10% significance respectively.

Appendix D. Heterogenous effect of risk aversion on occupational choice decisions

Table 3.16: Influence of risk aversion on occupational choices with heterogenous effects

	Self reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Probability of working in the public sector†, *observations = 657*								
Risk aversion coefficient	-0.032	-0.088	0.021	0.069	0.173	-0.025	0.079	0.350
	(0.148)	(0.135)	(0.148)	(0.145)	(0.123)	(0.181)	(0.056)	(0.217)
Education level (3 groups)	0.272	0.223	0.519*	0.664**	0.688***	0.490	0.901***	0.797***
	(0.284)	(0.271)	(0.267)	(0.306)	(0.235)	(0.327)	(0.347)	(0.250)
RA × Education level	0.010	0.025	-0.027	-0.064	-0.068	-0.026	-0.041*	-0.174**
	(0.055)	(0.050)	(0.052)	(0.052)	(0.045)	(0.065)	(0.021)	(0.080)
Belongs to a low caste (=1)	0.021	-0.957**	-1.059***	-1.072*	-0.534	-1.521***	-0.434	-0.346
	(0.438)	(0.424)	(0.397)	(0.560)	(0.382)	(0.509)	(0.420)	(0.325)
RA × Belongs to a low caste	0.010	0.202***	0.256***	0.217**	0.128*	0.326***	0.039	0.168
	(0.083)	(0.077)	(0.077)	(0.095)	(0.071)	(0.099)	(0.029)	(0.112)
Pseudo R^2	0.151	0.165	0.187	0.182	0.169	0.175	0.168	0.169
Probability of of being self-employed†, *observations = 657*								
Risk aversion coefficient	-0.099	-0.095	-0.096	-0.139	-0.115	-0.202	-0.023	-0.378**
	(0.117)	(0.112)	(0.098)	(0.100)	(0.07)	(0.147)	(0.040)	(0.167)
Education level (3 groups)	-0.630**	-0.556**	-0.483***	-0.655***	-0.589***	-0.814***	-0.395*	-0.661***
	(0.252)	(0.232)	(0.184)	(0.223)	(0.189)	(0.276)	(0.236)	(0.183
RA × Education level	0.067	0.056	0.047	0.071*	0.070*	0.112**	0.008	0.144**
	(0.047)	(0.043)	(0.036)	(0.038)	(0.037)	(0.054)	(0.016)	(0.064)
Belongs to a low caste (=1)	-0.380	-0.456	-0.393	-0.673*	-0.489	-0.610	0.038	-0.383
	(0.432)	(0.403)	(0.289)	(0.390)	(0.323)	(0.469)	(0.368)	(0.288)
RA × Belongs to a low caste	0.015	0.031	0.020	0.062	0.038	0.061	-0.028	0.029
	(0.080)	(0.074)	(0.060)	(0.068)	(0.063)	(0.092)	(0.026)	(0.105)
Pseudo R^2	0.204	0.203	0.201	0.206	0.209	0.209	0.209	0.203

Notes: Gender, age and household monthly income (dummies) are controlled for in all regressions. †Probit estimations. Robust standard errors are reported in parentheses. ***, ** and * stands for 1%, 5% and 10% significance respectively. * 'average' is the average of the five SRRA measures.

Appendix E. Significance of interviewer dummies

Table 3.17: Significance of interviewer dummies

	Self reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Probability of working in the private sector								
# of omitted interviewers	2	2	2	2	2	2	2	2
# of significant interviewers	13	13	13	13	13	13	13	13
# of non significant interviewers	1	1	1	1	1	1	1	1
Probability of working in the public sector								
# of omitted interviewers	4	4	4	4	4	4	4	4
# of significant interviewers	11	11	11	11	11	11	11	11
# of non significant interviewers	1	1	1	1	1	1	1	1
Probability of being self employed								
# of omitted interviewers	2	2	2	2	2	2	2	2
# of significant interviewers	7	7	6	7	5	5	8	8
# of non significant interviewers	6	6	7	6	8	8	5	5
Probability of smoking								
# of omitted interviewers	4	4	4	4	4	4	4	4
# of significant interviewers	9	10	8	9	8	10	11	9
# of non significant interviewers	3	2	4	3	4	2	1	3
Probability of drinking								
# of omitted interviewers	2	2	2	2	2	2	2	2
# of significant interviewers	10	11	11	10	11	11	10	10
# of non significant interviewers	4	3	3	4	3	3	4	4
Probability of smoking or/ and drinking								
# of omitted interviewers	1	1	1	1	1	1	1	1
# of significant interviewers	12	11	11	12	11	11	11	9
# of non significant interviewers	3	4	4	3	4	4	4	6

Remark: 17 interviewers worked on the data collection. One interviewer is used as reference in the regressions. When the number of interviewers varies from one risk aversion measure to the other, it is not always the same interviewers who have a significant coefficient.

Table 3.18: Table 3.7 – controlling for interviewers' unobservable characteristics if at least 50 questionnaires

	Self-reported risk aversion						**Lottery questions**	**Income prospect choices**
	in general	on the road	in sport	in health	in finance	average*		
Socio-demographics	yes	yes	yes	yes	yes	yes	yes	yes
Interviewer dummies	yes	yes	yes	yes	yes	yes	yes	yes
Probability of working in the private sector†, *observations = 495*								
Coefficient	0.030	-0.037	-0.057***	-0.023	-0.108**	-0.103*	0.013	-0.016
Robust SE	(0.021)	(0.051)	(0.020)	(0.029)	(0.042)	(0.059)	(0.016)	(0.092)
Pseudo R^2	0.216	0.217	0.220	0.216	0.232	0.221	0.217	0.215
Probability of working in the public sector†, *observations = 495*								
Coefficient	-0.049	0.096	0.038	-0.012	0.102***	0.079	0.005	-0.074
Robust SE	(0.033)	(0.067)	(0.025)	(0.028)	(0.034)	(0.050)	(0.013)	(0.078)
Pseudo R^2	0.289	0.296	0.289	0.287	0.299	0.290	0.287	0.289
Probability of being self employed†, *observations = 332*								
Coefficient	0.067	0.027	0.038	0.053	0.067	0.199*	-0.016	-0.132
Robust SE	(0.055)	(0.050)	(0.044)	(0.038)	(0.045)	(0.068)	(0.020)	(0.082)
Pseudo R^2	0.109	0.105	0.107	0.109	0.111	0.113	0.107	0.113
Probability of smoking†, *observations = 495*								
Coefficient	-0.134*	-0.202***	-0.025	-0.020	-0.023	-0.172***	0.121***	-0.056
Robust SE	(0.077)	(0.062)	(0.034)	(0.019)	(0.033)	(0.060)	(0.014)	(0.098)
Pseudo R^2	0.462	0.491	0.450	0.449	0.449	0.462	0.509	0.450
Probability of drinking†, *observations = 473*								
Coefficient	-0.159***	-0.065	-0.034	-0.009	-0.027	-0.119**	0.049**	-0.263**
Robust SE	(0.053)	(0.058)	(0.041)	(0.027)	(0.049)	(0.047)	(0.020)	(0.104)
Pseudo R^2	0.416	0.402	0.399	0.398	0.398	0.404	0.410	0.418
Probability of smoking or/ and drinking†, *observations = 473*								
Coefficient	-0.141**	-0.130**	-0.031	-0.032	-0.024	-0.151***	0.080***	-0.156
Robust SE	(0.063)	(0.065)	(0.039)	(0.028)	(0.026)	(0.048)	(0.019)	(0.098)
Pseudo R^2	0.413	0.416	0.398	0.398	0.398	0.408	0.431	0.405
Number of risky activities in which the individual is engaged‡, *observations = 473*								
Coefficient	-0.264**	-0.260**	-0.018	-0.028	-0.048	-0.255***	0.147***	-0.301*
Robust SE	(0.120)	(0.113)	(0.079)	(0.045)	(0.040)	(0.071)	(0.032)	(0.167)
Pseudo R^2	0.371	0.374	0.357	0.357	0.357	0.364	0.384	0.364

Notes: Gender, age, education level (3 category variable) and household monthly income (dummies) are controlled for in all regressions.
† Probit estimations. ‡ Ordered logit estimation. Dependent variable can take values 0, 1 or 2. * 'average' is the average of the five SRRA measures. Standard errors are clustered at the interviewer level. ***, ** and * stands for 1%, 5% and 10% significance respectively.

Chapter 4

Why do some motorbike riders wear a helmet and others don't? Evidence from Delhi, India

This Chapter was written with Michael Grimm (Erasmus University Rotterdam, Passau University and IZA). It has been submitted to Health Economics.

Abstract

Injuries to the head and the neck are a major cause of road traffic accident fatalities in most developing countries. We focus on helmet use behavior among motorbike users in Delhi. We use a detailed data set collected for the purpose of the study. To guide our empirical analysis, we rely on a simple model in which drivers decide on self-protection and self-insurance. The empirical findings suggest that risk averse drivers are more likely to wear a helmet, there is no systematic effect on speed. Helmet use also increases with education. Drivers who show a higher awareness of road risks are both more likely to wear a helmet and to speed less. Controlling for risk awareness, we observe that drivers tend to compensate between speed and helmet use. The results can provide a basis for awareness-raising policies. Improvements to the road infrastructure bear the risk of leading to risk-compensating behavior.

JEL Classification: D10, I10, K42, R41.
Key words: Road safety, helmet use, risky health behavior, self-protection, self-insurance, India.

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Contents

In some states of India, women are exempted from safety rules that mandate motorcycle passengers wear helmets – an exemption that kills or injures thousands each year. Women's rights advocates have argued the exemption springs from a culture-wide devaluation of women's lives. Supporters of the ban say they're just trying to preserve women's carefully styled hair and make-up – which isn't exactly a feminist response.
(Washington Post, October 27, 2013)

4.1 Introduction

Nearly 3,400 people die on the world's roads every day. 90% of these fatalities occur in developing countries (WHO; 2013). In 2020, road traffic injuries are expected to be ranked third in the global burden of disease (Lopez et al.; 2006). Despite these numbers and the related tremendous costs, road mortality is still a neglected public health issue in many low and middle income countries. India accounts for about 10% of road accident fatalities worldwide. The implied costs are estimated at around 3% of GDP (Mohan; 2002). In many developing countries, the share of two-wheeled vehicles largely dominates the vehicle fleet. In India this share is around 70%. Not surprisingly motorbike users constitute a large share of all road traffic accident injuries and fatalities; in Delhi for instance more than 30%. Injuries to the head and the neck are the main cause of death. Indeed 60% of *All India Institute of Medical Sciences'* (AIIMS) admissions — one of the biggest trauma centers in Delhi — are road related head injuries (see also Kumar et al.; 2008). Medical science stresses the efficiency of helmets in reducing the road related mortality and morbidity. Mandatory helmet use is thus one important policy that governments are recommended to implement in order to reduce road-related fatalities (WHO; 2004, 2006). The effectiveness of such laws, if enforced, has been shown in various contexts (see, e.g., Dee; 2009; French et al.; 2009). Despite the formal introduction of such

laws in most countries of the world (WHO; 2013), enforcement is however often very weak. Moreover motorbike users are often not aware of the protection that a helmet can provide.

India has had a helmet law since 1988. This national law should be implemented at the State level, yet it is hardly enforced. A major complication comes from the fact that the Sikh community successfully lobbied against this law as their religion requires a turban or at least no other headpiece. Since the exception also applies to Sikh women, and hence it is difficult to distinguish Sikh from other women, the exception was later extended to all women.[1] In Delhi less than 25% of all women wear a helmet when sitting on a motorbike — typically in the poised perched side-saddle position.[2] For men the share of helmet wearers is significantly higher, but is still far from full coverage. Understanding this heterogeneity, i.e. why some drivers and passengers wear a helmet and others not, is key to design effective interventions to increase helmet use.

Helmet use might be linked to risk aversion, the awareness of road-related risks, income, and as seen above, culture and traditions. Moreover, motorbike riders have various options to protect themselves or to seek insurance. Speed is obviously a second important decision parameter. To understand the behavior of helmet use, we first model this problem theoretically. Relying on the literature of self-insurance and self-protection, we adapt a simple model to the road safety context and use it for comparative static analysis. Based on this analysis we derive hypotheses which we test empirically using a unique data set covering more than 850 motorbike riders and passengers in Delhi.

The remainder of the paper is organized as follows. In section 2 we briefly review the related literature, highlight the existing knowledge gaps and elaborate on the paper's contribution. Section 3 presents the theoretical framework and derives from it testable predictions regarding helmet use and speed. Section 4 introduces the data set and shows how we operationalize the empirical tests. Section 5 presents the empirical analysis and discusses the results. Section 6 concludes.

4.2 Related literature

In what follows we briefly review the theoretical literature that considers the role of risk aversion on individual investment in different accident prevention activities. We emphasize in particular the role of risk compensating effects. After that we discuss the related empirical evidence.

Both Peltzman (1975) and Blomquist (1986) modeled the driver's behavior and derived insightful predictions for risk neutral agents. They focused in particular on risk compensation effects, i.e. behavioral responses to exogenous variations in risk. Others enriched such models with explicit consideration of the risk preferences of agents in their behavioral response. Dionne and Eeckhoudt (1985) and Bryis and Schlesinger (1990), for example, examined theoretically the impact of increased risk aversion on the optimal levels of self-insurance and self-protection.

[1] This softness in the helmet mandatory law implementation came to an end since Septembre 2014. Indeed, traffic police began to prosecute women riding two-wheelers without a helmet. Sick women are still exempted, but only if they are able to prove their identity (source: The Times of India, September 11, 2014).

[2] Figures derived from a household survey implemented by the authors in Delhi. See below.

Self-insurance refers to activities that reduce the severity of a loss. Self-protection decreases the probability that the loss occurs (Ehrlich and Becker; 1972). In their models the level of self-insurance monotonically increases with risk aversion, while the effect of risk aversion is ambiguous regarding self-protection. In other words, a more risk averse individual will always invest more in self-insurance but it is possible that the individual chooses a lower level of self-protection. Indeed, self-protection reduces the occurrence of a loss but does not reduce the loss in case the bad state occurs. Rather to the contrary, in addition to the loss, wealth is reduced by the increased cost of self-protection, thus leading to an even worse outcome if the bad state occurs. Hence, a higher level of self-protection might be considered as more, not less risky and may explain why a more risk averse individual might decide to invest less in such an activity. Finally, when combining both activities and investigating the influence of risk aversion on a self-insurance-cum-protection activity, a more risk averse individual will invest more in the prevention activity, if the marginal loss reduction in the bad state out-weights the marginal increase in the cost of the combined activity. This has been shown by Lee (1998).

Peltzman (1975) and Wilde (1982) introduced the idea that individuals may respond to an exogenous increase in safety in a way that it lowers or even annihilates (risk homostasis) the reduced risk. Such reactions are called 'risk compensation effects' and may arise if individuals target a fixed level of risk and therefore prefer taking more risks when their risk environment improves. Some studies empirically tested whether such effects indeed exist. However, these studies typically rely on highly aggregated data and hence potentially suffer from omitted variable bias. Chirinko and Harper Jr. (1993), for example, investigated the effect of improved car safety (measured through an index of safety regulations in relation to improved car safety for occupants since 1966) and of the introduction of the speed limit of 55 mph in the US. Their econometric estimates revealed that the offsetting behavior is quantitatively important and attenuates the effects of safety regulations on occupant fatalities. Using a modified expected utility model, the authors showed that the impact of regulatory policies depends on a mix of protection (direct effect of the regulation), substitution (offsetting behavior) and cognition elements. Based on Virginia State Police accident reports of 1993, Peterson et al. (1995) also showed that air-bag-equipped cars tend to be driven more aggressively, thus offsetting the effect of the air-bag for drivers and increasing the risk of death for others. However, other studies did not find any evidence of such risk-compensating effects (Lund and Zador; 1984; Lund and O'Neill; 1986).

To circumvent problems inherent in the use of aggregate data, Sobel and Nesbit (2007) used micro-level data from NASCAR (National Association for Stock Car Auto Racing) races. Their setting allowed them to control for problems of enforcement, weather conditions and variation in automobile safety devices. According to their results, NASCAR drivers drive more recklessly in response to an increase in car safety. However, total injuries still fall since the side effect is not large enough to completely offset the direct impact of increased vehicle safety. Obviously, the external validity of this study might be low, as NASCAR drivers might not be very representative of drivers in general. Stetzer and Hofmann (1996) in turn conducted two laboratory experiments to investigate the individual's behavioral response and the perceived risk associated with various driving situations. They found a negative correlation indicating some risk compensation following an increase in environmental safety but this was not large

enough to return to the initial level of risk. Messiah et al. (2012) ran a randomized controlled trial in Bordeaux to analyze motorcyclists' chosen speed conditional on helmet adoption. Risk compensation was observed exclusively among men and was of moderate size. Therefore the feedback effect did not offset the benefits of helmet use.

McCarthy and Talley (1999) also provided evidence on risk compensating behaviors. They relied on data from recreational boating. They empirically tested whether an operator's past experience and formal training induces or reduces safety related behaviors. Moreover they investigated the influence of the operator's characteristics and the environmental factors on the attitude adopted by the boat passengers. The authors highlighted that an individual can adjust to risk changes using various strategies. In their study, they focused on two of them: the use of personal flotation devices and alcohol consumption. Passengers seemed to adapt their behavior to their perception of the operator's safety level. Indeed, an operator's boating experience was negatively correlated with flotation device utilization and positively correlated with alcohol consumption by passengers. The authors stressed the implication for motor vehicle travel. In particular, they pointed out that, since the opening of the debate by Peltzman (1975), little work has been done to identify alternative margins that individuals use to adjust their safety behavior.

We contribute to the above literature with respect to two dimensions: (i) the influence of risk aversion on prevention activities and (ii) the existence of risk compensating effects. Regarding the first aspect, we adapt the existing theoretical framework to the road safety context and derive theoretical predictions regarding the role of risk aversion on a set of different types of prevention efforts. Moreover, thanks to an original dataset of motorbike riders and passengers in Delhi, we are able to test these assumptions empirically. In particular, we focus on the drivers' simultaneous decision-making with respect to self-protection and self-insurance and how risk preferences affect this trade-off. With respect to the second dimension, we look at the existence of risk compensating effects. An interesting feature of our data is that we also observe passengers. For passengers speed can be seen as exogenously determined if the assumption is made that the driver decides on speed. We are thus able to investigate the relation between a passenger's safety effort and the environment such as the quality of roads and motorbike and driver characteristics. As for the driver, we can examine the relationship between alternative dimensions of safety behaviors and provide evidence with respect to their complementability or substituability.

4.3 Theoretical framework

Based on Dionne and Eeckhoudt (1985) and Bryis and Schlesinger (1990), we investigate the individual decision to invest in self-insurance and self-protection road-related activities using a relatively simple expected utility model. As in Ehrlich and Becker (1972), self-insurance refers to any activity that reduces the loss if an accident occurs, while self-protection refers to any activity that reduces the probability of experiencing an accident.

In our theoretical framework we address three questions: (i) How does risk aversion influence the investment in insurance and protection? (ii) How do motorbike users respond to exogenous changes in safety? (iii) Are protection and insurance complements or substitutes for one another?

We consider two road related attitudes: helmet use and speed. Helmet use can be seen as a self-insurance activity given that a helmet reduces the severity of an injury if an accident occurs.[3] For simplicity, lowering speed is assumed to be a self-protection activity. However, it may be more appropriate to consider the latter as a self-insurance-cum-protection activity, since speed may impact both the frequency and the severity of road accidents. Theoretical predictions in this case are presented in the Appendix A (Drivers – Self-insurance-cum-protection activity). While we assume that the drivers of a motorbike choose both helmet use and speed, we suppose that passengers only make a decision on helmet use, and take speed as given.[4] We examine these two types of road users in turn. We start with the case of passengers.

4.3.1 Passengers

Consider a risk averse passenger with wealth W. With a probability p, the passenger is involved in a road accident and with probability $(1-p)$ the passenger is not. If an accident occurs, the passenger faces a loss I; however, the passenger can invest in the self-insurance activity to reduce the size of the potential loss. This decision includes whether to use a helmet, the type of helmet and whether for instance the strap is closed. However, helmet use comes at a cost in the form of discomfort. Passengers may also be able to negotiate the speed with the driver, but we assume that for the passenger full control over speed is highly unlikely, hence this strong assumption. Below, when we discuss the case of drivers, we endogenize both the use of a helmet and the choice of speed.

Let h denote the level of self-insurance. $I(h)$ represents the effect of a helmet on the severity of an injury, which is obviously assumed to decrease with the chosen level of self-insurance, $I'(h) < 0$. Discomfort, $c(h)$, is assumed to increase monotonically with h. Preferences, $U(\cdot)$, are assumed to be of the von Neumann-Morgenstern type, where $U' > 0$ and $U'' < 0$.

The individual's expected utility can be written as:

$$EU = p \cdot U[W - c(h) - I(h)] + (1-p) \cdot U[W - c(h)]. \tag{4.1}$$

The first order condition for maximizing (4.1) with respect to h is:

$$\frac{\partial EU}{\partial h} = -p \cdot [c'(h) + I'(h)] \cdot U'(B) - (1-p) \cdot c'(h) \cdot U'(G) = 0, \tag{4.2}$$

where $G = W - c(h)$ and $B = W - c(h) - I(h)$.

Note that in order to have an interior solution, we must have $[c'(h) + I'(h)] < 0$, i.e. the magnitude of the potential marginal benefit, $-I'(h)$, must be at least as high as the marginal cost following the increase in h, $c'(h)$.

[3] Indeed Liu et al. (2008) reviewed 53 studies that investigate the efficiency of helmets. They found that on average the use of a standardized helmet reduces the risk of death and serious injuries by 40% and 70% respectively. Goldstein (1996) stressed however that there is a 'head-neck injury trade-off', i.e. given the weight of a helmet, the use of a helmet increases the risk of neck injuries.

[4] The influence of passengers behaviors on drivers travelling conduct as well as bargaining between individuals riding on the same motorbike will be discussed in the empirical analysis.

Risk aversion

Let h_U denote the optimal level of insurance for the passenger with utility function U defined above. Let us now consider a second, more risk averse, passenger with a utility function V which exhibits higher risk aversion than U, i.e. $V(\cdot)$ is a concave increasing transformation of $U(\cdot)$, hence $V(\cdot) = g[U(\cdot)]$, with $g' > 0$, and $g'' < 0$ (Pratt; 1964).

Assuming the same wealth prospect and choice set as in Equation (4.2) but taking into account the preferences of the more risk averse individual it can be shown that the level of self-insurance, i.e. helmet use, increases with the level of risk aversion. For a proof, see Appendix A.

Risk compensating effect

An increase in the probability that an accident occurs from p to q (with $q > p$) implies an increase in the investment in self-insurance and hence compensate at least partially for the increased risk. In turn, if safety increases exogenously, passengers are thought to invest less. In the literature, this effect is called "Peltzman-effect" (Peltzman; 1975). See also Wilde (1982) and Blomquist (1986). A proof can be found in Appendix A.

4.3.2 Drivers

Unlike passengers, drivers are assumed to invest simultaneously in self-insurance (helmet use) and in self-protection (speed). It is assumed that the probability that an accident occurs, $p(s)$, increases with speed, $p'(s) > 0$. The time spent on the road $t(s)$ in turn decreases with speed, i.e. $t'(s) < 0$ and thus leaves the driver with a higher level of wealth. As for passengers, we assume that drivers are risk averse and have an increasing concave utility function U.

In this case the expected utility is given as:

$$EU = p(s) \cdot U[W - t(s) - c(h) - I(h)] + (1 - p(s)) \cdot U[W - t(s) - c(h)]. \tag{4.3}$$

The first order conditions for maximizing (4.3) with respect to h and s are:

$$\frac{\partial EU}{\partial h} = -p(s) \cdot [c'(h) + I'(h)] \cdot U'(B) - (1 - p(s)) \cdot c'(h) \cdot U'(G) = 0 \text{ and} \tag{4.4}$$

$$\frac{\partial EU}{\partial s} = p'(s) \cdot [U(B) - U(G)] - t'(s) \cdot [p(s) \cdot U'(B) + (1 - p(s)) \cdot U'(G)] = 0. \tag{4.5}$$

Risk aversion

Again, one can show that a more risk averse individual invests more in self-insurance, however the effect on self-protection is ambiguous. This is due to the fact that a more risk averse individual invests always more in self-insurance but not necessarily in self-protection. Indeed, self-protection reduces the occurrence of a loss but does not reduce the loss in case the accident occurs. Rather to the contrary, in addition to the loss, wealth is reduced by the increased cost of self-protection, leading to an even worse outcome if the accident occurs. Hence, a higher

level of self-protection can be considered as more, not less risky and can explain why a more risk averse individual may not necessarily decide to invest more in such an activity (Dionne and Eeckhoudt; 1985; Bryis and Schlesinger; 1990).

When considering speed as a self-insurance-cum-protection activity, we highlight that a sufficient condition for a more risk averse individual to invest more in such prevention effort is that the marginal increase in loss if an accident occurs is greater than the marginal gain in time spent on the road at the optimal level of speed of the less risk averse individual (cf. Lee; 1998). A proof can be found in Appendix A.

Risk compensating effect

Just as passengers do, drivers invest more in self-insurance following an exogenous rise in the probability that an accident occurs. It is important to note that any change in speed has also wealth effects, as the travel time is altered. Therefore, when a driver increases speed, he or she also increases helmet use. In other words, for risk averse drivers, helmet use and higher speed are complements, and hence self-insurance and self-protection activities are substitutes. For a proof, see Appendix A.

Awareness

There are different options to model awareness in our framework. One possibility is to assume that increased awareness implies that the expected probability of an accident at any speed is not underestimated relative to actual figures. In Appendix A we show that this implies that a driver with a higher (less downward biased) awareness level invests more in helmet use. However, the effect of increased awareness on speed depends on whether the utility loss induced by a marginal change in the probability that an accident occurs reinforces or compensates the first effect. If a more aware driver thinks that a marginal increase in speed modifies less the probability of being involved in an accident, he invests less in self-protection and travel at a higher speed than a less aware driver. Indeed, in that case the loss in utility and the expected gain in traveling time reinforce one another.

Another possibility to show the effect of increased awareness is to assume that the expected gain of helmet use should an accident occur is not underestimated relative to actual figures. By making this assumption one can again show, that a higher expected loss induces a higher level of helmet use. Regarding the chosen level of speed, the higher expected level of injuries implies a larger loss in terms of wealth leading to both a greater difference in utilities between the two states and a higher marginal utility in the bad state. Given the former, a marginal increase in speed increases the loss. Moreover, the marginal increase in speed also raises the level of gain in terms of traveling time due to the latter effect. Hence, again, the effect of an increase in the expected level of injuries on speed is ambiguous.

4.4 Methods

4.4.1 Data

General presentation

During the months July to September 2011 we conducted a representative two-stage randomly sampled household survey in Delhi to collect information from motorbike riders and pillion passengers regarding their behavior when using the motorbike including helmet use and speed, their degree of risk aversion and risk awareness. In addition the survey collected socio-demographic and economic characteristics, information on insurance coverage as well as characteristics of the motorbike in use. In total 1,502 households were surveyed. In 545 households at least one member had used a motorbike in the past four weeks. These households were given a long questionnaire. All other households only received a short questionnaire (collecting only basic socio-demographic information). 87% of the households in our 'long' sample also own a motorbike. Most motorbikes are rather small (mostly scooters and mopeds). Only 16% have an engine displacement of more than 150 cubic centimeters. More than 80% of the respondents report having insurance for their motorbike. In households with at least one motorbike user, up to three, either drivers or passengers, were selected. On average, there were two eligible members per household.

Given the importance of motorbike status in our analysis, we analyze drivers and passengers separately. Seeing that we do only have 15 female drivers in our sample, we only consider female passengers. Since, road usage behavior, helmet use and speed vary a lot with the distance of a trip, the type of roads used and traffic density, for each user we collected information for up to three different types of trips: trips in residential neighborhoods, short distance trips (partly outside the neighborhood) and long distance trips (>15 mn). Hence, in the empirical analysis we exploit the variation across different types of trips using single trips as the unit of analysis and clustering standard errors at the individual level. Table 4.1 shows some basic descriptive statistics of our sample, separated by drivers and passengers. In Appendix B we explain how we dealt with missing data.

Table 4.1: Socio-demographic characteristics of drivers and passengers

(%)	Male drivers	Passengers		All respondents
		Male	Female	
Male	-	-	-	67.41
Age distribution				
15-29 years	37.83	32.26	27.70	34.92
30-39 years	25.36	13.98	32.37	26.05
40-49 years	20.25	15.05	25.18	20.84
50-59 years	11.25	17.20	8.99	10.98
60 years and above	5.32	21.51	5.76	7.21
Average (in years)	35.44	42.10	37.00	36.47
Married	69.34	68.82	85.56	73.39
Contributes to HH income	80.78	68.78	5.80	55.00
Share of the contribution				
less than 40%	32.09	44.09	96.01	54.59
between 40% and 60%	19.67	22.58	3.62	14.77
more than 60%	48.24	33.33	0.36	30.65
Education level				
illiterate	2.49	7.53	14.75	6.95
primary school	3.53	11.83	4.73	4.93
secondary school	48.55	65.59	49.09	50.34
tertiary education	45.44	15.05	30.94	37.78
Religion				
Hindu	83.44	86.02	86.69	84.37
Muslim	12.07	10.75	9.35	11.09
Sikh	1.23	2.15	3.24	3.44
other	3.27	1.08	0.72	1.11
Prays daily	65.30	74.19	80.73	71.24
Believes fate is in god's hands	87.50	90.22	87.27	88.18
Has health insurance	15.11	11.83	12.64	13.77
Observations	*489*	*93*	*278*	*902*

Notes: The group "all respondents" includes 27 individuals that declared to be sometimes driver and sometimes passenger as well as 15 female drivers. Both groups are not included in any of the sub-samples.

Helmet use and speed

Respondents were asked whether they own a helmet and whether they use their helmet for different types of trips. The corresponding descriptive statistics are shown in Table 4.2.

Among drivers, 86% of all helmets in use are full face helmets. Inspections by our enumerators revealed that in general helmets are in a rather good condition. Only a few helmets were broken and sometimes manually fixed. Almost all helmets had a strap. Passengers, and in particular female passengers, often use half-helmets, which obviously offer less protection.

The speed at which drivers and passengers travel is derived from the information on time spent on the road and distance traveled. This is more reliable than asking respondents directly. First, drivers might be reluctant to tell the truth if they notoriously exceed the official speed limit, even if it is only weakly enforced. Second, drivers may tend to report maximum rather than average speed.[5]

[5]We acknowledge that this average speed might to some extent reflect the traffic density. Nonetheless, the small size of engine often allows drivers to sneak between cars. Moreover, we control for circumstances to some extent.

Table 4.2: Helmet use and other safety behaviors by type of user and gender

	Male drivers	Passengers		All respondents
		Male	Female	
HELMET CHARACTERISTICS (%)				
Helmet ownership				
yes	93.24	51.61	56.20	76.92
Observations	*488*	*93*	*274*	*897*
Type of helmet				
full face helmet	86.49	82.98	65.77	80.68
open face helmet	6.08	2.13	6.04	6.09
half helmet	6.98	14.89	27.52	12.78
building site helmet	0.45	0	0.67	0.45
Condition of the helmet				
good condition	72.93	74.47	79.33	74.59
some scratches	25.95	25.53	20.00	24.22
broken but manually fixed	1.12	0	0.67	1.18
Helmet with strap				
yes	97.75	93.75	93.42	96.49
Observations	*447*	*47*	*152*	*684*
HELMET USE (%)				
In neighbourhoods				
yes	73.80	48.91	20.15	54.41
For short trips on main roads				
yes	79.84	48.39	30.97	60.97
For long trips on main roads				
yes	96.88	83.87	52.08	81.14
Observations	*481*	*93*	*268*	*884*
OTHER SAFETY BEHAVIORS				
Speed (kph)[a]				
average	36.67	30.64	29.58	33.83
variance	21.56	17.47	17.28	20.53
Observations	*410*	*73*	*170*	*686*

Notes: The group "all respondents" includes 27 individuals that declared to be sometimes driver and sometimes passenger as well as 15 female drivers. Both groups are not included in any of the sub-samples. a) observations with a declared speed of more than 150 kph are excluded.

Measure of risk aversion

We measure risk aversion using the respondent's answer to the question whether he or she is taking risks in general and in the four specific domains: on the road, in finance, in sports and in health. We think this choice makes sense in our case, since road accidents typically have financial and health implications. Moreover, driving has, at least for some, features of a sport and hence it is reasonable to take into account this dimension as well. Hence we calculate the arithmetic mean of the self rated degree of risk taking (reported from 0 (risk seeking) to 7 (extremely risk averse)) in general and in these four domains. This variable is thus a continuous variable taking values between 0 and 7 which we call the "Risk aversion score". Our preferred choice is also in line with recent studies in this field. Ding et al. (2010), Dohmen et al. (2011) and Hardeweg et al. (2012) for instance use Chinese, German and Thai data respectively and all find experimental evidence that at least in larger surveys self assessed risk aversion measures perform much better than risk aversion measures derived from lottery or hypothetical investment questions. Indeed while lottery choices are useful for predicting behavior regarding risky financial decisions, they appear to be uninformative for behaviors in other domains (see Wölbert and Riedl; 2013). Moreover, context specificity of risk aversion has also been shown by Barseghyan et al. (2011) and Einav et al. (2012). These two studies found that many individuals reveal different degrees of risk aversion in different life domains (such as health, disability and car insurance).

A further validation of our choice is shown in Table 4.3, where we report the correlation between the risk aversion score and three health-related risky behaviors: smoking, drinking and heavy drinking. Throughout we find a significant negative correlation, i.e. risk aversion is negatively correlated with smoking and drinking, suggesting that our preferred measure is a reasonable measure of risky behaviors with health implications. Comparisons with other risk aversion measures show that the average of self reported risk aversion in different domains is one of the best predictors of health risky behaviors (see Chapter 3).

However, given the choices made in the theoretical modelling and since any measure of risk preferences can be subject to debate, we will check the robustness of our results with respect to alternative measures (such as lottery questions, specific risk awareness questions related to finance and health), although we do not expect all measures to give similar results as some of these measures are clearly less adapted to our context than others and may not capture exactly the same information (see Chapter 3).

Finally, because the literature suggests that answers to questions about risk aversion, health related behavior and safety perceptions may be subject to framing effects, i.e. answers may depend on how and by whom the questions have been asked (see Lutz and Lipps; 2010), we also include in all estimations below interviewer-effects.

Table 4.3: Probability of engaging in risky health behaviors, linear probability model

	Smoking	Drinking	Drinking heavily[a]
Risk aversion score	-0.020**	-0.017**	-0.011**
	(0.008)	(0.007)	(0.006)
Interviewer fixed effects	yes	yes	yes
R^2	0.276	0.195	0.244
Observations	*832*	*807*	*806*

Notes: * p<0.10, ** p<0.05, *** p<0.01. Sample of all respondents.
Robust standard errors are reported in parentheses.
a) had three alcoholic beverages in a row at least once in the past two weeks.

Other road use behaviors, safety perceptions and motorbike characteristics

To get a good sense of the frequency of road usage, respondents were asked to provide the reason for the use of the motorbike (see Table 4.4). Drivers were also asked to assess their own driving skills and whether they had any type of formal training, either by getting a driving license, taking at least some lessons or some type of exam.

Lastly, we collected information about risk perceptions and own road accident experiences.[6] For instance, respondents were asked to provide an estimate on the number of road deaths, road injuries and the share of motorcyclists among total road accident fatalities they thought had taken place during the previous year in Delhi. Their answers were then compared to the official figures provided by the National Crime Record Bureau for the year 2010. Hence, for each respondent we could establish whether the respondent underestimated, roughly accurately estimated or overestimated road risks. In what follows, we define underestimation as a lack of awareness. I.e. if someone overestimated the figure, we still consider this person as more aware than someone who underestimates it. So what counts is that someone is aware of how many fatalities occur at least.

[6] Dionne et al. (2007) have shown that risk perceptions influence driving behavior.

Table 4.4: Driving behaviors and risk awareness

	Male drivers	Passengers		All respondents
		Male	Female	
DRIVING BEHAVIORS (%)				
Road exposure				
Uses motorbike to commute (=1)	83.37	67.74	29.96	64.40
Observations	*487*	*93*	*277*	*899*
Never uses ring roads (=1)	12.92	16.09	24.23	16.53
Observations	*480*	*87*	*227*	*835*
# of persons on motorbike	1.42	2.46	2.72	1.95
Observations	*478*	*87*	*267*	*869*
Driving skills				
Confident in own driving ability (=1)	55.67			
Reports driving more carefully than others (=1)	73.74			
Observations	*476*			
Formal training				
Has a driving licence (=1)	92.83			
Took driving lessons (=1)	43.04			
Took a driving exam (=1)	66.46			
Observations	*474*			
Says own driver should pay more attention (=1)		56.06	67.00	
Observations		*66*	*200*	
SAFETY PERCEPTIONS (%)				
Experienced road traffic accident (=1)	9.67	8.79	2.17	7.15
Observations	*486*	*91*	*277*	*895*
Awareness				
Underest. Annual road injuries (=1)	50.57	60.81	54.63	53.46
Underest. Annual road deaths (=1)	42.60	47.30	40.28	42.88
Observations	*439*	*74*	*216*	*765*
MOTORBIKE CHARACTERISTICS (%)				
HH owns a motorbike (=1)	92.62	48.39	90.65	87.35
Observations	*488*	*93*	*278*	*901*
Size of the motorbike				
Less than 100cc	28.07	30.00	32.58	29.45
Between 100cc and 150cc	54.52	57.50	53.39	54.52
Above 150cc	17.40	12.50	14.03	16.03
Observations	*431*	*40*	*221*	*730*
Has motorbike insurance (=1)	80.96	85.71	82.25	81.61
Observations	*436*	*42*	*231*	*745*

Notes: The group "all respondents" includes 27 individuals that declared to be sometimes driver and sometimes passenger as well as 15 female drivers. Both groups are not included in any of the sub-samples. Other differences in the number of observations are due to missing data.

4.4.2 Empirical specifications

The theoretical considerations made above imply an empirical focus on three aspects: (i) How does risk aversion affect helmet use and speed? (ii) If both can be chosen simultaneously, how are these choices correlated? (iii) How do other socio-demographic and economic characteristics as well as behaviors and perceptions influence both helmet use and speed? We consider two functions one for helmet use, h_i and one for speed, s_i. We estimate them simultaneously to account for the possible correlation of the residuals. Helmet adoption is used in a binary form, i.e. the driver wears a helmet ($h = 1$) or not ($h = 0$). Hence we use a simple probit model for estimation. Speed is measured continuously (in kph) and we thus use a linear regression model.

$$\text{Probit}(h_i = 1|x_i) = \theta(x_i'\beta_h + \epsilon_{hi}), \tag{4.6}$$

$$s_i = \beta_{s0} + x_i'\beta_{s1} + \epsilon_{si}. \tag{4.7}$$

We jointly estimate Equations (4.6) and (4.7) with full maximum likelihood, assuming that the errors, ϵ_{si} and ϵ_{hi}, follow a bivariate normal distribution, and then test the covariance of the error terms. In the absence of convincing instruments we exclude speed from the helmet equation and helmet use from the speed equation. Hence, we cannot directly test how speed affects helmet use and vice versa, but examining the correlation of the residuals allows concluding how unobservable factors affect both.

4.5 Results

4.5.1 Drivers

Table 4.5 shows the results from the simultaneous equation system. We augment the model step-by-step as this allows us to see whether the estimated effects are sensitive to the inclusion and exclusion of particular variables. As mentioned above, we also include here and in all estimations that follow interviewer-effects. The computed marginal effects implied by the probit model are shown in Appendix C. (Table 4.8).

It can be seen that risk aversion is positively associated with helmet use. At the sample mean, a one standard deviation increase in the risk aversion measure (i.e. by 1.60 points or 33%) increases the probability of helmet use by roughly 2 percentage points (see columns 3 to 5 in Table 4.8). However, risk aversion does not have a significant impact on speed. This is coherent with the predictions of our theoretical model. Risk averse individuals engage in self-insurance, but the effect on self-protection is ambiguous. These results also largely hold if we estimate separately by the type of trip. They are also confirmed if we take risk taking behavior in finance alone (see Table 4.10, Appendix D). If we take the other risk-measures in our data set we find insignificant results except for one of the lottery-based measures and the measure that tries to elicit how people are prepared to gamble with their health). Again, we trust our self-reported risk measures more. We also obtain absolutely coherent results if, instead of the binary helmet variable, we use the combined helmet and strap use (5 categories, see Table 4.2).

Regarding the other observable explanatory variables, we find that helmet use is lower among the illiterate population, between 10 to 12 percentage points depending on the specification. Tertiary education seems to further increase the probability of helmet use, but this effect loses significance if religiousness and social status is added to the list of regressors. Sikhs are less likely to wear a helmet (17 to 20 percentage points less likely), but they also drive on average slower (8 to 12 kph less (5 to 7 mph)). For that group, not wearing a helmet is not necessarily the preferred choice, but rather a (religious) constraint and hence risk compensation can be a rational response. The more children a driver has the lower the chosen speed level (roughly 3 kph (1.9 mph) less per child), however, more children is not associated with a higher probability of helmet use. Income also does not correlate with helmet use conditional on all other included variables, however it plays a role for speed. The results suggest that speed first increases and then decreases with income. Drivers with a monthly household income of more than 25,000 INR drive on average 15 to 25 kph (9 to 16 mph) slower than drivers with a monthly household income of 10,000 to 15,000 INR, controlling, among others, for the size of the motorbike.

Among the variables measuring driving behavior and safety perceptions, a few effects stand out. Drivers who use their motorbike regularly to commute to work are more likely to wear a helmet (+6 percentage points). There is no effect on speed. Risk awareness seems to matter: drivers who took driving lessons are more likely to wear a helmet (+7 percentage points). Interestingly, individuals who have a driving license but did not take driving lessons are not more likely to use a helmet than those who don't have a license at all (effect not shown in Table 4.5). Again, this suggests that it is awareness that matters. Drivers who underestimate the annual number of road traffic accident injuries, and thus the implied risk more generally, are less likely to wear a helmet. More passengers on the motorbike is also associated with lower helmet use. Remarkably, drivers with health insurance are more likely to wear a helmet and to drive slower. Note that this result holds even if we control for income, education and a whole range of other characteristics.

Finally, since we estimate helmet use and the choice of speed with a simultaneous equation system, it is interesting to examine the correlation between the error terms of both equations. The error terms capture those determinants that are not included in the list of regressors and of course measurement error. If we control only for risk aversion (col. (1)), the error terms are significantly negatively correlated, implying that the net effect of the unobserved or not included factors tends to increase helmet use and to lower speed, or, in turn to decrease helmet use and to increase speed. As more and more explanatory variables are included (col. (2) and col. (3)), we see that the correlation remains significantly negative and even increases in absolute size. If we include those variables that account for driving behavior and safety perceptions (col. (4)), we see that the correlation coefficient loses its significance. This is not due to the reduced sample size, as col. (5) shows, where we re-estimate the regression on the same sample without controlling for driving behavior and safety perceptions. As discussed above, among the variables measuring driving behavior and safety perceptions, of particular significance in both equations are those that can be related to risk awareness, such as taking driving lessons, underestimating the number of annual fatalities and having an insurance. Put differently, given that we control (even if imperfectly) for risk aversion and a large set of socio-demographic and economic characteristics including religiousness, we believe that risk awareness is a

major determinant that can explain why some individuals wear a helmet and drive slowly and others do not wear a helmet and drive fast. Hence, whereas risk aversion motivates drivers to compensate for higher speed through a higher propensity to use a helmet, a lack of awareness comes with both, high speed and no helmet, i.e. both decisions seem to complement each other. In our sample, about 55% of the respondents underestimate the incidence of road traffic accident injuries. For fatalities the share is closer to 45%. On average, 7% of the respondents had already experienced a road traffic accident most of these involving injuries and some fatalities.

All our results are qualitatively not different if we limit the sample to those drivers that own a helmet; about 93% (not shown in Table). This is not surprising, as a standard helmet is easy to find and relatively cheap. They are offered in shops nearby the road for typically less than USD 20; not much compared to the price of the motorbike or the gasoline and maintenance costs. More precisely, households who own a motorbike in our sample paid on average 45,800 INR (around 1,000 USD) their vehicle and spend each month 1,250 INR (28 USD) in gasoline.[7] Put differently, modelling the choice of buying a helmet or the choice of using the helmet does not make a significant difference.

In our analysis, we assumed that the safety behavior adopted by the passenger doesn't influence the speed at which the driver travels. Yet, it is likely that the rider chooses his velocity conditional on carrying or not a passenger and whether the latter is wearing a head protection or not. We know from the data whether each driver has at least an household member who is a pillion rider. Furthermore, if interviewed, we know if he or she wears a helmet or not. We introduce this information in our analysis (cf. Table 4.10, Appendix E).[8] Drivers who carry passengers who don't wear a helmet don't seem to adapt their traveling speed. Nevertheless this absence of results may also be due to the fact that we only have the information on average speed and that it is difficult to know what is the share of trips the rider makes with and without the pillion riders considered. When restricting the analysis to drivers who have a household member who is a passenger and who has also been interviewed (cf. Table 4.11, Appendix E), we note as in Table 4.10 that drivers and passengers from the same household are more likely to adopt the same behavior with regard to helmet use. While this result may indicate some peer effects, the fact that individuals from a same family may have experienced the same shocks or have the same information, an alternative interpretation could be that individuals from the same household may influence one another when answering the survey. This can also occur for motorcyclists who have family members present during the interview. Yet, we can introduce household fixed effects in order to control for the fact that two drivers belong to the same household. It is the case of 34% of drivers. All the results previously reported remain similar when controlling for this type of effect (Table not shown).

[7] However, individuals may balance the purchase of a helmet with other consumption goods not related with the expenditures made in the transportation area.

[8] Assuming that the driver and the passenger who belong to the same household indeed travel with each other. If several passengers were interviewed in one household, one of them was taken randomly and his or her behavior was considered.

Table 4.5: Helmet use and speed level chosen by drivers

Simultaneous equation system, coefficients	(1)	(2)	(3)	(4)	(5)
HELMET USE (Probit)					
Risk aversion score	0.076	0.070	0.094^{+}	0.103^{+}	0.148**
	(0.058)	(0.059)	(0.059)	(0.067)	(0.061)
Socio-demographic characteristics					
Age (in years)		-0.004	0.001	0.007	-0.001
		(0.009)	(0.010)	(0.009)	(0.010)
Married (=1)		0.135	0.167	0.179	0.160
		(0.237)	(0.251)	(0.290)	(0.266)
Number of children		0.082	0.033	0.006	0.075
		(0.079)	(0.076)	(0.086)	(0.083)
Household head (=1)		0.167	0.150	0.051	-0.000
		(0.243)	(0.256)	(0.273)	(0.287)
Household size		-0.083**	-0.077**	-0.111***	-0.094***
		(0.034)	(0.035)	(0.038)	(0.036)
Education, *ref:* Primary-secondary education					
Illiterate		-0.754***	-0.649**	-0.672*	-0.678**
		(0.249)	(0.284)	(0.362)	(0.300)
Tertiary education		0.304**	0.233^{+}	0.153	0.224^{+}
		(0.142)	(0.145)	(0.158)	(0.147)
Household monthly income, *ref:* less than 5,000 INR					
between 5,000 and 10,000 INR		-0.268	-0.180	-0.283	-0.179
		(0.277)	(0.269)	(0.297)	(0.302)
between 10,000 and 15,000 INR		-0.402^{+}	-0.266	-0.302	-0.212
		(0.257)	(0.253)	(0.266)	(0.279)
between 15,000 and 20,000 INR		0.063	0.099	0.038	0.165
		(0.306)	(0.304)	(0.327)	(0.338)
between 20,000 and 25,000 INR		0.131	0.166	0.460	0.572^{+}
		(0.331)	(0.347)	(0.348)	(0.356)
above 25,000 INR		0.372	0.342	0.288	0.394
		(0.399)	(0.414)	(0.540)	(0.452)
Contribution to hh income (share)		-0.003	-0.003	-0.001	0.011
		(0.059)	(0.060)	(0.065)	(0.064)
Religion, *ref:* Hindu					
Muslim			-0.004	-0.144	-0.212
			(0.222)	(0.245)	(0.230)
Sikh			-1.193***	-1.094***	-1.040***
			(0.406)	(0.399)	(0.403)
Believes fate in god's hands (=1)			-0.090	-0.240	-0.043
			(0.215)	(0.284)	(0.246)
Caste (=1)			-0.239^{+}	-0.032	-0.164
			(0.146)	(0.156)	(0.154)
Driving behaviors and safety perceptions					
Uses motorbike to commute (=1)				0.402*	
				(0.229)	
Never uses ring roads (=1)				0.049	
				(0.236)	
# of persons on motorbike				-0.300**	
				(0.120)	
Confident in own driving ability (=1)				-0.143	
				(0.178)	
Took driving lessons (=1)				0.437**	
				(0.188)	
Underest. ann. road inj. (=1)				-0.431**	
				(0.188)	
Experienced road traffic accident (=1)				-0.048	
				(0.258)	
Owns motorbike (=1)				-0.059	
				(0.366)	
Size of motorbike in cc, *ref:* 100cc or less					
between 100cc and 150cc				0.050	
				(0.193)	
above 150cc				0.348	
				(0.257)	
Has motorbike insurance (=1)				-0.028	
				(0.233)	
Has health insurance (=1)				0.020**	
				(0.008)	
Type of trips, *ref:* Short distance trip					
Long distance trip	1.191***	1.276***	1.338***	1.646***	1.525***
	(0.147)	(0.149)	(0.156)	(0.182)	(0.187)
Neighbourhood trip	-0.194***	-0.237***	-0.255***	-0.320***	-0.283***
	(0.072)	(0.078)	(0.081)	(0.093)	(0.088)

(continues next page)

Table 4.5 (... continued)

Simultaneous equation system, coefficients	(1)	(2)	(3)	(4)	(5)
SPEED (kph) (Linear model)					
Risk aversion score	0.778	1.018	1.000	0.181	0.303
	(0.740)	(0.745)	(0.757)	(0.770)	(0.722)
Socio-demographic characteristics					
Age (in years)		-0.172	-0.109	-0.067	-0.087
		(0.125)	(0.125)	(0.121)	(0.120)
Married (=1)		7.227*	6.853*	5.002	5.411
		(3.725)	(3.685)	(3.607)	(3.780)
Number of children		-2.650**	-2.936**	-3.443***	-3.323***
		(1.281)	(1.290)	(1.163)	(1.250)
Household head (=1)		3.129	3.184	3.497	3.399
		(2.946)	(2.817)	(2.729)	(2.847)
Household size		-0.096	-0.114	0.244	0.162
		(0.600)	(0.583)	(0.546)	(0.531)
Education, *ref:* Primary-secondary education					
Illiterate		3.470	4.920	3.667	6.413
		(7.601)	(7.407)	(7.167)	(7.014)
Tertiary education		-0.674	-0.327	1.363	0.786
		(2.037)	(2.024)	(2.110)	(2.084)
Household monthly income, *ref:* less than 5,000 INR					
between 5,000 and 10,000 INR		1.508	2.002	0.579	2.070
		(3.304)	(3.369)	(3.471)	(3.382)
between 10,000 and 15,000 INR		7.446**	8.177**	3.971	6.175*
		(3.559)	(3.690)	(3.727)	(3.660)
between 15,000 and 20,000 INR		2.849	3.460	0.104	2.178
		(3.510)	(3.637)	(3.783)	(3.620)
between 20,000 and 25,000 INR		5.356^{+}	6.886*	3.140	5.441
		(3.694)	(3.735)	(3.927)	(3.819)
above 25,000 INR		-8.466*	-8.285*	-15.083***	-10.907**
		(4.482)	(4.599)	(4.338)	(4.600)
Contribution to hh income (share)		0.602	0.626	0.604	0.694
		(0.704)	(0.690)	(0.643)	(0.651)
Religion, *ref:* Hindu					
Muslim			0.075	0.136	-1.024
			(2.473)	(2.527)	(2.487)
Sikh			-11.653**	-9.624**	-8.334**
			(4.719)	(4.226)	(4.249)
Believes fate in god's hands (=1)			-5.837^{+}	0.064	-3.548
			(3.806)	(3.473)	(3.205)
Caste (=1)			2.001	0.711	0.519
			(2.260)	(2.135)	(2.306)
Driving behaviors and safety perceptions					
Uses motorbike to commute (=1)				0.914	
				(2.599)	
Never uses ring roads (=1)				-6.880***	
				(2.444)	
# of persons on motorbike				1.970	
				(2.207)	
Confident in own driving ability (=1)				-0.720	
				(2.100)	
Took driving lessons (=1)				1.256	
				(1.953)	
Underest. ann. road inj. (=1)				3.179	
				(2.440)	
Experienced road traffic accident (=1)				-0.233	
				(3.332)	
Owns motorbike (=1)				6.026^{+}	
				(3.817)	
Size of motorbike in cc, *ref:* 100cc or less					
between 100cc and 150cc				2.019	
				(2.286)	
above 150cc				3.450	
				(3.263)	
Has motorbike insurance (=1)				0.945	
				(2.371)	
Has health insurance (=1)				-0.139**	
				(0.061)	
Type of trips, *ref:* Short distance trip					
Long distance trip	0.012	0.014	0.029	0.022	0.024
	(0.022)	(0.024)	(0.032)	(0.024)	(0.028)
Neighbourhood trip	0.003	0.011	0.006	-0.004	-0.002
	(0.022)	(0.024)	(0.031)	(0.022)	(0.025)
Interviewer fixed effects	yes	yes	yes	yes	yes
Correlation residuals	-0.096*	-0.108*	-0.153**	-0.119^{+}	-0.125*
Observations	*1367*	*1328*	*1295*	*1160*	*1160*
# of respondents	456	443	432	387	387
# of observations per respondent (mean)	3.00	3.00	3.00	3.00	3.00

Notes: Standard errors in parentheses are clustered at the individual level. $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01.

4.5.2 Passengers

Again, for passengers we assume that they only make a choice regarding helmet use and consider speed to be determined by the driver, although there might be possibilities for the passenger to influence the driver to some extent. This is discussed in more detail below. Table 4.6 shows the results of a simple probit model. We only present marginal effects.

Interestingly, for passengers we do not find any significant effect for risk aversion. One of the most important determinants of helmet use among passengers is gender. Men are between 25 to 40 percentage points more likely to wear a helmet than women, controlling for all other socio-demographic and economic characteristics and differences in travel habits and safety perceptions. Again, women are exempted from the helmet law. Moreover, women may refuse to wear a helmet because of their hair-dress.

Religiousness and whether a passenger believes that life is in the hands of a superior force does not explain helmet use. Although the coefficient associated with the latter variable is negative throughout, it is never statistically significant. Education and income also seem to play no role. The same is true for marital status, having children and household size. However, being of a lower caste decreases helmet use by 8 to 15 percentage points.

Based on the predictions derived from our theoretical model, we expect a negative correlation between helmet use and exogenous improvements in the safety level (the "Peltzman-effect"). In Table 4.6 we do indeed see that the passenger's choice to wear a helmet is influenced by the driver's choice of speed. Helmet use increase with speed, at least if a speed below 20 kph is compared to a speed between 20 and 40 kph (12 and 25 mph). If passengers could negotiate the speed or if drivers simply slowed down when the passenger is not wearing a helmet, the positive correlation would still be consistent with risk compensation, but speed would obviously be endogenous.

As with drivers, we again find that people who underestimate the risk of a road traffic accident wear a helmet less often (10 to 15 percentage points less likely). Surprisingly, for passengers, in contrast to drivers, we find that passengers with health insurance wear a helmet less often (12 percentage points less likely). It could be that for passengers there is some moral hazard, in a sense that passengers think better health care reduces the cost of an injury, but this hypothesis would need further empirical testing. Finally, we see that passengers who think their driver is speeding too much and where we may speculate that they urge their driver to pay more attention, wear a helmet less often (9 to 12 percentage points less likely). Again, such a finding could still be considered as evidence for a 'Peltzman effect' as it reflects a trade-off between the passenger's and driver's safety efforts.

Finally, we explore the interaction between drivers and passengers. For this, we introduce the driver's attitude regarding helmet adoption when a driver belonging to the household of the passenger has also been interviewed. We note that driver's and passenger's conducts are positively and significantly correlated (cf. Table 4.12, Appendix F). As with drivers, we run again the analysis introducing household fixed effects (30% of our passengers have a household member who is a pillion rider who have also been interviewed). The significance of the results remains similar (Table not shown).

Table 4.6: Determinants of helmet use for passengers

probit specification, marginal effects	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk aversion score	-0.033	-0.030	-0.036	-0.012	-0.029	-0.010	-0.009	-0.031
	(0.020)	(0.022)	(0.023)	(0.017)	(0.020)	(0.017)	(0.010)	(0.025)
Speed, *ref:* between 20 and 40 kph								
below 20 kph					-0.115*	-0.093*		
					(0.064)	(0.054)		
above 40 kph					-0.061	-0.041		
					(0.062)	(0.050)		
Owns a helmet (=1)							0.314***	
							(0.120)	
Socio-demographic characteristics								
Age (in years)		-0.003	-0.003	-0.003*		-0.003*	-0.002	-0.004*
		(0.002)	(0.002)	(0.002)		(0.002)	(0.001)	(0.002)
Male (=1)		0.411***	0.425***	0.401***		0.405***	0.245**	0.430***
		(0.076)	(0.075)	(0.111)		(0.110)	(0.109)	(0.082)
Married (=1)		0.046	0.049	0.049		0.045	0.023	0.071
		(0.066)	(0.069)	(0.053)		(0.052)	(0.033)	(0.080)
Number of children		-0.009	0.003	0.008		0.007	0.007	0.008
		(0.024)	(0.025)	(0.018)		(0.018)	(0.011)	(0.027)
Household head (=1)		-0.089	-0.074	-0.034		-0.051	-0.032	-0.084
		(0.085)	(0.087)	(0.069)		(0.065)	(0.040)	(0.092)
Household size		0.013	0.009	0.003		0.003	0.000	0.003
		(0.011)	(0.011)	(0.009)		(0.009)	(0.005)	(0.012)
Education, *ref:* Primary-secondary education								
Illiterate		-0.103	-0.084	-0.069		-0.057	-0.021	-0.079
		(0.081)	(0.083)	(0.058)		(0.059)	(0.036)	(0.089)
Tertiary education		-0.070	-0.093	-0.071		-0.069	-0.020	-0.112
		(0.060)	(0.062)	(0.052)		(0.052)	(0.030)	(0.069)
Household monthly income, *ref:* less than 10,000 INR								
between 10,000 and 20,000 INR		-0.062	-0.057	-0.013		-0.010	-0.023	-0.023
		(0.062)	(0.063)	(0.051)		(0.049)	(0.029)	(0.069)
above 20,000 INR		0.059	0.027	0.002		0.019	-0.037	-0.006
		(0.090)	(0.091)	(0.069)		(0.071)	(0.038)	(0.103)
Religion, *ref:* Hindu								
Muslim			0.033	0.034		0.017	0.025	0.062
			(0.093)	(0.077)		(0.073)	(0.051)	(0.102)
Sikh			-0.030	-0.046		-0.027	-0.056	-0.015
			(0.127)	(0.067)		(0.068)	(0.037)	(0.127)
Believes fate in god's hands (=1)			-0.046	-0.039		-0.018	-0.023	-0.057
			(0.090)	(0.084)		(0.076)	(0.052)	(0.106)
Caste (=1)			-0.110**	-0.091*		-0.088*	-0.042	-0.146**
			(0.056)	(0.048)		(0.047)	(0.034)	(0.060)
Driving behaviors and safety perceptions								
Uses motorbike to commute(=1)				-0.010		-0.010	-0.018	
				(0.050)		(0.048)	(0.027)	
Never uses ring roads (=1)				0.034		0.059	0.028	
				(0.067)		(0.071)	(0.044)	
Size of motorbike in cc, *ref:* 100cc or less								
between 100cc and 150cc				0.075		0.075	0.024	
				(0.053)		(0.053)	(0.035)	
above 150cc				0.219		0.191	0.063	
				(0.137)		(0.133)	(0.082)	
Experienced road traffic accident (=1)				-0.081		-0.079	-0.032	
				(0.056)		(0.056)	(0.031)	
Underest. ann. road inj. (=1)				-0.141**		-0.135**	-0.092*	
				(0.065)		(0.063)	(0.053)	
Has health insurance (=1)				-0.122***		-0.125***	-0.117***	
				(0.035)		(0.031)	(0.020)	
Says own driver should pay more attention (=1)				-0.124**		-0.120*	-0.092*	
				(0.065)		(0.068)	(0.052)	
Type of trips, *ref:* Short distance trip								
Long distance trip	0.262***	0.298***	0.296***	0.275***	0.264***	0.273***	0.231***	0.336***
	(0.026)	(0.029)	(0.029)	(0.066)	(0.026)	(0.065)	(0.089)	(0.034)
Neighbourhood trip	-0.063**	-0.078**	-0.078**	-0.056*	-0.065**	-0.055*	-0.038	-0.081**
	(0.028)	(0.031)	(0.031)	(0.030)	(0.028)	(0.030)	(0.026)	(0.036)
Interviewer fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Pseudo R^2	0.152	0.247	0.256	0.310	0.159	0.316	0.440	0.267
Observations	*963*	*954*	*936*	*759*	*963*	*759*	*756*	*756*
# of respondents	324	321	315	255	324	255	254	254
# of observations per respondent (mean)	2.98	2.98	2.98	2.99	2.98	2.99	2.99	2.99

Notes: Standard errors in parentheses are clustered at the individual level. * p<0.10, ** p<0.05, *** p<0.01.

4.6 Conclusion

Risky health behavior is in many domains still only poorly understood. The analysis is often plagued by incomplete data and a general lack of information. In this study, we try to understand the behavior of helmet use among motorcycle riders and passengers in Delhi, a context in which road safety is low and helmet use is far from being the norm. We use a very detailed data set collected exactly for the purpose of that study. To guide our empirical analysis, we rely on a simple model in which drivers decide on their speed and helmet use. While a helmet provides insurance if an accident happens, speed affects the probability that an accident will occur. However, a lower speed implies time costs and helmet use comes with a level of discomfort that has to be borne by the user. Key variables in our analysis are risk aversion as well as aspects related to risk awareness.

The empirical findings suggest that risk averse drivers are more likely to wear a helmet. A one standard deviation increase in our risk aversion score (i.e. by 29%) increases the probability of using a helmet on a given trip by 3 percentage points. This is certainly not a very strong effect, but cumulated over many trips it means a substantial reduction in the risk of being seriously injured in the event of an accident. We do not find any systematic effect of risk aversion on speed. Both results are coherent with our theoretical model. Interestingly, helmet use also increases with education: illiterate drivers are by about 10% less likely to wear a helmet than literate drivers. Tertiary education further increases helmet use. Speed decreases with the number of children at home suggesting that family responsibilities stimulate drivers to take fewer risks. Speed first increases and then decreases with income, i.e. the middle class drives the fastest.

Drivers who show a higher awareness of road risks, because, for instance, they are more conscious about the health risks faced when traveling on Delhi's roads or have taken driving lessons, are both more likely to wear a helmet and to speed less. In turn, those drivers who show a high level of unawareness take the highest risks. Controlling for risk awareness, we observe that drivers tend to compensate between speed and helmet use: the Sikh who cannot wear a helmet because of the turban, drive, on average, slower.

For passengers, we find a similar pattern. Their probability of helmet use increases with the driver's chosen level of speed. The fact that generally passengers less often wear a helmet than drivers, and women less often than men, even controlling for helmet ownership, suggests that norms and habits also play an important role. Breaking these is one of the major challenges that needs to be overcome.

The most obvious solution to India's road safety problem and the related high social costs that result from it, is to enforce the helmet law and speed limits and hence to ignore the associated private costs such as time costs and discomfort. An alternative strategy, and probably more feasible in the current context, is to design interventions which raise awareness of road risks. In terms of our model, this means bringing the expected probability of an accident at a given speed and the expected gain of helmet use closer to its actual levels. Improvements to the road infrastructure such as separate lanes for cars and motorbikes are also a possible solution, but, as our analysis and a few other examples in the literature show, these measures bear the risk that drivers will react by increasing speed or lowering helmet use.

We end our analysis with a word of caution. In this study we work with purely observational data and hence

we cannot really claim to tease out causal relationships. However, given the detail of the information we have, we think there are good reasons to believe that biases due to omitted variables are relatively limited. Further research should try to validate some of the findings we generated through an adequate experimental design. Nevertheless, we believe that our analysis is a first important step in understanding helmet use in a low-income but highly-motorized context.

4.7 Appendices

Appendix A. Theoretical framework

Passengers — Risk aversion

Let h_U denote the optimal level of insurance for the passenger with utility function U defined above. Let us now consider a second, more risk averse, passenger with a utility function V which exhibits higher risk aversion than U, i.e. $V(\cdot)$ is a concave increasing transformation of $U(\cdot)$, hence $V(\cdot) = g[U(\cdot)]$, with $g' > 0$, and $g'' < 0$ (Pratt; 1964).

Assuming the same wealth prospect and choice set as (4.2) but taking into account the preferences of the more risk averse individual, we obtain:

$$\frac{\partial EV}{\partial h} = -p \cdot [c'(h) + I'(h)] \cdot g'(U(B)) \cdot U'(B) - (1-p) \cdot c'(h) \cdot g'(U(G)) \cdot U'(G). \tag{4.8}$$

To see whether a more risk averse individual invests more in self-insurance, we need to evaluate $\frac{\partial EV}{\partial h}$ at $h = h_U$. Since, $g'' < 0$, we have $g'(U(B)) > g'(U(G))$. Therefore, when computing $\frac{\partial EV}{\partial h}$ at the optimal point h_U (for which we have $\frac{\partial EU}{\partial h} = 0$) we obtain $\frac{\partial EV}{\partial h}|_{h=h_U} > 0$. In other words, a more risk averse passenger invests more in self-insurance, i.e. helmet use.

Passengers — Risk compensation

We consider again the passenger with utility function U and explore an increase in the probability that an accident occurs from p to q, where $q > p$. Substituting q in Equation (4.2), we obtain:

$$\frac{\partial EU(q)}{\partial h} = -q \cdot [c'(h) + I'(h)] \cdot U'(B) - (1-q) \cdot c'(h) \cdot U'(G). \tag{4.9}$$

To see whether the passenger invests more in self-insurance following an exogenous increase in the probability that an accident occurs, we need to evaluate $\frac{\partial EU(q)}{\partial h}$ at $h = h_U$. Since $q > p$ and $-[c'(h) + I'(h)] > 0$ (the condition for an interior solution), we have $-q \cdot [c'(h) + I'(h)] > -p \cdot [c'(h) + I'(h)]$ and $(1-q) \cdot c'(h) < (1-p) \cdot c'(h)$. Thus, when computing $\frac{\partial EU(q)}{\partial h}$ at the optimal point h_U, we obtain $\frac{\partial EU(q)}{\partial h}|_{h=h_U} > 0$, i.e. if the probability that an accident occurs increases, the passenger invests more in self-insurance and hence compensate at least partially for the increased risk. In turn, if safety increases exogenously, passengers are thought to invest less.

Drivers — Risk aversion

Again we consider the case of two individuals with different degrees of risk-aversion, U and V:

$$\frac{\partial EV}{\partial h} = -p(s) \cdot [c'(h) + I'(h)] \cdot g'(U(B)) \cdot U'(B) - (1-p(s)) \cdot c'(h) \cdot g'(U(G)) \cdot U'(G) \tag{4.10}$$

and

$$\frac{\partial EV}{\partial s} = p'(s)\cdot[g(U(B)) - g(U(G))] - t'(s)\cdot[p(s)\cdot g'(U(B))\cdot U'(B) + (1-p(s))\cdot g'(U(G))\cdot U'(G)]. \tag{4.11}$$

To see whether the more risk averse driver invests more in self-insurance and self-protection, we need to compute the sign of Equations (4.10) and (4.11) at $h = h_U$ and $s = s_U$ respectively. The results show that a more risk averse individual invests more in self-insurance, while the effect on self-protection is ambiguous.

Drivers — Self-insurance-cum-protection activity

Let's relax the assumption made and consider that low speed reduces both the probability of the road crash realization and the size of the loss in case of accident.

In that case the expected utility is given as:

$$EU = p(s)\cdot U[W - t(s) - c(h) - I(h,s)] + (1-p(s))\cdot U[W - t(s) - c(h)] \tag{4.12}$$

Remark: we assume that I'_h does not depend on s and I'_s does not depend in h.

We focus on the SICP activity. The first order condition for maximizing (1) with respect to s is:

$$\frac{\partial EU}{\partial s} = p'(s)\cdot[U(B) - U(G)] - p(s)\cdot[t'(s) + I'(s)]\cdot U'(B) - (1-p(s))\cdot t'(s)\cdot U'(G) = 0 \tag{4.13}$$

As before, we compare the level of SICP chosen by two individuals, U and V, V being more risk averse than U:

$$\frac{\partial EV}{\partial s}|_{s=s_U} = p'(s)\cdot[g(U(B)) - g(U(G))] - p(s)\cdot[t'(s) + I'(s)]\cdot g'(UB))\cdot U'(B) - (1-p(s))\cdot t'(s)\cdot g'(U(G))\cdot U'(G) \tag{4.14}$$

If $\frac{\partial EV}{\partial s}|_{s=s_U}$ is negative, a more risk averse individual invest more in the SICP activity.

From Equation (4.13) we have: $p'(s) = \dfrac{p(s)\cdot[t'(s) + I'(s)]\cdot U'(B) + (1-p(s))\cdot t'(s)\cdot U'(G)}{U(B) - U(G)}$

Due to the concavity of $g(U)$), we can write that:

$$\Rightarrow p'(s) < \frac{g'(U(G))}{g(U(B)) - g(U(G))}\cdot[p(s)\cdot[t'(s) + I'(s)]\cdot U'(B) + (1-p(s))\cdot t'(s)\cdot U'(G)]$$

$$\Rightarrow p'(s)\cdot[g(U(B)) - g(U(G))] > p(s)\cdot[t'(s) + I'(s)]\cdot g'(U(G))\cdot U'(B) + (1-p(s))\cdot t'(s)\cdot g'(U(G))\cdot U'(G)$$

$$\Rightarrow \frac{\partial EV}{\partial s}|_{s=s_U} > p(s)\cdot[t'(s)+I'(s)]\cdot g'(U(G))\cdot U'(B)+(1-p(s))\cdot t'(s)\cdot g'(U(G))\cdot U'(G)$$
$$-p(s)\cdot[t'(s)+I'(s)]\cdot g'(U(B))\cdot U'(B)-(1-p(s))\cdot t'(s)\cdot g'(U(G))\cdot U'(G)\frac{\partial EV}{\partial s}|_{s=s_U}$$
$$> [g'(U(G))-g'(U(B))]\cdot p(s)\cdot[t'(s)+I'(s)]\cdot U'(B) \tag{4.15}$$

Since $g'(U(G))-g'(U(B))<0$, Equation (4.15) will be negative if $t'(s)+I'(s)\geq 0$ at s_U.

Similar as in Lee (1998), a sufficient condition for a more risk averse individual to invest more in the SICP activity, in our framework, is that $t'(s)+I'(s)\geq 0$ at s_U. In other words, a more risk averse individual will invest more in such prevention effort if the marginal increase in loss if an accident occurs is greater than the marginal gain in time spent on the road at the optimal speed level of the "reference" individual.

Drivers — Risk compensation

We investigate the influence of a change in the probability that an accident takes place on helmet use by drivers. Such variation may be exogenous (as in the case with passengers) or endogenous. The marginal change in helmet use following a marginal change in speed is given by the following cross-derivative:

$$\frac{\partial^2 EU}{\partial h\partial s} = p'(s)\cdot(-[c'(h)+I'(h)]\cdot U'(B)+c'(h)\cdot U'(G))+$$
$$t'(s)\cdot(p(s)\cdot[c'(h)+I'(h)]\cdot U''(B)+(1-p(s))\cdot c'(h)\cdot U''(G)). \tag{4.16}$$

Using Equation (4.4), we obtain the following two equalities:

$$\begin{cases} -[c'(h)+I'(h)]\cdot U'(B)=\dfrac{(1-p(s)}{p(s)}\cdot c'(h)\cdot U'(G) \text{ and} \\ p(s)\cdot[c'(h)+I'(h)]=-(1-p(s))\cdot c'(h)\cdot\dfrac{U'(G)}{U'(B)}. \end{cases}$$

Replacing these two equalities in Equation (4.16) allows us to derive the sign of the cross derivative at the optimal point h_U:

$$\frac{\partial^2 EU}{\partial h\partial s}|_{h=h_U} = \frac{p'(s)}{p(s)}\cdot c'(h)\cdot U'(G)+t'(s)\cdot(1-p(s))\cdot c'(h)\cdot[U''(G)-\frac{U'(G)}{U'(B)}\cdot U''(B)]. \tag{4.17}$$

Assuming a constant relative risk aversion rate ($-\dfrac{U''(G)}{U'(G)}=-\dfrac{U''(B)}{U'(B)}=r$), we find that $\dfrac{\partial^2 EU}{\partial h\partial s}|_{h=h_U}>0$. Therefore, a driver increases speed, he or she also increases helmet use.

Drivers — Awareness

Case #1: Raising the expected probability that an accident occurs at any speed level

We denote the initial probability p and the probability after awareness has risen q_A, i.e. $q_A > p$. Hence, we substitute in Equations (4.4) and (4.5) p by q_A and obtain:

$$\frac{\partial EU_1}{\partial h} = -q_A(s) \cdot [c'(h) + I'(h)] \cdot U'(B) - (1 - q_A(s)) \cdot c'(h) \cdot U'(G) \text{ and} \tag{4.18}$$

$$\frac{\partial EU_1}{\partial s} = q'_A(s) \cdot [U(B) - U(G)] - t'(s) \cdot [q_A(s) \cdot U'(B) + (1 - q_A(s)) \cdot U'(G)]. \tag{4.19}$$

In this case, the weight that is associated with the net marginal gain of using a helmet and being involved in an accident increases ($q_A > p$) while the one associated with the marginal cost of wearing a helmet in the good state decreases ($(1 - q_A) < (1 - p)$). Hence, a driver with a higher (less downward biased) awareness level invests more in helmet use.

Regarding the chosen speed level, as was the case with the decision on helmet usage, the weight associated with the marginal utility derived in the bad state increases while the one associated with the marginal utility derived in the good state decreases. Thus, raising awareness leads in this case to a decrease in the expected marginal gain of higher speed in terms of traveling time. Therefore the effect of increased awareness on speed depends on whether the utility loss induced by a marginal change in the probability that an accident occurs reinforces or compensates the first effect.

Case #2: Raising the expected loss if an accident occurs for any level of helmet use

Now we denote the initial expected loss $I(h)$ and the expected loss after awareness has increased $I_A(h)$, i.e. , $I_A(h) > I(h)$ and hence $B_A < B$, $U(B_A) < U(B)$, $U'(B_A) > U'(B)$. We substitute again in Equations (4.4) and (4.5) and obtain:

$$\frac{\partial EU_2}{\partial h} = -p(s) \cdot [c'(h) + I'(h)] \cdot U'(B_A) - (1 - p(s)) \cdot c'(h) \cdot U'(G) \text{ and} \tag{4.20}$$

$$\frac{\partial EU_2}{\partial s} = p'(s) \cdot [U(B_A) - U(G)] - t'(s) \cdot [p(s) \cdot U'(B_A) + (1 - p(s)) \cdot U'(G)]. \tag{4.21}$$

In this case, the level of wealth in the bad state is reduced ($B_A < B$) because of the increased severity of injuries. Therefore, given the concavity of the utility function, a marginal increase of consumption at B_A is higher than at point B. If Equation (4.20) is evaluated at the optimal point $h = h_U$, we obtain $\frac{\partial EU_2}{\partial h} | h = h_U > 0$, i.e. a higher expected loss induces a higher level of helmet use.

Regarding the chosen level of speed, the higher expected level of injuries implies a larger loss in terms of wealth leading to both a greater difference in utilities between the two states of the world ($U(G) - U(B_A) > U(G) - U(B)$) and a higher marginal utility in the bad state ($U'(B_A) > U'(B)$). Given the former, a marginal increase in speed increases the loss. Moreover, the marginal increase in speed also raises the level of gain in terms of travelling

time due to the latter effect. Hence, again, the effect of an increase in the expected level of injuries on speed is ambiguous. Note that in this case the utility of helmet use remains the same, i.e. $I'(h)$ is constant.

Appendix B. Determinants of non-reporting

In total 212 sampled individuals refused to answer to the questionnaire, leading to a final sample of 902 individuals which corresponds to a response rate of 81%. Yet, among those who have answered to our survey, there are respondents who could not or did not want to answer to some of the questions. We decided to use in our analysis always the largest possible sample. However we show that our results across different specifications are robust to the exact sample chosen. We also show below the results from a probit model in which we regress for drivers and passengers a dummy variable “having at least one missing variable" on a set of basic socio-demographic and socio-economic variables. It can be seen that for male drivers, none of these variables is significant, suggesting that non-reporting is rather random. For passengers we see that women, higher income and caste categories are more likely to have some missing information. In all our regressions we control for these characteristics. Not surprisingly, income is the variable where most of the missings occur. In our regressions we introduce (but do not show) next to the various income categories a category “income not reported”. This dummy was in none of the regressions significant, also suggesting that there is no systematic non-reporting in the data. We also have 27 individuals in the sample that reported to be sometimes a driver and sometimes a passenger. They are also excluded from the driver and passenger samples.

Table 4.7: Socio-demographic and economic correlates of missing information

probit specifications, coefficients	Male drivers		All passengers	
Male (=1)			-0.753***	-0.649**
			(0.194)	(0.282)
Age (in years)	-0.005	-0.006	0.010*	0.010
	(0.005)	(0.009)	(0.006)	(0.007)
Education level (3 categories)	0.006	0.054	0.012	-0.060
	(0.117)	(0.130)	(0.109)	(0.133)
HH monthly income, *ref:* Less than 10,000 INR				
Between 10,000 and 20,000 INR	0.079	-0.009	0.044	-0.017
	(0.186)	(0.204)	(0.177)	(0.191)
More than 20,000 INR	0.012	-0.174	-0.268	-0.529**
	(0.220)	(0.255)	(0.240)	(0.262)
Married (=1)		0.131		-0.214
		(0.282)		(0.254)
Number of children		-0.044		-0.051
		(0.089)		(0.083)
Head of household (=1)		-0.122		0.264
		(0.243)		(0.364)
Household size		0.025		0.039
		(0.042)		(0.031)
Contributes to HH income (share)		0.057		-0.220**
		(0.067)		(0.111)
Religion, *ref:* Hindu				
Muslim		-0.235		-0.309
		(0.253)		(0.300)
Sikh		-0.395		-1.013*
		(0.455)		(0.569)
Believes fate is in god's hands		-0.344		-0.250
		(0.221)		(0.235)
Belongs to low caste (=1)		-0.189		-0.563***
		(0.172)		(0.182)
Constant	-0.936***	-0.967*	-0.853**	-0.174
	(0.345)	(0.510)	(0.343)	(0.484)
Pseudo R^2	0.006	0.023	0.052	0.122
Observations	*482*	*456*	*368*	*354*
Total observations in survey	489	489	371	371
Share of observations in sample (%)	98.50	93.25	99.00	95.40

Notes: ***, ** and * stands for 1%, 5% and 10% significance respectively. Robust standard errors reported in parentheses.

Appendix C. Marginal effects

Table 4.8: Helmet use and speed level chosen by drivers – marginal effects

Simultaneous equation system, marginal effects	(1)	(2)	(3)	(4)	(5)
HELMET USE					
Risk aversion score	0.015	0.013	0.016^{+}	0.016^{+}	0.025**
	(0.011)	(0.011)	(0.010)	(0.011)	(0.010)
Socio-demographic characteristics					
Age (in years)		-0.001	0.000	0.001	-0.000
		(0.002)	(0.002)	(0.001)	(0.002)
Married (=1)		0.024	0.029	0.028	0.027
		(0.043)	(0.043)	(0.045)	(0.045)
Number of children		0.015	(0.006)	0.001	0.013
		(0.014)	(0.013)	(0.013)	(0.014)
Household head (=1)		0.030	0.026	0.008	-0.000
		(0.044)	(0.044)	(0.043)	(0.048)
Household size		-0.015**	-0.013**	-0.017***	-0.016***
		(0.006)	(0.006)	(0.006)	(0.006)
Education, *ref:* Primary-secondary education					
Illiterate		-0.135***	-0.111**	-0.105***	-0.114**
		(0.045)	(0.049)	(0.056)	(0.051)
Tertiary education		0.055**	0.040^{+}	0.024*	0.038
		(0.026)	(0.025)	(0.025)	(0.025)
Household monthly income, *ref:* less than 5,000 INR					
between 5,000 and 10,000 INR		n.e.	n.e.	n.e.	n.e.
between 10,000 and 15,000 INR		n.e.	n.e.	n.e.	n.e.
between 15,000 and 20,000 INR		n.e.	n.e.	n.e.	n.e.
between 20,000 and 25,000 INR		n.e.	n.e.	n.e.	n.e.
above 25,000 INR		n.e.	n.e.	n.e.	n.e.
Contribution to hh income (share)		-0.001	-0.000	-0.000	0.002
		(0.011)	(0.010)	(0.010)	(0.011)
Religion, *ref:* Hindu					
Muslim			-0.001	-0.022	-0.036
			(0.038)	(0.038)	(0.039)
Sikh			-0.204***	-0.171***	-0.175***
			(0.069)	(0.061)	(0.067)
Believes fate in god's hands (=1)			-0.015	-0.037	-0.007
			(0.037)	(0.045)	(0.042)
Caste (=1)			-0.041	-0.005	-0.028
			(0.025)	(0.024)	(0.026)
Driving behaviors and safety perceptions					
Uses motorbike to commute (=1)				0.063*	
				(0.038)	
Never uses ring roads (=1)				0.008	
				(0.037)	
# of persons on motorbike				-0.047**	
				(0.019)	
Confident in own driving ability (=1)				-0.022	
				(0.028)	
Took driving lessons				0.068**	
				(0.030)	
Underest. ann. road inj. (=1)				n.e.	
Experienced road traffic accident (=1)				-0.007	
				(0.040)	
Owns motorbike (=1)				-0.009	
				(0.057)	
Size of motorbike in cc, *ref:* 100cc or less					
between 100 and 150cc				n.e.	
above 150cc				n.e.	
Has motorbike insurance (=1)				n.e.	
Has health insurance (=1)				0.003***	
				(0.001)	
Type of trips, *ref:* Short distance trip					
Long distance trip	0.232***	0.229***	0.229***	0.257***	0.257***
	(0.023)	(0.022)	(0.022)	(0.025)	(0.025)
Neighbourhood trip	-0.038***	-0.042***	-0.044***	-0.050***	-0.048***
	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)
Interviewer fixed effects	yes	yes	yes	yes	yes
Observations	*1367*	*1328*	*1295*	*1160*	*1160*

Notes: n.e. stands for not estimable. $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01.

Appendix D. Using self reported risk aversion in finance

Table 4.9: Helmet use and speed level chosen by drivers

Simultaneous equation system, coefficients	(1)	(2)	(3)	(4)	(5)
HELMET USE (Probit)					
SRRA in finance (8 point scale)	0.073**	0.057^{+}	0.072*	0.093**	0.097**
	(0.034)	(0.036)	(0.037)	(0.041)	(0.040)
SPEED (kph) (Linear model)					
SRRA in finance (8 point scale)	-0.344	-0.073	-0.019	-0.648	-0.601
	(0.517	(0.537)	(0.543)	(0.549)	(0.517)
Correlation residuals	-0.052	-0.062	-0.099^{+}	-0.071	-0.061
Observations	*1373*	*1334*	*1301*	*1166*	*1166*
# of respondents	460	448	433	388	388

Notes: $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01.

Appendix E. Controlling for passengers' behaviors

Table 4.10: Helmet use and speed level chosen by drivers – full sample

Simultaneous equation system, coefficients	(1)	(2)	(3)	(4)	(5)
HELMET USE (Probit)					
Risk aversion score	0.074	0.075	0.099*	0.110*	0.156**
	(0.059)	(0.060)	(0.060)	(0.066)	(0.061)
ref: drivers who have a HH passenger who doesn't wear a helmet					
drivers who have a HH passenger who wears a helmet	0.891***	1.008***	0.920***	0.714***	0.863***
	(0.229)	(0.221)	(0.223)	(0.246)	(0.254)
drivers who have a HH passenger but helmet use unknown	0.318	0.325^{+}	0.272	0.015	0.115
	(0.221)	(0.225)	(0.235)	(0.245)	(0.238)
drivers who don't have a HH passenger	0.224	0.281^{+}	0.212	-0.026	0.188
	(0.157)	(0.171)	(0.180)	(0.186)	(0.184)
SPEED (kph) (Linear model)					
Risk aversion score	0.711	0.943	0.942	0.170	0.326
	(0.719)	(0.728)	(0.732)	(0.760)	(0.703)
ref: drivers who have a HH passenger who doesn't wear a helmet					
drivers who have a HH passenger who wears a helmet	4.656^{+}	4.016	2.866	0.488	1.499
	(2.835)	(2.824)	(2.800)	(2.571)	(2.773)
drivers who have a HH passenger but helmet use unknown	5.635	5.738	5.646	4.242	4.739
	(4.827)	(4.774)	(4.874)	(5.108)	(5.324)
drivers who don't have a HH passenger	-2.526	-2.301	-2.517	-3.662+	-3.814^{+}
	(2.454)	(2.455)	(2.501)	(2.494)	(2.643)
Correlation residuals	-0.107*	-0.120*	-0.151**	-0.117^{+}	-0.119*
Observations	1367	1328	1295	1160	1160

Notes: $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01. HH stands for household.

Table 4.11: Helmet use and speed level chosen by drivers – restricted sample

Simultaneous equation system, coefficients	(1)	(2)	(3)	(4)	(5)
HELMET USE (Probit)					
Risk aversion score	0.067	0.038	0.055	-0.103	0.180*
	(0.089)	(0.096)	(0.098)	(0.127)	(0.108)
HH passenger wears a helmet	0.809***	1.173***	1.032***	1.022***	1.045***
	(0.253)	(0.250)	(0.249)	(0.274)	(0.276)
SPEED (kph) (Linear model)					
Risk aversion score	-0.098	0.588	0.879	1.403	0.022
	(1.393)	(1.460)	(1.399)	(1.610)	(1.311)
HH passenger wears a helmet	3.593	3.170	2.458	-0.270	0.057
	(3.267)	(3.254)	(3.022)	(2.345)	(2.676)
Correlation residuals	-0.202**	-0.181*	-0.218**	-0.222**	-0.212*
Observations	*561*	*535*	*517*	*463*	*463*
# of respondents	187	178	172	154	154

Notes: $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01. HH stands for household.

Appendix F. Controlling for drivers' behaviors

Table 4.12: Determinants of helmet use for passengers

Probit specification, coefficients	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk aversion score	-0.145*	-0.125	-0.131	-0.140	-0.139^{+}	-0.151^{+}	-0.143	-0.140
	(0.088)	(0.099)	(0.099)	(0.104)	(0.086)	(0.101)	(0.113)	(0.106)
HH driver wears a helmet	0.721**	0.834***	0.798***	1.019***	0.772***	1.081***	1.654***	0.636**
	(0.292)	(0.288)	(0.291)	(0.266)	(0.294)	(0.279)	(0.327)	(0.289)
Pseudo R^2	0.186	0.264	0.267	0.390	0.194	0.401	0.528	0.294
Observations	*457*	*451*	*446*	*393*	*457*	*393*	*390*	*390*
# of respondents	152	150	148	131	152	131	130	130

Notes: $^{+}$ p<0.15, * p<0.10, ** p<0.05, *** p<0.01. HH stands for household.

Chapter 5

“Your money or your life!” The influence of injury and fine expectations on helmet use among motorcyclists in Delhi

Abstract

In this paper, I study the individual decision of wearing a helmet using original data collected among motorcyclists in New Delhi in 2011. The data measures the motorcyclists' subjective expectations of medical expenditures and fines. In my empirical analysis, I first study whether previous personal experiences influence individuals' beliefs. I show that knowing some one who experienced a road crash or having been sanctioned by the traffic police modify motorcyclists' subjective expectations. Nonetheless, differences across individuals may be partly due to actual differences in health hazards and police enforcement intensity. In a second step, I investigate to what extent injury and fine expectations impact helmet adoption, this depending on the characteristics of the trip. I find that subjective expectations of injuries are correlated with helmet use for long distance journeys while expected fines are rather linked with helmet adoption for short distance trips either on main roads or within residential neighborhoods. I use geographical fixed effects to control for area related specificities which could bias my estimates, such as differences in health infrastructures or neighbors' attitudes. Finally, in view of designing policies, I assess the impact of different safety measures which raise either expected medical expenditures or expected fines. The increase of police threat, through enforcement, information and fine levels are likely to increase helmet adoption among motorcyclists. Information campaigns stressing the utility of helmet to avoid severe injuries even for motorbike trips nearby one's home should have a similar effect.

***JEL* Classification:** C81, D84, I15, K42, 012, R41

Key words: Subjective expectations, road safety, risky behaviors, India

Contents

5.1 Introduction

Every five minutes in India someone dies from a road traffic accident (NCRB; 2011). This phenomenon is expected to escalate to one death every three minutes by 2020. Many of these fatalities are nevertheless preventable. While Hsiao et al. (2013) found that 62% of Indian road casualties suffered from a cerebral trauma;[1] Liu et al. (2008) highlighted that standardized quality helmets efficiently reduce risk of mortality and injuries by 40% and 70% respectively. Besides road infrastructures or the quality of motorized vehicles, behaviors adopted by road users are actually a crucial lever to reduce the frequency and severity of road traffic accidents. Indeed, individual characteristics and attitudes toward risk may play a role in road habits, risk exposure and conduct while traveling. Grimm and Treibich (2014) (cf. Chapter 4) studied the influence of individual risk aversion on helmet use and choice of speed among motorcyclists. Their results suggest that risk averse drivers are more likely to wear a helmet. Nevertheless, safety behaviors adopted on the road correspond to "economic decisions involving uncertainty" that are, according to Delavande et al. (2011b), "shaped not only by preferences but also by subjective expectations of future

[1] Their study is based on a nationally representative survey of 1.1 million homes.

outcomes". Given the important share of motorcyclists in the traffic mix and among road fatalities in developing countries, a better understanding of the individual decision process of this particular group would definitively help design appropriate and efficient policies. In order to fill this gap, this paper considers individuals' heterogeneity regarding expected consequences of not using a helmet. More precisely, it provides empirical evidence on the relation between helmet adoption and subjective expectations of injuries and fines among motorbike users in New Delhi, as well as insights into the way these beliefs are shaped.

In recent years, a growing literature of applied development economics has started to investigate the impact of subjective expectations on probabilities and outcomes in the individual decision making process in areas like investment, education, health and entrepreneurship (see for instance Attanasio; 2009; Delavande and Kohler; 2009; Dominitz and Manski; 1997a; McKenzie et al.; 2007). As all other uncertain decisions, road safety conducts are likely to be the result of a combination of factors among which perceptions and beliefs play a key role. These include the subjective probability to be caught by the police for infringing road rules, or, in case of an accident, be injured and suffer financial, physical and psychological losses.

Awareness programs on road dangers have extensively used shocking ads in order to raise citizens' expectations of negative outcomes in case they should choose not to use a seat belt or a helmet. Nevertheless, given the low probability of accident occurrence on a given trip, individuals still face difficulties in internalizing this risk and adapting their behaviors. Many countries have therefore chosen to bind attitudes by law. In low and middle income countries, where two wheelers represent up to 70% of all motorized vehicles, an increasing number of governments have implemented compulsory helmet legislations. This, to urge motorcyclists to protect themselves. In India, for instance, a legislation was enacted in 1988 (Motor Vehicle Act). However, it is the responsability of each and every Indian state to implement and enforce the law. The effect of such a punitive measure on road safety attitudes may thus vary substantially across the country depending on the actual and perceived strength of its enforcement.[2] This can be captured by the subjective probability of being caught by the police if infringing the law and the subsequent expected fines.

In this study, elicited subjective expectations of injury and fine if one does not use a helmet were obtained through a unique dataset collected among motorcyclists in New Delhi in 2011. The methodology, which will be presented in detail below, comes from studies on investment in education (Attanasio; 2009), migration decisions (McKenzie et al.; 2007) or health prevention exams (Delavande; 2008). This questionnaire allows me to estimate the impact of injury and fine expectations on road safety behaviors, in particular helmet adoption. Moreover, information gathered on previous experiences of road crash and traffic police stop enables me to investigate how individuals form their beliefs on the consequences of not using a helmet. Finally, based on my findings, the impact of various road safety measures on helmet use are simulated. This will provide evidence as for the possible ways to improve road safety in large metropolitan cities in developing countries.

[2] In the last Global Status Report on Road Safety WHO (2013), the Indian rate of enforcement of helmet law appears to be very low (2 on a scale going from 0 to 10). Nonetheless, this figure does not reflect the potential variation across Indian states.

The remainder of the paper is organized as follows. Section 2 summarizes the road safety literature, with a focus on the work done at the microeconomic level. In particular, I stress why information on subjective probabilities and outcomes could help to understand the behavior of road users. Then, the methodological literature on the measurement of subjective expectations of probabilities and outcomes is introduced. Section 3 presents the data and the survey methods used to draw expectations out. Some descriptive statistics are also reported. In section 4, I discuss the channels through which personal experiences may impact the formation and updating of beliefs as well as the role of the latter in the decision process regarding helmet adoption by motorcyclists. Section 5 reports the empirical strategy and findings. In this analysis, I first explore the influence of previous experiences of road crash or police stop on subjective expectations. In a second step, I look at the extent to which subjective expectations of medical expenditures and fines influence helmet use conditional on trips' characteristics. The impacts of different policy measures raising either expected medical costs or expected fines are reported in section 6. Section 7 concludes.

5.2 Literature review

5.2.1 Studies on motorcycle safety

Studies implemented in developed countries have examined the effectiveness of compulsory helmet legislations. For instance, using U.S. longitudinal data, Dee (2009) found that a universal helmet law reduces motorcyclist fatalities by 27 percent. As for French et al. (2009), they compared the capacity of different safety policies to reduce both fatal and non fatal road injuries and showed that legislations making helmet use mandatory outperform alcohol policies as well as speed limit measures or education programs targeted to riders. It is worth highlighting that motorbike users from the U.S.A or Europe differ – in terms of demographics, uses and engine sizes – from those of developing countries such as India. In low income countries for instance, most drivers ride scooters or mopeds, and this on rather short distances. Given the specificities of motorcyclists and the traffic environment in which they evolve, contextualized evaluations are required. Nonetheless, to my knowledge, and despite the implementation of compulsory helmet legislations in many developing countries, studies estimating the efficiency of such regulation have not yet been undertaken in these regions.

In addition, very few studies have investigated the determinants of road safety habits. One exception is Ritter and Vance (2011) who looked at the socio economic characteristics influencing voluntary helmet use among German cyclists. The scarcity of behavioral analysis can be explained by the absence of data on road habit issues. Indeed, micro level data on road safety behavior are all but inexistent, partly because this issue has been less prioritized by the authorities. This considerably limits research on the topic. We started filling the gap in 2011 by collecting information on road habits among motorcyclists in New Delhi. Information on socio demographic characteristics, preferences toward risk and beliefs were also gathered. In a previous paper (Grimm and Treibich; 2014, cf. Chapter 4), we focused on the influence of risk aversion on helmet use and choice of speed and on the existence of risk compensation behaviors. We found that among drivers, individuals who are more risk averse are

significantly more likely to use a helmet. As to passengers, their use of a helmet depends on the environment they face (driver's characteristics or traveling speed for instance).

While Grimm and Treibich (2014) (cf. Chapter 4) assumed that expected probabilities of accident and subsequent injuries are identical for all motorcyclists, this paper takes into account the possible heterogeneity in expectations individuals may have regarding the consequences of not using a helmet. Indeed, besides their risk aversion, the discomfort of wearing a helmet, the protection it offers in case of a crash (in terms of probability and severity of the injury) or the capacity of avoiding police sanctions are various dimensions that may enter the individual decision process regarding helmet adoption and which plausibly differ from one person to the other. Introducing subjective expectation data in the analysis allows to disentangle explanations based on preferences and those based on beliefs. More adequate behavioral interventions might then be suggested.

Both the concern about negative health outcomes and the threat of financial sanctions may influence motorcyclists' behavior toward helmet use. Elicited subjective probability of injury and subsequent medical expenditures on the one hand, and subjective probability of police halt and financial penalties on the other hand have been gathered using similar methodologies to the ones already extensively used in the literature (see Delavande et al.; 2011b; Manski; 2004, for reviews). In other words, the "frequency" and the "severity" dimensions have been elicited through our survey. This paper discusses the possible mechanisms at play in the formation of beliefs and their theoretical impact on helmet use. Based on a unique dataset, I then empirically test these relations.

To summarize, behavioral studies on road safety conducts investigating the influence of educational and repressive policies, in particular in developing countries, have not yet been undertaken. Individuals' beliefs regarding the gains and costs of not using a helmet are certainly an important dimension to explore in the safety decision process. Moreover, the formation or updating of road related subjective expectations as well as the influence of the latter on helmet adoption are questions which remain overlooked. To fill these gaps, I first explore the role of personal experiences on the observed heterogeneity in beliefs across individuals. Second, I study to what extent subjective expectations of medical expenditures and fines impact helmet adoption in different trip circumstances and third I estimate the impact on helmet use of various safety measures modifying expectations. I report in the following subsection the various methods used in the literature to elicit this specific type of information.

5.2.2 Measurement of subjective expectations

Despite the development of elicitation methodologies, in particular in psychology, economic empirical studies of individual choices have often only focused on preferences, while individuals' beliefs were assumed homogenous. However, Tversky and Kahneman (1974)'s results suggested that individuals tend to use heuristic rules to process data. These findings brought concerns regarding the assumption of rational and homogenous expectations across agents. Furthermore, as pointed by Manski (2004), expectations may vary from one person to the other and different combinations of subjective expectations and preferences may lead to the same observed behavior. By collecting data on individuals' expectations regarding the occurrence of specific events and their subsequent

outcomes, researchers aim at relaxing the homogeneity assumptions made on expectations.

Attanasio (2009) highlighted that a careful design of questionnaires should enable to elicit information on subjective probabilities and distribution of future variables. He added that such procedure is important for economic welfare and relevant to determine economic choice. Because of lower cost and higher willingness of individuals to spend time on answering surveys in developing countries, such data collection has particularly increased in these regions. Detractors have called into question the quality of these datasets putting forward the limited formal education of some respondents and their unfamiliarity with the formal concept of probability. Delavande et al. (2011b) refuted these arguments based on a survey of recent contributions to the literature on the measurement of subjective expectations in developing countries. They showed that elicitation of probability is feasible in low income countries despite the average low level of education of respondents. These authors also provided advice regarding the methods to be used in the questionnaire to limit numeracy difficulties. For instance, visual aids (balls, beans, sticks) could be used in low income countries where probability concepts might be too abstract for respondents. When such tools were used only few people gave degenerated forecasts, supporting the idea that individuals understand the questions asked (cf. Luseno et al.; 2003; Lybbert et al.; 2007). Initial formulation of questions eliciting continuous variables, such as future earnings or retirement benefits, enabled to obtain only one value of the outcome of interest, leaving unclear whether the respondent gave the minimum, the maximum, the median or the average of what he expects. Different methods have been used since then to draw out the distribution of the outcome of interest. Dominitz and Manski (1997b), for instance, asked the following questions to respondents: *"what do you think is the percent chance that your total household income, before taxes, will be less than Y over the next 12 months?"*. Four income thresholds in increasing order were presented to the individual. The thresholds about which a given respondent was queried were determined by the respondents' answer to a pair of preliminary questions asking for the lowest and highest possible income that the household might experience in the next year. Such methodology generates flexible thresholds, a way of avoiding the anchoring problem which appears when using pre-determined intervals among population differing regarding their wealth. Finally, Delavande et al. (2011a) conducted an experiment in India to test the sensivity of elicited expectations to variation in three dimensions of the elicitation methodology: (i) the number of beans,[3] (ii) the design of the support (pre-determined vs. self-anchored) and (iii) the ordering of questions. While more accuracy was obtained by using more beans and a larger number of intervals with a pre-determined support, the results remained very robust to variations in the elicitation design.

I now proceed with the presentation of the dataset.

[3] Beans are used as visual aids by respondents.

5.3 Data

5.3.1 Road safety survey

With the help of a local survey firm, we implemented an household survey in Delhi in 2011 targeting motorcyclists. Besides socio demographic characteristics, data on risk aversion, perception of road rule enforcement and of road risks were gathered along with helmet use, previous involvement in road traffic crashes or traffic police stops. Finally, we attempted to elicit the subjective expectations of medical expenditures and fines, based on the methodologies developed in the literature and describe in more detail below in section 5.3.2.

The following sampling design was adopted: (i) New Delhi was divided into five zones, (ii) in each zone, ten polling booths were randomly drawn, (iii) the location of each of these polling booths represented the starting point from which every fifth household was selected for the interview. Around each polling booth, 30 households were interviewed, leading to a total of 1,502 households. In 545 of them at least one member had traveled by motorbike in the previous four weeks. Up to three drivers or passengers per household could answered the survey. In the end, 902 motorbike users agreed to reply to our questions.

Our respondents are 36 years old on average, two thirds of them are men and 70% pray daily. 97% of the drivers are men while they only represent 25% of the passengers. Regarding road safety efforts, while men use full face helmets, women more often opt for a half helmet. Motorcyclists were asked about their helmet use in three different circumstances. On average, motorbike users are more likely to declare wearing a helmet for long trips[4] (81%) than for short trips on main roads (61%) or trips in residential neighborhoods[5] (54%). Nonetheless, significant differences in helmet use are observed between men and women, drivers and passengers and motorcyclists who frequently or occasionally use this mode of transportation. Drivers without passengers travel at a higher speed on average. More than 60% of the passengers declare being three or more people when they use the motorbike. 46% of the respondents declare to frequently circulate on a motorbike, 64% use it mainly to commute to work. Finally, 7% of the interviewed motorcyclists have already been involved in a road crash, they are about the same percentage to have been sanctioned by the traffic police.

5.3.2 Eliciting subjective expectations of medical expenditures and fines

Subjective probability to be hurt in a road accident and subsequent medical expenditures

Starting with the potential injuries, two situations were presented to the interviewees. First, they were asked to consider the way they usually travel on their motorbike ("in general"). Second, they were put in the situation where they would not use the helmet ("if no helmet"). [6]

[4] Long trips are defined as journeys lasting more than 15 minutes.

[5] Residential neighborhoods correspond to residential areas with small food and clothes markets.

[6] We think that asking individuals about their subjective probabilities of being injured with and without helmet would have exacerbated the social desirability bias. Controlling by the type of injuries individuals have in mind and the answer to the "in general" question should allow me to capture the perceived utility of helmet. As a matter of fact, helmet use questions came before the elicitation of subjective probabilities and outcomes. Furthermore, in the case of respondents who report usually not wearing a helmet, the subjective probabilities of being involved

In each case, respondents were asked to establish the likelihood they would be involved in an accident and injured using an 11 point response scale going from 0 "this event will never happen" to 10 "this event will surely happen". Answers were divided by ten in order to obtain values between 0 and 1 which can be related to probabilities. In order to control for the understanding of the scale, five general questions were asked before eliciting subjective probabilities regarding road risks (further detail regarding these "check questions" are included in the Appendices).[7]

I acknowledge that no explicit time horizon was included in the formulation of the question. Despite a comprehensive training of interviewers, the possibility that some of the respondents might refer to the next trip while others might think about their entire lifetime can't be completely rule out. Literature on protective behaviors (Kunreuther and Slovic; 1978) highlighted that time horizon matters when asking about probability of accident. However, if individuals who refer to a really short time horizon are not systematically different from those who consider their whole life, the absence of time horizon is not such a concern. Later on, I discuss possible reasons implying a correlation between individuals' characteristics and elicited subjective expectations and attempt to control for this potential bias in the empirical analysis.

Table 5.1 provides the distribution of subjective probabilities of injury in the two situations of interest. Notably, the "no helmet" variable is on average higher and has fatter tails than the "in general" probability. The graph on the left of Figure 5.1a draws the distribution of subjective probability of being hurt if not wearing a helmet. The distribution is broken down by different socio demographic characteristics and preferences toward risk in Figure 5.2a. This subjective probability seems to vary substantially among respondents, even for individuals of similar gender, education, religion or presenting the same level of risk aversion.

in an accident if the respondent travels (i) as s/he usually does and (ii) not wearing a helmet should be similar.

[7] We use similar questions as Delavande and Kohler (2009). When performing robustness checks, I exclude from the sample individuals who did not answer correctly to the check questions (see results in Appendix F, Table 5.19).

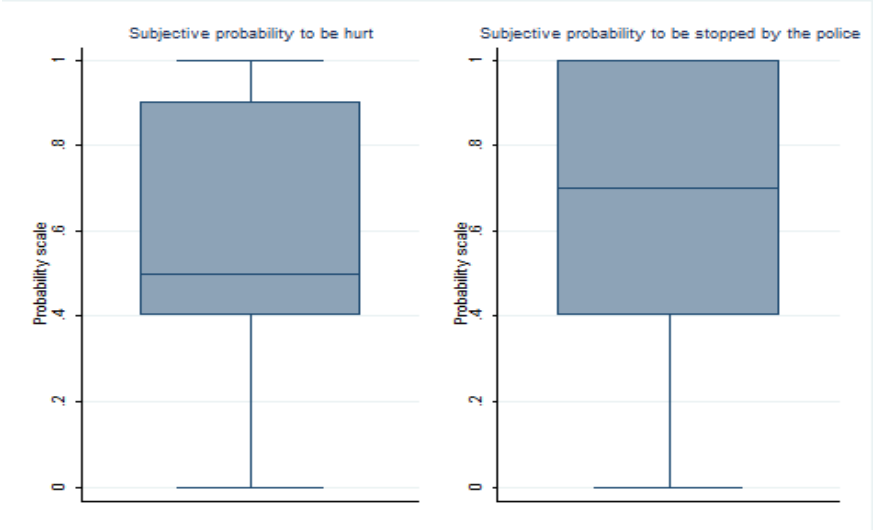
Table 5.1: Distribution of subjective probabilities of injuries and police sanctions

	percentile					
	25^{th}	50^{th}	75^{th}	mean	std. dev.	*observations*
Probability to be hurt						
in general	0.2	0.4	0.5	0.37	0.25	*841*
if no helmet	0.4	0.5	0.9	0.58	0.31	*836*
Probability to be stopped by the police						
in general	0.2	0.4	0.5	0.39	0.29	*840*
if no helmet	0.4	0.7	1	0.65	0.34	*878*
for no reason	0.1	0.3	0.5	0.36	0.30	*845*

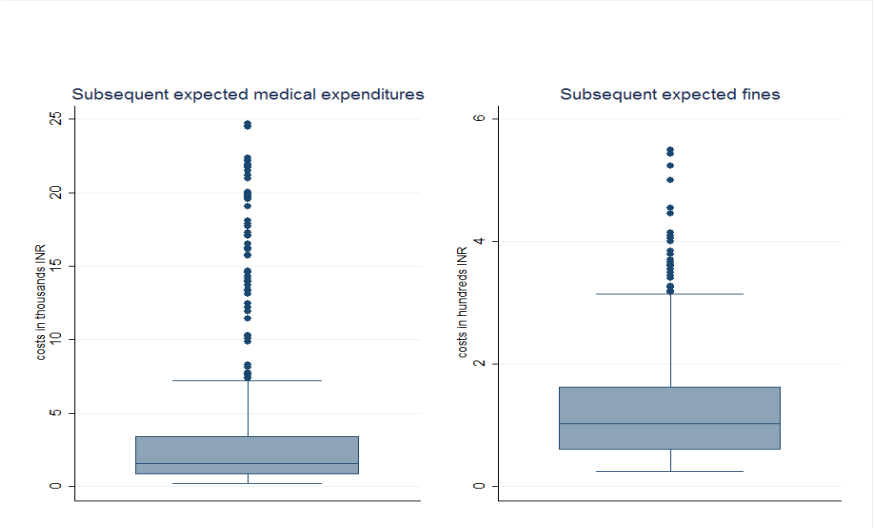
FORMULATION OF QUESTIONS
Probability to be hurt
in general - *"Think about the way you generally travel on the motorcycle. Given this, how likely do you think that you have an accident in which you get injured?"*
if no helmet - *"In case you are not wearing a helmet, how likely do you think that you have an accident in which you get injured?"*
Probability to be stopped by the police
in general - *"Think about the way you generally travel on the motorcycle, what is the likelihood that you will be stopped by the police in the next month?"*
if no helmet - *"If you do not use the helmet at all during the next month, what is the probability the police stops you at least once over the period?"*
for no reason - *"According to you, what is the likelihood you will be stopped by the police for no reason in the next month?"*
Answer scale
Respondents answered using a 11 point scale going from 0 "this event will never happen" up to 10 "this event will surely happen". I then divided their answer by 10 to obtain probabilities, between 0 and 1.

Figure 5.1: Heterogeneity in beliefs

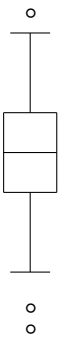
a. Subjective probabilities if non use of helmet



b. Subsequent expected outcomes



Box plot legend:



upper adjacent value

75^{th} percentile

median

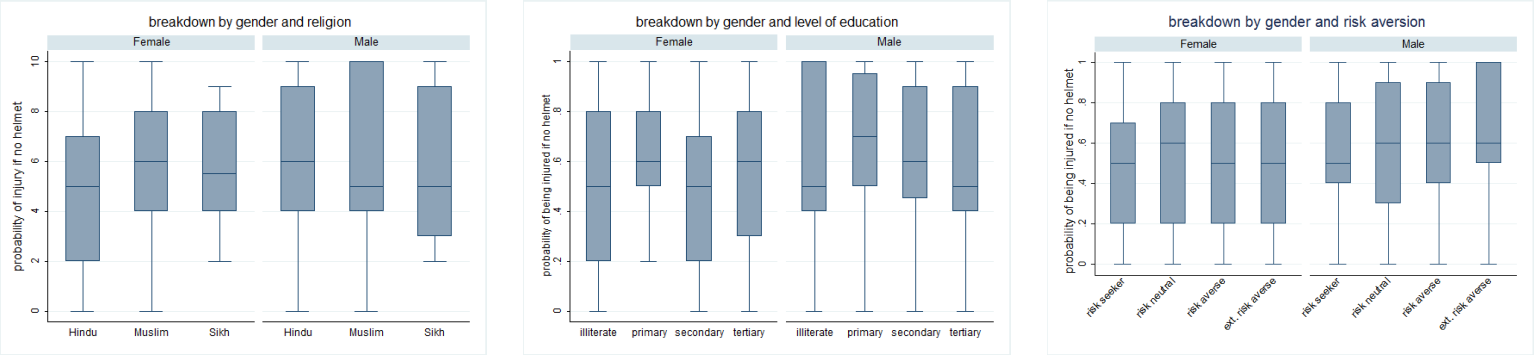
25^{th} percentile

lower adjacent value

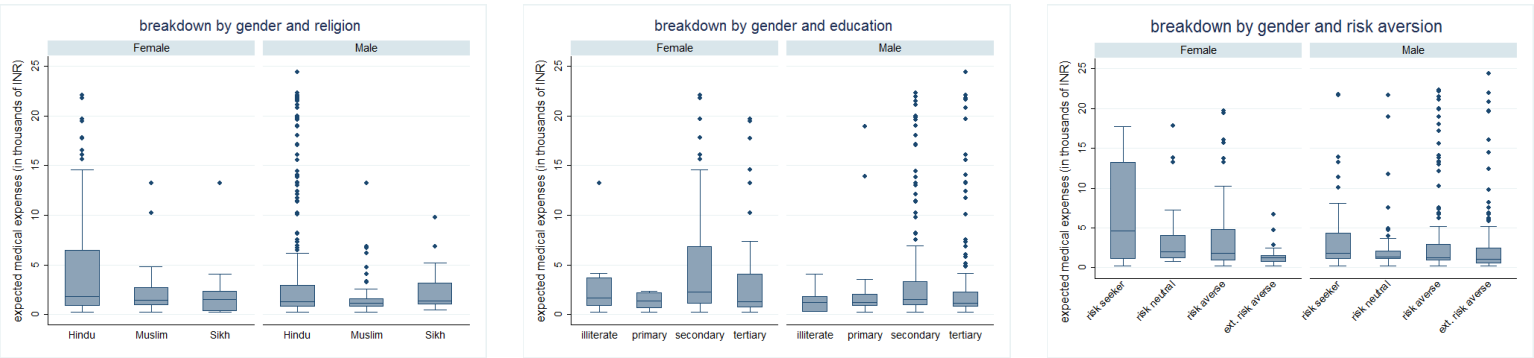
outside values

Figure 5.2: Heterogeneity in beliefs breakdown by socio-demographics

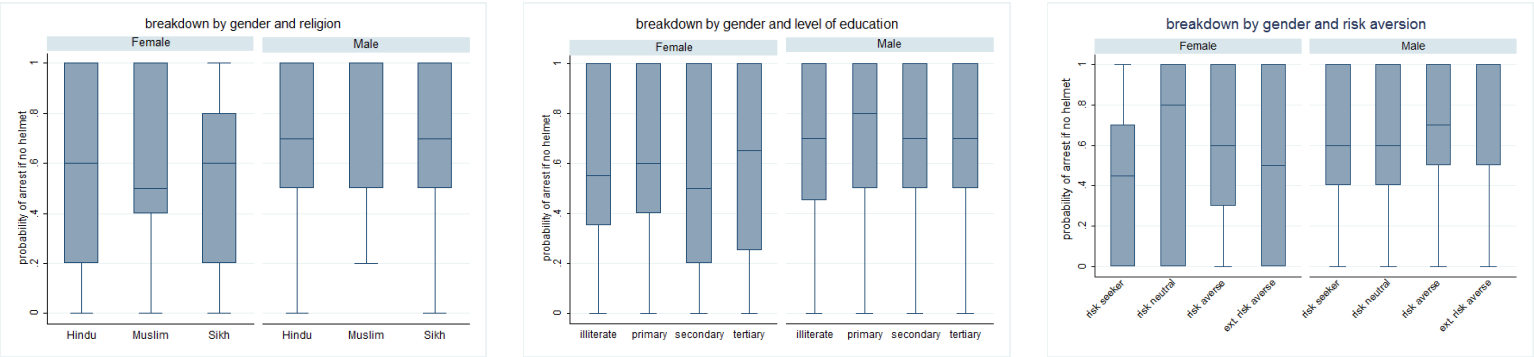
a. Subjective probability of being hurt if not using a helmet



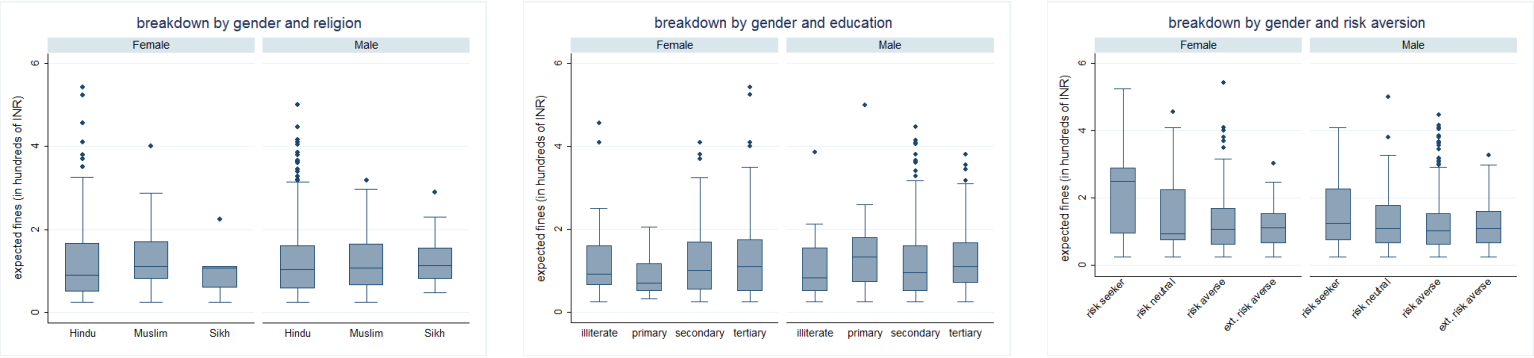
b. Subsequent expected medical expenditures



c. Subjective probability to be stopped by the police if not using a helmet



d. Subsequent expected fines



Notes: Answers to the self-assessed risk aversion in general question have been used to build the above graphs.

Following the question regarding the likelihood of being injured, respondents were asked which type of injury would most likely happen in each of the two cases ("in general" and "if no helmet"). Trauma to inferior and superior limbs[8] are the most commonly cited injuries. However, based on data from one of the biggest hospitals in Delhi, Kumar et al. (2008) highlighted that more than 60% of road related fatalities sustained head injuries. Cerebral trauma is mentioned by only 7% of my sample when considering the "in general" case.[9] This share goes up to 48% of respondents in case the individual is not using a helmet. Nevertheless, this figure is likely to cumulate actual beliefs and the fact that respondents answer what they think they should say.

If the individual answered that the probability of being hurt while not using a helmet was strictly higher than zero, the interviewer proceeded with questions regarding the subsequent medical expenditures. More precisely, respondents were asked the percent chance the medical expenditures would be less than a series of fixed amounts going from 500 INR up to 200,000 INR.[10] The enumerator kept proposing higher amounts till the respondent answered 100%. The main drawback of using one unique and fixed scale to elicit the distribution of a continuous variable, in particular among a heterogenous population, is the possibility that the range offered doesn't correspond to the intervals the individual has in mind. By asking each respondent about the range of values which is relevant for him, we would instead create a self-anchored support. In our case, expected medical expenditures may vary quite substantially according to the motorcyclist's wealth but also to his access to medical care, in particular whether he has health insurance or not. Taking into account this potential anchoring issue, in the initial version of the questionnaire the respondent was first asked about the minimum and the maximum amounts of medical expenditures. The interviewer then computed three thresholds and asked what was the percent chance the individual would have to pay less than each of these thresholds (the three computed thresholds and the maximum) following the elicitation methodology used by Dominitz and Manski (1997b). Nevertheless, the pilot phase revealed the interviewer's difficulties in computing the intervals, which also increased the duration of the interview and exacerbated interviewee's fatigue. This led us to opt for pre-determined scales to derive the distribution of medical expenditures each motorcyclist expect to pay. Yet, no significant differences in subjective medical costs are actually found between income groups. I acknowledge that not all relevant costs are drawn out here, in particular job revenues due to a temporary or a permanent incapacity to work were not asked to the respondents. Similarly, a possible fatal accident, which would correspond to the worst case scenario in terms of health but which doesn't imply any medical costs, is not explicitly elicited.

Based on the elicited cumulative distribution function, I built the expected cost for each respondent using the following methodology. Let's denote p_{ik} the percent chance that the cost will be less than the amount C_k for individual i. The motorcyclist's expected cost $E_i(C)$ is then equal to :

[8] This covers broken arm, broken leg or possibly the loss of one of these members.

[9] No significant differences are detected when comparing motorcyclists who declare using or not the helmet and this no matter the trip circumstance considered.

[10] The exact formulation used was the following: *"Thinking about the medical expenditure you would have to pay if you were injured in a road crash right now without wearing a helmet, what do you think is the percent chance that this amount will be less than X INR?"*

$$E_i(C) = \sum_{k=1}^{n} (p_{ik} - p_{ik-1}) \cdot \left(\frac{C_k + C_{k-1}}{2} \right)$$

with $\frac{C_k + C_{k-1}}{2}$ the central value of each interval and $p_{ik} - p_{ik-1}$ the percent chance associated to each interval. Initial values C_0 and p_{i0} are equal to zero.[11]

Let's take the example of a respondent who answered that there was a 20% chance the health expenses would be less than 500 INR, 50% chance that they would be less than 1,000 INR and 100% chance that they wouldn't exceed 1,500 INR. Following the above formula, this person's expected medical expenditures amounted to 900 INR ($0.2 \times 250 + 0.3 \times 750 + 0.5 \times 1{,}250$).

The average expected medical cost is 5,189 INR.[12] We observe a lot of heterogeneity across motorcyclists, the standard deviation being equal to 9,012 INR (cf. Table 5.2). Based on provided answers, the 25th and the 75th percentiles were derived through linear extrapolation. When a respondent gave for the first proposed amount a higher percentage than 25% or 75%, the lowest amount of medical expenditures (500 INR) was imputed to the related percentile.[13] Interquartile range (75th percentile - 25th percentile) captures the variation in the potential financial costs individuals have in mind. The extent of potential medical expenditures appears to vary a lot across respondents. Some individuals may consider both minor and extremely severe injuries when answering the outcome question while others may have a clear opinion of what type of injuries they would face. We note that expectation and variance parameters of medical expenditures are significantly correlated with the type of injuries a person thinks he would suffer from if he wasn't wearing a helmet at the time of the crash. More precisely, they are positively related to head trauma and negatively correlated with injuries to superior or inferior limbs.

[11] When using different computations of the first central value (either by applying an exponential function or a power function instead of a linear one or fixing a strictly positive minimum amount of medical costs), the expected cost is almost not modified – between 0.27% and 1.36% of change.

[12] I unfortunately can't compare this figure with actual medical expenses faced by road victims due to unavailability of hospital data.

[13] The minimum of 500 INR has been imputed to the 25th percentile for 236 individuals and to the 75th percentile for 97 of them.

Table 5.2: Summary statistics of expected medical expenditures and fines

	observations	mean	std. dev.	median	minimum	maximum
Expected costs (in INR)						
medical expenditures	*772*	5,189	9,012	1,688	250	64,003
fines	*760*	129	103	105	25	783
Interquartile range (in INR)						
medical expenditures	*772*	6,718	15,039	1,500	0	94,000
fines	*760*	112	109	88	0	500

FORMULATION OF QUESTIONS

Medical expenditures

"Thinking about the medical expenditure you would have to pay if you were injured in the road crash right now without wearing a helmet, what do you think is the percent chance that this amount will be less than X INR ?"

A serie of fixed amounts going from 500 INR up to 200,000 INR were proposed, the enumerator kept on proposing higher amounts till the respondent answered 100%.

Fines

"Thinking about the fine you would have to pay if you were stopped by the police right now without wearing a helmet, what do you think is the percent chance that this amount will be less than X INR ?"

A serie of fixed amounts going from 50 INR up to 1,000 INR were offered.

Variables built

1. Based on provided answers, the expected cost $E_i(C)$ was computed: $E_i(C) = \sum_{k=1}^{n}(p_{ik} - p_{ik-1}) \cdot \left(\frac{C_k + C_{k-1}}{2}\right)$, with p_{ik} the percent chance that the cost will be less than the amount Y_k for individual i, $\frac{C_k + C_{k-1}}{2}$ the central value of each interval and $p_{ik} - p_{ik-1}$ the percent chance associated to each interval. Initial values C_0 and p_{i0} being equal to zero.

2. The interquartile range, which corresponds to the difference between the 75^{th} and 25^{th} percentiles, has also been computed. Based on provided answers, the 25^{th} and the 75^{th} percentiles were derived through linear extrapolation. When a respondent gave for the first proposed amount a higher percentage than 25 or 75, the lowest amount of medical expenditures (500 INR) was imputed to the percentile.

Subjective probability to be stopped by the police and subsequent fines

The mandatory helmet law aims at providing incentives toward helmet use through financial penalties. Nonetheless, such sanctions are likely to modify motorcyclists' behavior only if they are credible and sizeable enough. To capture the actual beliefs of motorcyclists regarding helmet legislation, respondents were asked about their perception of road rules enforcement. More precisely, their subjective probabilities of being stopped by the police in the next month in three different situations were assessed. In addition to the "in general" and "if no helmet" cases, individuals were asked the likelihood they would be stopped by the police for no reason (situation hereinafter labelled "for no reason"). It seemed important to set this third case given that unfair and random police sanctions may have an unproductive and potentially adverse effect on safety decisions. From Table 5.1, it appears that the mean of the perceived probability of being stopped by the police in the "no helmet" situation is much higher than "in general" or "for no reason" (0.65 vs. 0.36-0.39). The variance is also a bit higher.

As previously, when the respondent said that there was a strictly positive probability of being stopped by the police when not wearing a helmet, his expectations regarding the fine he would have to pay were elicited by the interviewer. More precisely, interviewees were asked the percent chance the financial penalties would be less than a series of fixed amounts going from 50 INR up to 1,000 INR; the official fine for infringing the helmet law being 100 INR. Following the same methodology as the one used to derive the expected medical expenditures, expected fines have been computed for each individual. The individual's lack of information regarding the level of financial penalties has also been derived by computing the interquartile range.[14] On average, motorcyclists slightly overestimate the financial sanctions, the observed mean of expected fines across respondents in the sample being 129 INR (cf. Table 5.2).[15] Nonetheless, the variation in answers is quite important and half of the respondents have expectations which do not exceed the official fine. The dispersion parameter also indicates that the level of the official fine is somewhat unclear for many individuals given that on average interviewees gave an interquartile range which is higher than the official fine (112 INR).

After this presentation of the collected data, and before turning to the empirical analysis, I discuss in the next section the potential mechanisms at play in the formation of the subjective expectations of injury and fine as well as the expected role of such beliefs in the decision to wear a helmet or not.

[14] In this case, the minimum of 50 INR has been imputed to the 25^{th} percentile for 330 individuals and to the 75^{th} percentile for 78 of them.

[15] One may argue that the proposed pre-determined scale may have biased answers upward given that it starts at 50 INR. Nevertheless, respondents were not told the maximum offered amount (1,000 INR) and 75% of interviewees said the maximum possible fine was below 300 INR (90% below 500 INR). I acknowledge however that it could have been preferable to have a scale starting at 25 INR and increasing by a smaller amount. This would have allowed me to obtain more accurate information. Moreover, I cannot rule out the possibility that respondents also include in the financial consequences of being caught by the police for helmet non use additional fines related to other road regulations they would have simultaneously violated.

5.4 Mechanisms at play

Hereinafter, I approach the problem from the theoretical side. This discussion serves to guide the subsequent empirical analysis. First, I consider the formation and updating of individuals' beliefs regarding the medical expenditures and fines they expect to pay if they don't use a helmet. In particular, I look whether personal experiences of road crash or traffic police stop influence motorcyclists' subjective expectations. In a second step, I discuss the theoretical role of subjective expectations on the decision of helmet use along with additional variables which may directly impact the adoption of a head protection device.

5.4.1 Influence of previous experiences on subjective expectations

From every motorbike trip, individuals obtain new information with respect to the health and financial risks they face from not using a helmet. This new information can, as defined by Haselhuhn et al. (2012), come from a traffic accident they witness (information via observation) or from being involved in a road crash themselves (information via personal experience). Motorcyclists are also likely to modify their beliefs after hearing the story of someone who suffered from road injuries (information via description).

Being involved in an accident and injured or being caught by the police while not wearing a helmet certainly increase the subjective probabilities that such events occur. Nonetheless, the effect of personal experiences on expected medical costs and expected fines are more ambiguous. More precisely, whether personal experience increases or decreases expected outcomes depends on (i) the individual's prior belief and (ii) the severity of the loss the person faces. In other words, if a person, who expected to face tremendous medical expenditures in case of a road crash, is involved in a minor accident, he will certainly correct his expectations downward. If instead, the motorcyclist thought that he would not be injured at all, he will rather modify his beliefs upward. Furthermore, a person is likely to decrease or increase the expected fine to be paid in case of police halt if he was respectively able to corrupt or not the police officer. Finally, a same road experience may have different lasting effects depending on the frequency at which the victim uses the motorbike after the event.

One may think of many other variables which may play a role in the formation of individuals' expectations. Older people have had more time to experience road accident or police stop. As for women, given their low participation in the labor market, they are much less exposed to motorbike risks. Despite the influence of socio demographic characteristics, I mainly focus, in my empirical analysis, on previous experiences. Due to the cross section data at hand, I acknowledge that I am neither able to properly study the updating process nor to estimate accurately the impact of a road crash or a police stop on one's subjective expectations.[16] Nevertheless, I can look whether individuals who experienced a traffic accident or who have been sanctioned by the traffic police report significantly different beliefs regarding injuries and fines.

[16] Panel data could permit to estimate the influence of such events by comparing before and after level of expectations.

5.4.2 Potential influence of subjective expectations on helmet adoption

Unconditional expected costs

When investigating the impact of expectations on helmet adoption, it seems relevant to consider the product of the subjective probabilities and subsequent expected outcomes rather than the two dimensions separately. Indeed, on the one hand, two motorcyclists who think they will certainly be caught by the police if they don't wear a helmet but who have different expectations in terms of fines to be paid may not adopt the same conduct. On the other hand, a motorcyclist who thinks that he has a low probability of being injured but that he will suffer from severe injuries, should this occur, and a person who believes he has a high probability of accident but the subsequent medical expenditures will be rather small may opt for the same attitude toward helmet use. Therefore, it seems key to look at the combination of the two dimensions. This product of variables is called unconditional expected costs in the empirical analysis.

Different influence of expectations depending on trip circumstances

Helmet use is a renewed decision, i.e. individuals decide to use a helmet or not before each of their motorbike trips. The characteristics of each journey (its length, the type of roads taken, etc.) are therefore likely to influence the use of head protection. Habits and routines may also to some extent be adopted by motorcyclists who will always use the helmet in some circumstances and never in others. Very short trips in small streets are commonly assumed to be less dangerous in terms of injuries. While statistics from developed countries showed that a large share of accidents occur very close to the victims' home,[17] road users often only consider the risk of injuries in long distance trips on big roads where a lot of vehicles circulate at a high speed. A reason for that may be the willingness not to take into account all the risks, so as to limit the stress generated by the fear of injuries. Indian motorcyclists may follow a similar reasoning. Furthermore, the probability of crash remains low for short distance trips when compared to the number of times a person takes the same path. Given this difficulty in internalizing all the health risks constantly faced, it would not be surprising that subjective expectations of injuries either do not impact at all safety behaviors or only influence helmet use in long trips on main roads. On the contrary, traffic police operates throughout the city, both on main inner city roads and within neighborhoods. Therefore, the threat of financial penalties is more likely to impact helmet use on short distance trips.

Additional variables impacting the expected costs and gains of helmet use

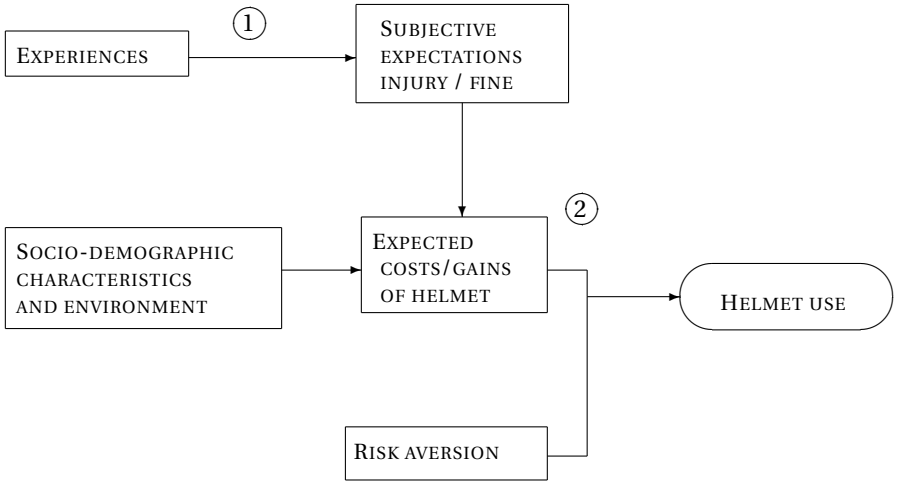
Other important determinants of helmet use include preferences toward risk. Indeed, a more risk averse individual will prefer to adopt a safe conduct to avoid the potential loss. Results from a previous paper (Grimm and Treibich; 2014, cf. Chapter 4) show that, indeed, more risk averse drivers wear a helmet more often. However, this relation is not found for passengers. Age is likely as well to affect the individual's time preference rate through the horizon over which the person discounts the consequences of a negative event. As for the level of education, it may capture

[17] This is the case of France where 75 % of road casualties are locals, pedestrians or occupants of vehicles registered in the district. A peak of mortality is also observed around 6 pm, when people return from work (www.securite-routiere.gouv.fr). Unfortunately, to my knowledge, no such data is available for the city of Delhi or at the Indian national level.

the person's ability to collect and deal with information regarding road risks. Income earners, in particular heads of households, married people and individuals with children, may also opt for a safer conduct because of their family responsibilities and the additional financial consequences implied by a temporary or permanent incapacity to work. Moreover, access to health care may also matter, through the mitigation of negative health consequences. Finally, people who believe that their life is in the hand of a superior force and that their date of death is already written may decide not to use a helmet despite high subjective expectations of injuries.

Figure 5.3 summarizes the main channels through which individuals may form their expectations of injury and fine and then choose whether to wear a helmet or not, in different traveling circumstances. The discussion above aimed at highlighting the role of previous experiences in the formation and updating of individuals' beliefs regarding injury and fine in case one doesn't use a helmet. It also stressed the potential role of these subjective expectations on helmet adoption. This guides my empirical analysis. In particular by helping me to decide which explanatory variables should be introduced in the different regressions of my empirical study.

Figure 5.3: Formation of subjective expectations and their influence on helmet adoption



Research questions:

(1) To what extent subjective expectations influence helmet use decision?

(2) Do individuals' experiences modify their subjective expectations?

5.5 Empirical analysis

I now empirically test the mechanisms previously brought to light. I first explore the influence of previous experiences on subjective probabilities, expected financial consequences and the variance regarding these costs. In a second step, I look at the extent to which subjective expectations influence helmet adoption. In particular, whether the beliefs regarding injury and fine impact the use of a head protection device in different ways depending on the circumstances of the motorbike trip.

5.5.1 Do individuals' experiences modify their subjective expectations?

I investigate here whether previous experiences of road crash and police stop influence the individuals' subjective expectations regarding the risk they face when not wearing a helmet.

Empirical specification

Road hazards and police enforcement intensity are likely to vary across neighborhoods and influence subjective expectations. In other words, if in a given area, police officers are more present, individuals living in that neighborhood are likely to report higher subjective probabilities of being stopped by the police. Similarly, in an accident prone area, individuals are more likely to report higher subjective probabilities of accident. These characteristics are thus likely to bias my estimates if not taken into account. New Delhi is divided into 47 police zones, called "circles". A specific police budget and man power is allocated to each of these areas. As 32 different circles are present in our survey, I take advantage of the geographical division of the city to capture potential local effects.

I therefore estimate the following specification:

$$\text{Expectation}_{itk} = \beta \cdot \text{Experience}_{it} + \sum_j \gamma_j \cdot X_{ij} + \mu_c + \varepsilon_{itck}$$

I consider seperately the subjective probabilities, the expected costs and the variance regarding these costs which is captured by the interquartile range (Expectation_{itk}, with $k = 1, 2$ or 3). My variables of interest are previous experiences (Experience_{it}) and differ depending on the type of subjective expectations t considered (injury or fine) and the individual i. In all regressions, I introduce a set of additional explanatory variables (X_{ij}). More precisely, I include the frequency and the purpose of motorbike use in order to control, at least partly, for the probability that the motorcyclist experienced either a road crash or a police stop. In addition, religious practices are also included in the analysis as they may actually alter individuals' beliefs. The local effects are captured by μ_c. Given that for several of my variables of interest no variation is found within a circle (cf. Table 5.12, Appendix A), I also report the results found with ordinary least square results and when relevant the results of the random effect specifications.

Influence of previous road traffic experiences on injury expectations

Both personal and relatives' experiences of road crash are introduced as dummy variables in the analysis. As mentioned previously, the purpose and the frequency of motorbike use control for possible differences in road risks and therefore for the probability of being involved in an accident.[18] Furthermore, the trauma caused by one experience of crash is likely to have a smaller impact on people who frequently uses this mode of transportation and who balances this negative event with many safe journeys. I thus introduce an interaction term between frequency of motorbike use and personal involvement in a road accident. Hausman tests indicate that the estimation with police zone fixed effects should be preferred to ordinary least square or random effect specifications.

Table 5.3 reports the results found for the different specifications described above. Interestingly, involvement in an accident decreases the variance related to medical costs. Following an accident, individuals actually seem to have a clearer idea of the health risks they face. While praying daily decreases one's subjective probability of being injured in a road crash when not using a helmet, expected medical expenditures and variation in these costs are higher among religious individuals who personally experienced a road accident than among those who didn't. As for individuals who use the motorbike to commute to work, they report significantly higher probabilities of being hurt. When looking at the interaction term, frequent use of a motorbike seems to decrease the impact of personal road crash on the subjective probability of being injured, indicating that the number of trips impact the repercussions of road crash experiences. Furthermore, it appears that knowing someone who has been involved in an accident increases by 0.09 the subjective probability of being injured in a road crash if not using a helmet, while personal experience has no significant impact (cf. column(1), Table 5.3). Different reasons may explain this finding. First, personal involvement in a traffic accident may cover very different types of events, in particular with regard to the seriousness of injuries faced by road victims. Second, a sample selection may be at play as individuals who suffered from severe road injuries may no longer use a motorbike or may not even have survived the crash.[19] Third, remembering that a friend or a family member got caught in a traffic accident is more likely if this crash was quite severe. Differences in road quality and incidence of road crash between neighborhoods may partly explain the level of expectations as the influence of knowing a person who got caught in an accident vanishes once circle fixed effects are introduced. In 15 circles out of 32, none of the respondents knew a person who got involved in a road traffic accident. This may either support the quality of roads argument or imply that individuals are rather homogenous in this regard within areas.

[18] In my sample, individuals who frequently use a motorbike are more likely to have personally experienced a road crash.

[19] While information on the severity of the accident was gathered, very few individuals (2% of the sample) were involved in a severe crash.

Table 5.3: Determinants of injury expectations

	subjective probability of injury if no helmet		**subsequent outcomes**			
			expected costs		**interquartile range**	
	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	FE	OLS	FE	OLS	FE
Experienced a road crash (=1)	0.078	0.042	-6.092***	-5.377**	-9.576***	-8.266**
	(0.080)	(0.052)	(1.366)	(2.146)	(2.553)	(3.607)
Has a relative involved in a road crash (=1)	0.093**	0.030	1.554	2.275	2.070	3.226
	(0.041)	(0.040)	(1.814)	(1.500)	(2.910)	(2.149)
Uses the moto to commute to work (=1)	0.044*	0.068***	-0.124	0.071	0.411	0.758
	(0.025)	(0.019)	(0.770)	(0.583)	(1.278)	(0.851)
Uses the moto frequently (=1)	0.071***	0.053**	-2.450***	-0.676	-3.804***	-1.254
	(0.025)	(0.023)	(0.723)	(1.064)	(1.192)	(1.769)
Experienced a road crash × Uses the moto frequently	-0.151**	-0.125	4.425**	2.263	7.670*	4.119
	(0.073)	(0.080)	(2.176)	(2.129)	(4.330)	(4.422)
Prays daily (=1)	-0.142***	-0.069***	-1.300*	-1.059	-1.714	-1.420
	(0.024)	(0.023)	(0.771)	(0.759)	(1.285)	(1.208)
Experienced a road crash × Prays daily	0.094	0.065	5.128***	5.668**	9.639***	10.401**
	(0.087)	(0.072)	(1.811)	(2.210)	(3.484)	(4.183)
R^2 / R^2 within	0.077	0.048	0.028	0.017	0.026	0.018
Observations	*828*	*828*	*765*	*765*	*765*	*765*
Hausman test (p-value)						
OLS vs. FE	0.000		0.000		0.000	
FE vs. RE	0.003		0.088		0.061	

Notes: Robust standard errors are reported in parentheses. *** 1%, ** 5% and * 10% significance.
Remark: The difference in the number of observations comes from the fact that individuals who gave a zero probability of injury did not answer to the medical expenditure questions. Moreover some respondents who gave a non zero probability did not reply to the outcome questions.

Influence of previous interactions with the traffic police on fine expectations

I now turn to the influence of personal experiences on fine expectations. Besides previous police stops for infringing road rules, individuals' subjective probability of being stopped by the police for no reason and the possibility of bribing police officers are my variables of interest. The former may capture the discretionary power of the police and the latter the bargaining power of the motorcyclist.[20] Both can be considered as proxies for previous interactions with traffic forces and might impact individuals' subjective expectations. As previously, road exposure and religious practices are introduced in all regressions.

From Table 5.4, it appears that the random effects specifications should be preferred to the fixed effects estimations. Having been already sanctioned by the traffic police increases both the expected fines to be paid and the uncertainty with respect to the financial penalty. This latter effect may be explained by repeated sanctions of different amounts. Arbitraireness in the traffic police sanctions increases the subjective probability of being sanctioned if not using a helmet. As for individuals who think they can bribe police officers, they report significantly lower probabilities of being stopped by the police. This variable may thus actually capture how serious the traffic police is about enforcing road rules.

As for the effect of road habits and religious practices. Motorcyclists who use the motorbike to go to work report significantly higher probabilities of being caught by the police if not wearing a helmet. The observed differences between ordinary least square and fixed effect specifications indicate that differences in expectations may also come from actual differences in police enforcement intensity in each circle. Nonetheless, I acknowledge that this result may be simply caused by the small variation within a circle. In 11 circles, none of the respondents reports having been stopped by the traffic police.

[20] Expectations and opinion on the work made by the traffic police may actually be both related with a third variable which reflects the individual's acceptance of authorities and their power.

Table 5.4: Determinants of fine expectations

	subjective probability of police stop if no helmet			**subsequent outcomes**					
				expected costs			**interquartile range**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Specification	OLS	FE	RE	OLS	FE	RE	OLS	FE	RE
Has been sanctionned by the police (=1)	0.086*	0.032	0.045	0.598**	0.538*	0.548*	0.516**	0.469*	0.487*
	(0.046)	(0.035)	(0.034)	(0.244)	(0.297)	(0.298)	(0.214)	(0.273)	(0.271)
Discretionnary power of police	0.271***	0.189***	0.201***	0.281**	0.168	0.198	0.492***	0.206	0.258
	(0.041)	(0.061)	(0.059)	(0.123)	(0.198)	(0.190)	(0.144)	(0.243)	(0.230)
Police officers can be bribed (=1)	-0.045*	-0.041	-0.044*	-0.085	-0.126	-0.123	-0.093	-0.153	-0.149
	(0.023)	(0.025)	(0.025)	(0.081)	(0.100)	(0.097)	(0.084)	(0.100)	(0.100)
Uses the moto to commute to work (=1)	0.011	0.034*	0.033*	0.002	0.045	0.044	0.009	0.038	0.036
	(0.027)	(0.018)	(0.019)	(0.086)	(0.084)	(0.084)	(0.091)	(0.083)	(0.081)
Uses the moto frequently (=1)	0.029	0.038	0.035	-0.098	-0.051	-0.059	0.010	0.023	0.017
	(0.026)	(0.027)	(0.027)	(0.083)	(0.090)	(0.093)	(0.087)	(0.077)	(0.078)
Prays daily (=1)	-0.050**	-0.040	-0.042	-0.137	-0.006	-0.020	-0.224**	-0.120	-0.132
	(0.025)	(0.029)	(0.029)	(0.089)	(0.074)	(0.074)	(0.101)	(0.097)	(0.099)
R^2 / R^2 within / R^2 overall	0.076	0.050	0.025	0.030	0.028	0.026	0.041	0.028	0.034
Observations	*821*	*821*	*821*	*702*	*702*	*702*	*702*	*702*	*702*
Hausman test (p-value)									
OLS vs. FE	0.000			0.000			0.000		
FE vs. RE		0.105			0.687			0.751	

Notes: Robust standard errors are reported in parentheses. *** 1%, ** 5% and * 10% significance.

Remark: The difference in the number of observations comes from the fact that individuals who gave a zero probability of injury did not answer to the medical expenditure questions. Moreover some respondents who gave a non zero probability did not reply to the outcome questions.

5.5.2 To what extent do subjective expectations influence helmet adoption?

Empirical specification

I investigate here whether fear of injuries and police threat actually make motorcyclists adopt safer road behaviors, in particular toward helmet use.

Dependent variables

As already mentioned, in our survey, two traveling dimensions were considered for helmet use: the type of roads and the length of the motorbike trip. More precisely, three different circumstances were presented to the respondents: trips (i) in residential neighborhoods, (ii) on the main roads for short distances and (iii) on the main roads for long distances (> 15mn). While the first situation refers to narrow streets in residential or market areas, the two last cases correspond to travels on large boulevards where the traffic is often heavy. The richness of the data collected allows me to look at the role of different types of subjective expectations (medical expenditures vs. fines) on specific trip situations.

Variables of interest

My variables of interest are the products of the subjective probabilities of being hurt or stopped by the police if not wearing a helmet and the related subsequent expected costs. In addition to the argument presented in the previous section, this choice is motivated by the fact that no information regarding expected outcomes is available for people who gave a zero probability for the negative event to occur. I set the unconditional expected costs to zero for those individuals. For the subsample of individuals who gave a non zero probability of being injured and stopped by the police if they are not wearing a helmet, I decompose the unconditional expected cost in order to see if there is one of its dimensions ("frequency" vs. "severity") which drive the results I found. Furthermore, one may also argue that the variance in potential financial consequences is important in the motorcyclist's decision process. I thus include the interquartile range in the decomposition analysis. Finally, in my robustness checks, I consider higher values of the expected outcomes (75^{th} percentile and maximum) as the conduct adopted by motorcyclists might be rather related to the worst case scenario.

Local effects

When studying the relation between beliefs and behaviors, one may argue that local specificities may be correlated with individual's subjective expectations and eventually bias the estimates.[21] While some variables, such as the quality of roads, the incidence of road crash or the police presence, may impact helmet use only through their effect on subjective expectations; others may also have a direct effect on helmet use. For instance, the presence of private emergency services in the area is likely to be associated with the expected medical costs but may as well partly influence the consequences of an accident (through the quality of health care), impacting directly the

[21] This issue is actually not relevant when looking at the influence of risk aversion on road safety efforts (helmet use and choice of speed), as done in Grimm and Treibich (2014) (cf. Chapter 4). Indeed, in that case, it is rather the interviewers themselves who potentially influence the declared helmet use and the elicited risk aversion and not the local environment.

helmet use. As for neighbor's attitudes (social norms), they are likely to be correlated with one's behavior regardless of his subjective expectations but they may also induce a modification regarding the perceived consequences of helmet use.

Therefore, living, for instance, in a neighborhood where no one uses a helmet, may lower simultaneously helmet adoption by motorcyclists in the area and their subjective expectations of being caught by the police. This would lead to an underestimation of the true relation existing between subjective expectations and helmet adoption. On the contrary, the presence of private health centers may increase the medical expenditures individuals expect to pay in case of road injury but also decreases the helmet adoption as individuals may expect to receive particularly high quality care. This in turn would lead to an overestimation of the true coefficient. In other words, some unobservable characteristics at the geographical level are likely to be correlated with the independent regressors of interest and have a direct effect on the behaviors we attempt to explain. However, the direction of this bias is ambiguous.

Identification strategy

Similar to what I did to study the formation of subjective expectations, I take advantage of the administrative organization of Delhi to capture the local effects. Yet, before implementing this kind of empirical strategy, it is important to make sure that there is enough variation within circles; this, in order to avoid making hasty conclusions. Based on the analysis of the intra circle heterogeneity, it seems that dependent and independent variables vary quite substantially, even within one area (cf. Table 5.13 in Appendix A).

I therefore estimate the following specification:

$$\text{Helmet use}_{it} = \beta_m \cdot \text{UEC}_i^{med} + \beta_f \cdot \text{UEC}_i^{fine} + \sum_j \gamma_j \cdot X_{ij} + \mu_c + \varepsilon_{ict}$$

with i referring to the individual and t to the type of trip. Helmet use$_{it}$ is a binary variable. UEC_i^{med} and UEC_i^{fine} are the unconditional expected medical costs and the unconditional expected fines respectively. X_{ij} is a set of individual socio demographic characteristics. Finally, μ_c corresponds to the respondent's circle of residence.

I run fixed effect linear probability estimations, I thus obtain the effect of the variations in subjective expectations on helmet use within each police zone. I clustered all standard errors at that level to control for potential autocorrelation in the error terms. My variables of interest are the unconditional expected costs. I include several individual characteristics which are likely to be correlated with both subjective expectations and helmet adoption and which thus may bias my estimates. More precisely, I introduce gender, age, education level, marital status, number of children, household monthly income, personal contribution to the family revenues, religious beliefs, preferences toward risk and health insurance. Indeed, as pointed out in the section discussing the underlying mechanisms, these variables are likely to be correlated with helmet adoption (through the expected costs and gains of helmet use) and with individuals' beliefs regarding risk of injury and fine (through the likelihood that the person has already experienced a road crash or a police stop). Introducing police zone fixed effects in the estima-

tions allows me to capture the previously mentioned specificities of each area along with the behaviors adopted by respondents' neighbors and the socio economic status of each residential locality. However, as Manski (1993) pointed out, these various effects are difficult to disentangle. Indeed, people with similar tastes and characteristics may select themselves into the same circles. Therefore, the absence of significant impact of some of the explanatory variables might be actually due to their too limited variation within a circle. From Table 5.13 (cf. Appendix A), we note that for some of the socio demographic characteristics this may be a concern. Furthermore, while circle effects pick up part of the differences in actual risks faced by individuals in different neighborhoods, it does not annihilate them completely. This because of, for instance, different traveling hours, different routes taken or different driving skills of motorcyclists living in the same police zone.

Results

Table 5.5 presents the results found for the three types of trips considered. Police threat and fear of injuries appear to impact helmet use in different ways depending on the traveling situation considered. Indeed, it seems that subjective expectations with respect to fines increases helmet use on short distance trips. On the contrary, higher expected medical expenditures lead to a greater helmet adoption on long distance trips only.[22] More precisely a raise of 1,000 INR in the unconditional expected medical costs increases by 0.5 percentage points the probability that the person wears a helmet for long trips on main roads. A raise of 100 INR in the unconditional expected fines increases by respectively 7.7 and 4.9 percentage points the probability of using a helmet for short trips on main roads and trips in residential neighborhoods. From the Hausman test's results, it seems that the fixed effect specification should always be preferred to the ordinary least square estimation. When looking at helmet use on short distance trips on main roads, the random effect specification appears to provide more efficient estimates. One issue with linear probability estimations is that predicted value may be out of the probability range. This is actually the case for only 40 (6%), 13 (2%) and 11(1.7%) observations regarding respectively the helmet use on long distance trips on main roads, short distance ones and trips in residential areas.

Table 5.14 (cf. Appendix B) reports the results obtained for the additional explanatory variables introduced in the regressions presented in Table 5.5. Men are significantly more likely to use a helmet than women, while Sikhs are significantly less likely than motorcyclists belonging to other religious communities to use such protective device. More precisely, when considering long distance trips, the probability of using a helmet increases by 41 percentage points if the motorcyclist is a man and decreases by 27 percentage points if he or she is a Sikh. These findings are not surprising given that the Sikhs successfully lobbied against the use of helmet on the ground that it goes against their religious beliefs.[23] They managed to be exempted from this obligation by the Delhi government. De facto, the helmet law has not been enforced for any women due to the difficulty to distinguish a Sikh from a Hindu or a Muslim.[24] Having a health insurance has a significant and negative impact on helmet use only for long

[22] The results on the significance of unconditional expected medical costs on helmet use for long distance trips without and with robust standard errors differ very marginally, but the latter specification makes the coefficient passes above the 10% significance level.

[23] In addition to religious constraints, men belonging to the Sikh community can't wear simultaneously their turban and a helmet.

[24] This softness in the helmet mandatory law implementation came to an end since Septembre 2014. Indeed, traffic police began to prosecute

distance trips when not controlling for the circle of residence (Table not shown). The absence of effect of access to health care on helmet use may actually be explained by the inefficiency of ambulatory services. According to Hsiao et al. (2013), 58% of all road traffic injury deaths in India occur on the scene of the collision, either immediately or while waiting for the emergency ambulance to come. No effect of income or impact of education are detected. Finally, preferences toward risk don't appear to significantly influence motorcyclists behaviors.[25]

Table 5.5: Influence of expectations on helmet use - using unconditional expected costs (UEC)

Helmet use	**on main roads**		**trips in the**
	long trips	**short trips**	**neighborhoods**
	(1)	(2)	(3)
UEC medical expenditures (th. INR)	0.005^{+}	-0.000	0.001
	(0.003)	(0.004)	(0.004)
UEC fines (hund. INR)	0.011	$0.077^{\star\star\star}$	$0.049^{\star\star}$
	(0.018)	(0.018)	(0.023)
R^2	0.296	0.261	0.243
Observations	*670*	*673*	*665*
Hausman test (p-value)			
OLS vs. FE	0.000	0.000	0.000
FE vs. RE	0.000	0.161	0.000
Predicted values			
1^{st} percentile	0.248	0.047	-0.002
99^{th} percentile	1.071	1.024	0.094

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance.
Fixed effect linear probability estimations with clustered standard errors reported in parentheses. Controls are marital status, # of children, head of household, gender, age, income, education level, contribution to income, Sikh, caste, risk aversion, health insurance and existence of a superior force.

women riding two-wheelers without a helmet. Sick women are still exempted, but only if they were able to prove their identity (source: The Times of India, September 11, 2014).

[25] In a previous paper (Grimm and Treibich; 2014, cf. Chapter 4), the effect of risk aversion on helmet adoption was detected only in the sample of drivers. Contrary to the analysis made then, I gather in this analysis all types of motorcyclists.

Differentiated influence of expectations on helmet use

Some socio demographic characteristics of individuals are likely to modify the influence of subjective expectations on helmet adoption. In particular, women may be more sensitive to health issues and react more strongly to a given level of expected medical costs. Furthermore, absolute amounts of medical expenditures and fines have been elicited, yet poorer individuals may be more responsive to a given level of costs as it represents a bigger share of their income. Finally, more risk averse individuals may adopt safer behaviors than less risk averse motorcyclists to avoid the same amount of costs. In order to study such differentiated effects, I interact the unconditional expected costs with gender, level of income and preferences toward risk. Results when introducing or not the interaction between risk aversion and subjective expectations are really similar. I report the coefficients obtained when not introducing the latter interactions in Table 5.6 and the corresponding net effects of subjective expectations on helmet use for the different subgroups in Table 5.7. Interestingly when allowing for heterogenous effects between income and gender, I find that the probability of wearing a helmet in long distance trips increases by 2 percentage points if the level of unconditional expected medical costs rises by 1,000 INR for all women. No effect is detected for men. Similarly, for a same level of subjective medical costs poor women are more likely to use a helmet in short trips on main roads. An income gradient is found when introducing interaction terms between subjective expectations and levels of income. More precisely, poor and middle income individuals are less likely to wear a helmet than individuals belonging to wealthier household. Moreover, among the poorest individuals (31% of the sample), a raise of 100 INR in the unconditional expected fines increases the probability of wearing a helmet in short distance trips on main roads by 11 percentage points against an increase by only 7 percentage points among the wealthiest motorcyclists (17% of the sample). Subjective expectations of fines have a significant impact on helmet use in trips in the residential neighborhoods only among middle class individuals. Finally, the impact of unconditional expected fines on helmet use for short trips on main roads decreases with the level of risk aversion of motorcyclists (Table not shown). While one might expect that risk preferences and beliefs reinforce one another, this finding may be explained by the fact that preferences toward risk already partly influence the behavior of more risk averse motorcyclists, or that extremely risk averse individuals with high expected medical costs simply do not use this mode of transport and are de facto excluded from our survey.

Table 5.6: Differentiated influence of expectations on helmet use by gender, income and risk aversion

Helmet use	**on main roads**				**trips in the neighborhoods**	
	long trips		**short trips**			
	(1)	(2)	(3)	(4)	(5)	(6)
UEC medical expenditures (th. INR)	0.005^{+}	0.022*	-0.000	0.005	0.001	0.006
	(0.003)	(0.010)	(0.004)	(0.008)	(0.004)	(0.012)
UEC fines (hund. INR)	0.011	-0.022	0.077***	0.076**	0.049**	-0.016
	(0.018)	(0.044)	(0.018)	(0.035)	(0.023)	(0.037)
Male (=1)	0.409***	0.428***	0.414***	0.474***	0.390***	0.388***
	(0.052)	(0.057)	(0.061)	(0.060)	(0.070)	(0.062)
Male × UEC medical expenditures		-0.019**		-0.020**		-0.013
		(0.009)		(0.008)		(0.012)
Male × UEC fine		0.025		-0.002		0.030
		(0.046)		(0.040)		(0.033)
Household monthly income, *ref: Rich (above 20,000 INR)*						
Poor (less than 10,000 INR)	-0.013	-0.066	-0.095^{+}	-0.185**	-0.092	-0.164*
	(0.042)	(0.063)	(0.064)	(0.068)	(0.078)	(0.092)
Middle (between 10,000 and 20,000 INR)	-0.019	-0.044	-0.097**	-0.090^{+}	-0.062	-0.164***
	(0.038)	(0.046)	(0.040)	(0.053)	(0.049)	(0.058)
Poor × UEC medical expenditures		0.001		0.017**		0.008
		(0.005)		(0.007)		(0.011)
Middle × UEC medical expenditures		0.002		0.003		0.010
		(0.006)		(0.006)		(0.009)
Poor × UEC fines		0.045		0.039		0.050
		(0.031)		(0.032)		(0.044)
Middle × UEC fines		0.016		-0.015		0.082***
		(0.031)		(0.034)		(0.028)
Risk aversion (average, 8 points)	-0.009	-0.013	0.002	-0.000	0.001	-0.003
	(0.015)	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)
R^2	0.296	0.317	0.261	0.284	0.243	0.254
Observations	*670*	*670*	*673*	*673*	*665*	*665*

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance. Fixed effect linear probability estimations with clustered standard errors reported in parentheses. Controls are marital status, # of children, head of household, age, education level, contribution to income, Sikh, caste, health insurance and existence of a superior force.

Table 5.7: Influence of subjective expectations on helmet use - net effects for different subgroups

Helmet use	**on main roads**				**trips in the neighborhoods**	
	long trips		**short trips**			
	UEC medical costs	UEC fine	UEC medical costs	UEC fine	UEC medical costs	UEC fine
Rich women	0.022**	-0.022	0.005	0.076**	0.006	-0.016
	(0.010)	(0.044)	(0.008)	(0.035)	(0.012)	(0.037)
Rich men	0.003	0.003	-0.015***	0.074***	-0.007	0.014
	(0.004)	(0.029)	(0.005)	(0.027)	(0.009)	(0.037)
Middle class women	0.024**	-0.005	0.007	0.061^{+}	0.015	0.066**
	(0.009)	(0.044)	(0.010)	(0.040)	(0.014)	(0.031)
Middle class men	0.005	0.020	-0.012**	0.059**	0.002	0.095***
	(0.006)	(0.014)	(0.005)	(0.022)	(0.008)	(0.029)
Poor women	0.023**	0.023	0.021**	0.114***	0.014	0.034
	(0.009)	(0.037)	(0.009)	(0.032)	(0.015)	(0.038)
Poor men	0.004	0.048*	0.002	0.112***	0.001	0.063
	(0.004)	(0.024)	(0.006)	(0.029)	(0.008)	(0.043)

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance.

Household monthly income categories: Poor = less than 10,000 INR, Rich = above 20,000 INR.

Decomposing the unconditional expected costs

In the previous analysis, my variables of interest were the products between the subjective probabilities of being hurt or being stopped by the police when not using a helmet and their related subsequent costs. This choice was mainly driven by the fact that individuals who think that they will never be hurt in a road accident or stopped by the police if they don't use a helmet were not questionned about the possible financial consequences of these events. However, empirical evidence, consistent with prospect theory (Tversky and Kahneman; 1974), highlighted the fact that individuals tend to be overly responsive to low probabilities of high costs events. The reported probabilities may therefore already contain some overweighting. In other words, in this case, we should observe that individuals who declare higher subjective probabilities of injury or fine also report higher levels of costs. When looking at the pairwise correlation coefficients between subjective probabilities and subsequent costs, we note that this is true for police sanctions, individuals who think they have a higher probability of being stopped by the police also expect to pay a higher amount of fine. However, individuals who declare higher subjective probabilities of being hurt disclose lower medical costs. Furthermore, we are here interested in the impact of subjective expectations on individual behaviors and not on whether motorcyclists accurately estimate the probabilities injury or police halt occur.

For the subsample of respondent who provided a strictly positive probability of injury and fine, I am able to investigate the respective roles of subjective probabilities and subsequent outcomes on helmet adoption. This corresponds to excluding 104 individuals from the sample. In addition, one may argue that the variance of potential financial consequences is also a dimension which motivates the conduct adopted by motorcyclists. Therefore, I also included the interquartile range in the specification to study the influence of variance and lack of information regarding possible losses on individuals' risky behaviors.

Table 5.8 presents the results found. When comparing coefficients of unconditional expected costs obtained with the full sample (Table 5.5) and the restricted one (cf. Table 5.8 – columns 1, 4 and 7), we see that stronger effects are obtained with the latter sample either in terms of significance of the coefficient (for long distance trips) or in terms of its magnitude (for short distance trips). When looking at the respective effect of "frequency" (subjective probabilities) and "severity" (expected costs) dimensions (cf. columns 2, 5 and 8), we note that it is the expected costs which actually drive the relations previously detected. Finally, when introducing the dispersion dimension (cf. columns 3, 6 and 9), I find that an increase of 1,000 INR in the expected medical expenditures increases by 1.5 percentage points the probability of wearing a helmet in long distance journeys. On the contrary, a similar increase in the variance regarding such costs decreases by 0.7 percentage points the probability that the motorcyclist adopt a safe behavior. Comparable relations between subjective medical costs and helmet use are found in short distance trips on main roads. Regarding expected fines, in both short distance trips on main roads and trips in residential neighborhoods, the lack of information regarding the amount to pay drives the individual's behavior. More precisely, an increase in 100 INR of the dispersion in the fine boosts the probability of using a helmet by around 6 percentage points. The coefficient of expected financial cost is then no longer significant.

Table 5.8: Influence of expectations on helmet use - non zero probability sample

Helmet use	**on main roads**						**trips in the neighborhoods**		
	long trips			**short trips**					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UEC medical expenditures (th. INR)	0.005*			0.000			0.002		
	(0.003)			(0.003)			(0.004)		
UEC fines (hund. INR)	0.001			0.085***			0.059***		
	(0.016)			(0.020)			(0.022)		
Subjective probability of injury		0.077	0.085		-0.164	-0.158		0.064	0.051
		(0.062)	(0.065)		(0.142)	(0.141)		(0.120)	(0.116)
Expected medical costs (th. INR)		0.003*	0.015**		0.002	0.017**		-0.000	-0.012
		(0.002)	(0.007)		(0.003)	(0.007)		(0.003)	(0.008)
IQR of medical costs (th. INR)			-0.007*			-0.008**			0.007
			(0.004)			(0.004)			(0.004)
Subjective probability of police stop		-0.001	-0.003		0.163	0.163		-0.004	-0.003
		(0.052)	(0.050)		(0.103)	(0.102)		(0.071)	(0.073)
Expected fine (hund. INR)		-0.013	-0.020		0.065***	0.013		0.075***	0.028
		(0.023)	(0.033)		(0.014)	(0.030)		(0.022)	(0.034)
IQR of fine (hund. INR)			0.008			0.061**			0.056**
			(0.026)			(0.026)			(0.024)
R^2	0.262	0.264	0.269	0.244	0.253	0.265	0.223	0.231	0.239
Observations	*589*	*589*	*589*	*591*	*591*	*591*	*583*	*583*	*583*

Notes: *** 1%, ** 5% and * 10% significance. Fixed effect linear probability estimations with clustered standard errors reported.
Controls are marital status, # of children, head of household, gender, age, income, education level, contribution to income caste, risk aversion, health insurance and existence of a superior force. IQR stands for interquartile range and captures the dispersion in the outcome.

Robustness checks

In order to provide evidence for the reliability of my results, I implement different robustness checks, the results of which are reported hereinafter.

Considering alternative information of the expected outcomes' distribution

One may argue that it is the highest possible values with respect to potential financial consequences (i.e. the costs corresponding to the worst case scenario the individual has in mind), rather than its expected level, which motivates the conduct adopted by motorcyclists. When replacing expected costs by the 75^{th} percentile or the maximum value, I find similar results regarding the influence of subjective expectations on helmet use (cf. Table 5.15, Appendix C).

Tackling the reverse causality issue

A main concern regarding the previous results is the possibility that individuals who decide not to wear a helmet may report lower expectations of negative consequences in order to reduce the stress induced by the behaviors they choose to adopt. This effect is known as cognitive dissonance and has been first highlighted by Akerlof and

Dickens (1982). In order to tackle the reverse causality issue previously mentioned, I try to show that helmet use does not cause subjective expectations regarding injury or fine. I take advantage of a regulation implemented in Delhi since July 2009 that makes it compulsory to provide a helmet with every new motorbike that is sold. I regress helmet use on unconditional expected costs instrumenting the former variable by mandatory helmet provision. More precisely, the instrument takes value one if the respondent is a driver and rides a motorbike purchased first hand less than two years ago. I assume that this variable is indeed exogenous and unrelated with any omitted variable. Results presented in Table 5.16 (Appendix D) show that helmet adoption does not explain fine or injury expectations and that the instrumental variable (helmet provision) is positively and significantly correlated with the endogenous regressor (helmet use). More precisely the F-statistics takes values from 12 to 18 conditional on the circumstances of the trip.

Individual omitted characteristics

I acknowledge that some individual's characteristics (such as optimism, overconfidence regarding one's driving skills, preference for present, level of speed or road habits) still remain unobserved and might bias my results. Optimism, for instance, is likely to reduce the subjective probability of accident and the size of injury. Similarly, overconfident drivers are likely to think they are able to avoid both police officers and road crashes. These two characteristics, so far unobserved, are negatively correlated with subjective expectations regarding the usefulness of a helmet. On the contrary, the velocity at which motorcyclists travel may influence both subjective expectations of medical expenditures and helmet adoption. Speed certainly increases the probability of accident and the severity of injuries. If low speed and helmet use are substitutes,[26] individuals with high subjective expectations of injuries may decide to reduce their speed instead of wearing a helmet. The estimates would in that case be an overestimation of the true relation between beliefs and head protection use. As for the absence, in the formulation of the question, of a clear time horizon to be considered by the respondent when answering to the likelihood of being hurt in a road crash, I acknowledge that comparability between individuals might be problematic. As pointed before, some may refer to the next trip while others think about their entire life time. The absence of time horizon would jeopardize my results if individuals who refer to a really short time horizon are different than those who consider their whole life. One may argue that present oriented individuals may be more likely to refer to the next motorbike trip and then may report lower probabilities of injuries. If preference for the present is negatively correlated with subjective expectations (and not included in the analysis) then the estimate of unconditional expected medical costs on helmet use will be an underestimation of the true relation.

In Table 5.17 (Appendix E), I add the following variables to the previous specifications: average speed (Panel 1), road habits (Panel 2), preference for present (Panel 3) and confidence on one's driving skills (Panel 4, restricted to the drivers subsample).

A significant relation between subjective expected medical costs and helmet use in long distance trips appears when average speed is introduced in the specification. In addition, we note that subjective expectations of fines

[26] In the previous article Grimm and Treibich (2014) (cf. Chapter 4), we provide evidence regarding the relation between these two safety behaviors.

also increase helmet use on long distance trips when average speed or confidence are included in the regressions. Similar results as the ones previously presented are found regarding the influence of subjective expectations of fines on helmet adoption in the two types of short distance journeys. One issue raised when discussing the relation between subjective expectations regarding injuries and safety effort was the possible link between individuals' preferences for present and the time horizon they considered when answering to the probability of being hurt in a road crash. Nonetheless, when introducing preference for present in the regression as additional control, results found previously are not modified. Regarding the impact of the previously omitted variables on helmet adoption, speed appears to be positively correlated with helmet use on long travels. Individuals who frequently use a motorbike are significantly more likely to wear a helmet when traveling on main roads. Finally, drivers who believe they drive better than others are less likely to use a helmet for long trips or trips in neighborhoods. In this latter case, risk aversion is found to be positively correlated with helmet use on main roads. To conclude, adding these different characteristics leads to a reduction of the sample but findings are consistent with the previous results providing that my attempts to control for omitted local environmental variables have already given reliable estimates.

Excluding individuals who did not seem to understand the probability scale

The understanding, by all respondents, of the probability scale used to derive subjective probabilities may be questioned. Before eliciting subjective expectations of probabilities and outcomes regarding injury and fine, several questions were asked to interviewees in order to be able to verify whether they properly understood the probability scale (cf. Appendix F). I compare the results reported in Table 5.5 to the coefficients obtained if excluding individuals who did not correctly answered to the check questions (see Table 5.19). Similar findings of the influence of subjective expectations on helmet adoption are found for the different samples considered (excluding individuals who answered incorrectly to one or several check questions). The magnitude of the effects are quite constant across samples: a raise of 100 INR in the unconditional expected fines increases by around 7 percentage points (from 6.3 to 7.9) the probability of wearing a helmet in short distance trips on main roads and by 5 percentage points (from 4.8 to 5.2) the probability of using a helmet in residential neighborhoods.

On the direct influence of experiences on helmet use

When studying the formation of subjective expectations, I have assumed that previous experiences related to road risks only influence helmet adoption through expectations, these being updated based on the new information the individual gets from a road traffic accident or a police stop.

Nonetheless, the event *per se* is likely to impact the safety conduct adopted by motorcyclists. Haselhuhn et al. (2012) used data on video rental fines and showed that, controlling for the level of information regarding the financial sanctions of a delay in returning the video, previous experience with a fine significantly improved the future compliance rate. Using the same specification as the one presented in Table 5.5, I introduce road crash and police stop as explanatory variables along with interaction terms between (i) road accident and unconditional expectated

medical costs and (ii) police stop and unconditional expected fines. From Table 5.9, we note that the effect of injury expectations on helmet use for short trips appears to be lower among individuals who have been involved in a traffic accident. The effect of fine expectations on helmet use for trips in the residential neighborhoods among individuals who have been caught by the traffic police doubles compared to its effect among those who have never been in that situation. This last result shows the importance of combining information and enforcement to make motorcyclists adopt safe behaviors.

Table 5.9: Differentiated influence of expectations on helmet use by previous experiences

Helmet use	**on main roads**				**trips in the neighborhoods**	
	long trips		**short trips**			
	(1)	(2)	(3)	(4)	(5)	(6)
UEC medical expenditures (th. INR)	0.005	0.005	-0.000	0.000	0.001	0.002
	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)	(0.005)
UEC fines (hund. INR)	0.010	0.007	0.076***	0.085***	0.050**	0.031
	(0.018)	(0.023)	(0.018)	(0.021)	(0.023)	(0.026)
Road crash (=1)		-0.049		-0.015		-0.097
		(0.059)		(0.061)		(0.064)
Road crash × UEC medical expenditures		-0.002		-0.010**		0.002
		(0.005)		(0.004)		(0.005)
Police stop (=1)		0.030		0.047		-0.112
		(0.050)		(0.072)		(0.095)
Police stop × UEC fines		0.009		-0.041		0.080**
		(0.026)		(0.031)		(0.030)
R^2	0.287	0.289	0.259	0.262	0.242	0.248
Observations	*662*	*662*	*665*	*665*	*657*	*657*

Notes: *** 1%, ** 5% and * 10% significance.
Fixed effect linear probability estimations with clustered standard errors reported.
Controls are gender, marital status, # of children, head of household, age, education level, income, contribution to income, Sikh, caste, risk aversion, health insurance and existence of a superior force.

5.6 Policy implications

In order to be able to formulate policy recommendations, I now consider different road safety policies which are likely to influence individuals' subjective expectations of injuries and fines when not wearing a helmet, and estimate their impact with respect to helmet use.

5.6.1 Raising subjective expectations of fines

I first study policies which impact subjective expectations of fines if infringing the helmet law, either through the information on the official level of fine, its perceived enforcement or its level *per se*.

In order to simulate policies and estimate their impact on helmet adoption, I run probit specifications with circle dummies clustering standard errors at the police zone level. Results obtained, both in terms of significance and magnitude, are very similar to those obtained with the fixed effect linear probability model. I report them in the Appendix G, Table 5.20. Based on these probit estimations, Table 5.10 reports the estimated impact on helmet use if motorcyclists perfectly know the current level of fine (Scenario 1), if the official fine is raised up to 500 INR (Scenario 2), if individuals perfectly know the current level of fine and expect to always be caught by the police when not wearing a helmet (Scenario 3), and if perfect enforcement and information is associated with a higher official fine of 500 INR (Scenario 4). The chosen multiplicator factor of fines (×5) coincides with an amendment of the Motor Vehicle Act currently under discussion in the Indian Parliament. As expected from the empirical analysis, larger gains regarding helmet adoption are obtained on short distance trips, in particular on main roads. The limited increase in helmet use for longer trips can be explained both by a bigger role of expected injuries in this particular decision and by the smaller room for improvement in this type of trip. A larger impact is found when raising the official fine substantially. More precisely, scenarios 2 and 4 lead to an increase of 25% to 40% of helmet use for short distance trips.

When comparing previous police stops experienced by respondents with administrative traffic police data, we note that the number of offences for not using a helmet in 2011 per police zone is positively correlated with the share of respondents living in that area who declare they have been stopped by the police for infringing the helmet law. According to these figures, it seems important not only to publicize the financial penalties individuals may face when not using a helmet but also to increase the actual enforcement of helmet legislation. Similar findings are found by Lu et al. (2012). These authors implemented a randomized experiment in China and showed that telling drivers that they have been catched by the electronic devices deters them from infringing the road rules in the future while providing them with information on the likelihood of punishment does not. The acceptance and efficiency of such repressive rules depend also on the way they are implemented. Information prior the change of traffic sanctions and a period where road users are stopped by the police but not sanctioned are key for individuals to accept the offence and its amount.

Table 5.10: Estimated helmet use for changes in expectations of fines

Helmet use	on main roads: for long trips	on main roads: for short trips	for trips in the neighborhood
observations	*610*	*663*	*660*
Current UEC fines (INR)	90	93	93
Declared helmet use (%)	78.20	59.58	53.03
Declared - predicted helmet use (average)	-0.003	-0.004	-0.005
% change in helmet use			
Scenario 1 EC = 100 INR	+ 0.14%	- 3.12%	- 1.36%
Scenario 2 EC = 500 × info. coeff.	+ 2.33%	+ 23.36%	+ 25.12%
Scenario 3 UEC = 100 INR	+ 0.41%	+ 2.55%	+ 1.53%
Scenario 4 UEC = 500 INR	+ 2.85%	+ 49.56%	+ 32.43%

Notes: Computations based on probit regression with circle dummies (cf. Table 5.20).
Scenario 1: perfect information, individuals expect to pay 100 INR, i.e. the official fine.
Scenario 2: raising the official fine up to 500 INR, but keeping enforcement and information level as it is.
Scenario 3: perfect information and enforcement with current level of fine.
Scenario 4: perfect information and enforcement with an official fine at 500 INR.

5.6.2 Raising subjective expectations of medical expenditures

I now focus on different scenarios of subjective expectations of medical costs and relate them to policies such as awareness campaigns regarding the road mortality rate or the usefulness of a helmet.

I unfortunately don't have access to any official data regarding the actual health expenditures road victims have to pay. I therefore simply consider different scenarios with increasing unconditional expected medical costs and estimate the helmet use associated to each of these levels of expenditures for different motorbike trips. Table 5.11 reports the simulated change in percentage of use. While no increase in the share of motorcyclists wearing a helmet is found on short distance trips, doubling the expectations of injury costs (from 2,400 to 5,000 INR) raises the use of a head protection device for long distance trips by 0.5 percentage points. A share of 98.2% of motorcyclists using a helmet in long distance trips, implying an increase of 20 percentage points, is obtained when multiplying by 20 the individuals' beliefs. These results suggest that awareness campaigns stressing the high cost of road injuries in case of an accident and in particular if not using a helmet might be useful to increase helmet use among motorcyclists in Delhi. Lewis et al. (2007) summarized the literature on road safety media campaigns and concluded that the impact of shocking advertisement is rather mixed and inconsistent. Fear campaigns must therefore be used with caution. Using factual information or humor might be alternative options.

Finally, highlighting the risk one faces even in short distance trips could raise the use of helmets among individuals who use a motorbike only in the vicinity of their homes or who wear a head protection only in long distance journeys. When imputing the estimated impact of unconditional expected medical costs found for long trips to helmet use on short distance ones (scenario 8), it appears that if individuals thought that short distance journeys imply similar health risks as longer trips, an increase of around 6% in the share of individuals who use a helmet would be observed.

Table 5.11: Estimated helmet use for changes in expectations of medical expenditures

	on main roads		for trips in
Helmet use	for long trips	for short trips	the neighborhood
observations	*610*	*663*	*660*
Current UEC medical expenditures (INR)	2,408	2,704	2,755
Declared helmet use (%)	78.20	59.58	53.03
Declared - predicted helmet use (average)	-0.003	-0.004	-0.005
% change in helmet use			
Scenario 5 UEC = 5,000 INR	+3.04%	+0.82%	+1.21%
Scenario 6 UEC = 10,000 INR	+7.40%	+0.99%	+1.79%
Scenario 7 UEC = 50,000 INR	+25.63%	+2.40%	+6.56%
Scenario 8 $\hat{\beta}^{long}_{UECinj}$	-	+4.63%	+6.54%

Notes: Computations based on probit regression with circle dummies (cf. Table 5.20).

5.7 Conclusion

Road mortality is a growing burden in many developing countries. To counteract this trend, an increasing number of low and middle income countries have started to implement mandatory helmet regulations. Yet, helmet use remains low in a majority of African and Asian countries, where motorcyclists represent an important share of both traffic mix and road casualties. Understanding the mechanisms leading to the adoption of a helmet by motorcyclists is therefore key to implement efficient safety measures in these regions.

This paper studies motorbike users' decisions whether to wear a head protection or not, using original data collected in a low income country metropolitan city, New Delhi.

I first explore the factors which may explain the observed differences in beliefs across individuals and show that road exposure and previous experiences of road related risks impact the formation of motorcyclists' beliefs. Nonetheless, differences across individuals seem also to come from differences in actual health hazards and police enforcement intensity.

In a second step, I study the impact of subjective expectations of injury and fine on helmet adoption; this, in various traveling situations differing by the length of the trip and the type of roads taken. Both fear of injuries and police threat are indeed likely to play a role in the safety conduct adopted by motorcyclists.[27] I therefore investigate whether one type of belief is more likely to be associated with the adoption of a helmet for a specific type of travel. In the empirical analysis, I find that while expectations regarding medical expenditures increase the adoption of helmet on long distance trips on main roads, it is rather the threat of police sanctions which explains helmet use on short distance journeys. Differentiated effects are found for helmet use on short distance trips on main roads between gender and income groups. In particular, expected medical costs impact the decision of using a helmet for women but not for men. Moreover, the influence of financial penalties varies across income groups, richer individuals being less sensitive to fines. This is not surprising as sanctions represent a smaller share of wealthier individuals' revenues.

In view of designing policies, various measures impacting expectations of injury or fine have been considered and their impact on helmet use have been assessed. Based on these predictions, different policy directions can be suggested. First, the increase of police threat through enforcement, information or fine levels should increase helmet use in short distance journeys. As a matter of fact, combining these measures should be even more effective. Second, information campaigns stressing the usefulness of a helmet to avoid severe injuries (implying important health expenditures) even for motorbike trips nearby one's home are also likely to make motorcyclists adopt safer conducts.

[27] By using the slogan *"Protect yourself from hefty fines and serious injuries. Wear a helmet."* in its 2012 road safety campaign, the Cambodian government actually intented to impact both dimensions.

5.8 Appendices

Appendix A. Variation within circles

Table 5.12: Variation within circles - previous experiences and expectations

	Observations			Mean	Standard deviation			# of circles without
	N	n	T-bar	overall	overall	between	within	variation†
EXPECTATIONS								
Probability of injury◇	836	32	26.13	0.58	0.31	0.20	0.26	0
Expected medical costs (in INR)	772	32	24.13	5,189	9,012	4,217	8,013	0
IQR of medical costs (in INR)	772	32	24.13	6,718	15,039	6,162	13,763	0
Probability of police stop◇	878	32	27.44	0.65	0.34	0.20	0.29	1
Expected fines (in INR)	760	32	23.75	129	103	60	85	0
IQR of fines (in INR)	760	32	23.75	112	109	67	92	0
PREVIOUS EXPERIENCES								
Experienced a road crash (%)	836	32	26.13	7.04	26.22	7.46	25.44	11
Has a relative involved in a road crash (%)	836	32	26.13	6.70	25.01	12.39	23.39	15
Has been sanctionned by the police (%)	867	32	27.09	7.04	25.59	9.81	24.85	11
Discretionnary power of police◇	841	32	26.28	0.36	0.30	0.19	0.25	1
Police officers can be bribed (%)	869	32	27.16	36.48	48.16	21.86	44.59	1
ROAD HABITS								
Uses the moto to commute to work (%)	833	32	26.03	65.07	47.70	14.35	46.09	0
Uses the moto frequently (%)	835	32	26.09	44.55	49.73	20.27	46.70	0
RELIGIOUS PRACTICES								
Prays daily (%)	832	32	26	71.80	44.93	16.80	42.21	1

Notes: T-bar is the average number of respondents per circle (N/n). † Total number of circles is 32.

◇ This variable takes values from 0 to 1.

Table 5.13: Variation within circles - expectations and helmet use

	Observations			Mean	Standard deviation			# of circles without
	N	n	T-bar	overall	overall	between	within	variation†
HELMET USE								
Long trips on main roads (%)	670	32	20.94	80.15	39.92	12.62	38.03	4
Short trips on main roads (%)	673	32	21.03	59.44	49.14	24.05	44.86	2
Trips in neighborhoods (%)	664	32	20.75	53.46	49.92	21.36	46.56	2
EXPECTATIONS								
UEC medical costs (INR)	673	32	21.03	2,729	5,087	2,357	4,636	0
UEC fines (INR)	673	32	21.03	93	102	58	86	0
SOCIO-DEMOGRAPHICS								
Male (%)	673	32	21.03	69.54	46.06	14.78	44.18	2
Age (in years)	673	32	21.03	36.01	12.86	4.42	12.48	0
Level of education (3 groups)	673	32	21.03	2.26	0.65	0.40	0.60	2
Household monthly income								3
less than 10,000 INR (%)	673	32	21.03	32.84	47.00	28.96	41.66	
10,000 to 20,000 INR (%)	673	32	21.03	34.47	47.56	20.85	43.99	
above 20,000 INR (%)	673	32	21.03	16.94	37.54	18.80	33.78	
Share of one's contribution to income$^{\diamond}$	673	32	21.03	0.38	0.38	0.13	0.37	0
Head of HH (%)	673	32	21.03	38.48	48.69	14.90	47.73	1
Married (%)	673	32	21.03	72.96	44.45	11.70	43.21	0
Number of children	673	32	21.03	1.47	1,32	0.47	1.27	0
Sikh (%)	673	32	21.03	4.31	20.32	11.04	18.68	22
Belongs to a low caste (%)	673	32	21.03	37.30	48.40	26.85	43.91	5
Believes his life is in god's hands (%)	673	32	21,03	89.90	30.16	9.93	28.77	15
Risk aversion score$^{\diamond\diamond}$	673	32	21.03	2.72	0.78	0.43	0.70	0
Has a health insurance (%)	673	32	21.03	12.93	33.58	14.71	31.76	7

Notes: T-bar is the average number of respondents per circle (N/n). This table shows the statistics for the sample used in my analysis. $^{\diamond}$ this variable takes values from 0 to 0.9. $^{\diamond\diamond}$ the risk aversion score takes values from 1 to 4. † Total number of circles is 32.

Appendix B. Additional explanatory variables

Table 5.14: Influence of expectations on helmet use - complete set of independent variables

Helmet use	**on main roads**		**trips in the**
	long trips	**short trips**	**neighborhoods**
	(1)	(2)	(3)
UEC medical expenditures (th. INR)	0.005^{+}	-0.000	0.001
	(0.003)	(0.004)	(0.004)
UEC fines (hund. INR)	0.011	$0.077^{\star\star\star}$	$0.049^{\star\star}$
	(0.018)	(0.018)	(0.023)
Risk aversion (average, 8 points)	-0.009	0.002	0.001
	(0.015)	(0.013)	(0.014)
Male (=1)	$0.409^{\star\star\star}$	$0.414^{\star\star\star}$	$0.390^{\star\star\star}$
	(0.052)	(0.061)	(0.070)
Married (=1)	-0.002	0.044	0.014
	(0.045)	(0.057)	(0.072)
# of children	0.003	-0.007	-0.014
	(0.016)	(0.016)	(0.019)
Head of the household (=1)	0.004	0.043	0.059
	(0.042)	(0.048)	(0.050)
Age (in years)	-0.003	-0.002	-0.002
	(0.002)	(0.002)	(0.001)
Level of education (3 groups)	-0.009	0.047^{+}	0.053^{+}
	(0.028)	(0.029)	(0.032)
Household monthly income, *ref: less than 10,000 INR*			
between 10,000 and 20,000 INR	-0.006	-0.002	0.030
	(0.041)	(0.046)	(0.053)
more than 20,000 INR	0.013	0.095+	0.092
	(0.042)	(0.064)	(0.078)
Share of one's contribution to income	0.045	0.004	0.055
	(0.072)	(0.086)	(0.079)
Sikh (=1)	$-0.272^{\star}$	-0.221^{+}	-0.217^{+}
	(0.141)	(0.142)	(0.133)
Belongs to a low caste (=1)	-0.034	$-0.080^{\star}$	-0.063
	(0.042)	(0.045)	(0.054)
Has health insurance (=1)	-0.010	-0.018	-0.048
	(0.025)	(0.046)	(0.053)
Believes fate is in god's hands (=1)	0.006	-0.061	-0.126
	(0.030)	(0.077)	(0.085)
R^2	0.296	0.261	0.243
Observations	*670*	*673*	*665*

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance. Clustered standard errors are reported in parentheses.

Appendix C. Highest values of expected costs

Table 5.15: Influence of expectations on helmet use - using alternative distribution's information

Helmet use	**on main roads**		**trips in the**
	long trips	**short trips**	**neighborhoods**
	(1)	(2)	(3)
UP75 medical expenditures (th. INR)	0.002	-0.001	0.002
	(0.002)	(0.002)	(0.002)
UP75 fines (hund. INR)	0.106	0.591***	0.377*
	(0.134)	(0.148)	(0.157)
Risk aversion (average, 8 points)	-0.010	0.001	0.000
	(0.015)	(0.013)	(0.014)
R^2	0.295	0.265	0.246
Observations	*670*	*673*	*665*
Hausman test (p-value)			
OLS vs. FE	0.000	0.000	0.000
FE vs. RE	0.000	0.224	0.000
UMAX medical expenditures (th. INR)	0.001^{+}	0.000	-0.000
	(0.001)	(0.001)	(0.001)
UMAX fines (hund. INR)	0.072	0.478***	0.287***
	(0.107)	(0.127)	(0.123)
Risk aversion (average, 8 points)	-0.010	0.000	-0.000
	(0.015)	(0.013)	(0.014)
R^2	0.298	0.268	0.244
Observations	*670*	*673*	*665*
Hausman test (p-value)			
OLS vs. FE	0.000	0.000	0.000
FE vs. RE	0.000	0.015	0.000

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance. Clustered standard errors are reported in parentheses. Controls are marital status, # of children, head of household, gender, age, income, education level, contribution to income, Sikh, caste, risk aversion, health insurance and existence of a superior force.

Appendix D. Tackling reverse causality

Table 5.16: Reverse causality tests

	UEC inj. (1)	UEC fine (2)	UEC inj. (3)	UEC fine (4)	UEC inj. (5)	UEC fine (6)
Helmet use						
Long trips on main roads	1.860	1.188				
	(9.388)	(1.796)				
Short trips on main roads			0.7309	0.404		
			(3.213)	(0.595)		
Trips in the neighbourhood					2.335	0.905
					(6.993)	(1.298)
observations	*670*	*670*	*673*	*673*	*665*	*665*

	on main roads		for trips in neighborhoods
	for long trips	for short trips	
First stage			
Helmet provision (=1) †	0.062***	0.182***	0.092*
	(0.021)	(0.044)	(0.054)
Weak identification test ‡	8.901	16.900	2.861
F statistic	12.08***	15.985***	17.95***
R^2	0.281	0.236	0.252
observations	*670*	*673*	*665*

Notes: *** 1%, ** 5% and * 10% significance. Controls are marital status, # of children, head of hh, gender, age, income, education level, contribution to income caste, risk aversion, health insurance and existence of a superior force. † helmet provision is a dummy variable which takes value 1 if the respondent is a driver and rides a moto purchased in first hand less than 2 years ago and 0 otherwise. ‡ Kleibergen-Paap rk Wald F statistic.

Appendix E. Individual omitted variables

Table 5.17: Influence of expectations on helmet use - using alternative distribution's information

Helmet use	**on main roads**		**trips in the**
	long trips	**short trips**	**neighborhoods**
	(1)	(2)	(3)
Panel 1 - adding average speed			
UEC medical expenditures (th. INR)	0.007**	-0.001	0.001
	(0.003)	(0.004)	(0.005)
UEC fines (hund.INR)	0.038***	0.085***	0.058**
	(0.013)	(0.016)	(0.028)
Average speed	0.002***	-0.001	0.000
	(0.001)	(0.001)	(0.001)
R^2	0.317	0.267	0.237
Observations	*525*	*527*	*522*
Panel 2 - adding road habits			
UEC medical expenditures (th. INR)	0.005+	-0.000	0.001
	(0.003)	(0.004)	(0.004)
UEC fines (hund.INR)	0.010	0.075***	0.048**
	(0.018)	(0.018)	(0.023)
Uses the moto frequently (=1)	0.064*	0.092*	0.050
	(0.032)	(0.047)	(0.045)
Uses the moto to commute to work (=1)	0.028	0.018	0.022
	(0.031)	(0.048)	(0.037)
R^2	0.299	0.267	0.244
Observations	*668*	*671*	*663*
Panel 3 - adding preference for present			
UEC medical expenditures (th. INR)	0.004	0.001	0.002
	(0.003)	(0.004)	(0.005)
UEC fines (hund.INR)	0.005	0.072***	0.045**
	(0.017)	(0.019)	(0.021)
Present oriented (=1)	-0.023	0.080*	0.015
	(0.037)	(0.040)	(0.040)
R^2	0.328	0.274	0.243
Observations	*626*	*629*	*621*
Panel 4 - adding confidence on one's skills (sample of drivers)			
UEC medical expenditures (th. INR)	0.003	-0.002	0.001
	(0.002)	(0.004)	(0.005)
UEC fines (hund.INR)	0.012+	0.069***	0.064**
	(0.008)	(0.022)	(0.027)
Risk aversion (8 point scale)	0.023*	0.022+	0.024
	(0.011)	(0.013)	(0.017)
Thinks he has a better driving skills than	-0.043**	-0.027	-0.073*
other drivers (=1)	(0.020)	(0.040)	(0.041)
R^2	0.244	0.148	0.148
Observations	*393*	*393*	*389*

Notes: *** 1%, ** 5%, * 10% and + 15% significance. Clustered standard errors are reported in parentheses. Controls are marital status, # of children, head of household, gender, age, income, education level, contribution to income, Sikh, caste, risk aversion, health insurance and existence of a superior force.

Appendix F. Excluding individuals who did not undestand the probability scale

Five general questions were asked to respondents in order to control for their understanding of the scale.

First, we check the understanding of the probability concept:

1. *"Imagine I have 5 balls, one of which is red and four of which are blue. If you pick one of these balls without looking, how likely it is that you will pick the red ball?"* - variable named "red ball" below.

Two nested questions were also asked:

2. *"How likely are you to go to the market sometime in the next two days?"* - variable named "2 days" below.
3. *"How likely are you to go to the market sometime in the next two weeks?"* - variable named "2 weeks" below.

The variable called "nested" takes value 1 if the individual gave consistent answers to above two questions.

Finally, we aimed at check whether the entire scale was used by the respondent and therefore asked about events for which everybody should reply the extreme values of the scale:

4. *"How likely do you think it is that you will go out of the house for any reason in the next month?"* - variable named "outside" below. This question turned out to be misleading, while we meant outside the house, some respondents understood out of the city. This confusion explain the unexpected results presented in Table 5.19.
5. *"How likely is it that Christmas will fall in the month of June?"* - variable named "christmas" below.

Only 4 respondents have no correct answer. 52% of interviewees provided only one or no inconsistent answer. 36% gave two consistent replies out of four.

Table 5.18: Check questions

	probability concept	**nested questions**		**extreme values**	
	red ball	2 days	2 weeks	outside	christmas
event will not happen (%)	3.05	2.83	1.36	6.59	**96.06**
1	8.77	3.28	1.36	6.14	0.48
2	**24.24**	4.87	1.25	4.89	0.48
3	9.99	3.74	3.28	2.05	0
4	15.35	3.96	2.60	1.14	0.48
5	26.55	12.46	6.46	7.61	1.08
6	5.97	4.53	4.19	3.07	0
7	2.68	7.47	8.61	6.02	0
8	1.34	8.04	9.29	8.07	0.36
9	0.37	4.87	6.91	6.59	0.12
event will happen	1.71	43.94	54.7	**47.84**	0.96
Share of correct answers	24.24	84.60		47.84	96.06
observations	*821*	*883*	*883*	*880*	*837*

Notes: In bold are indicating the share of individuals who provide the expected answer to each question.
Remark: 84.60% of respondents said that the probability that they will go to the market in the next two weeks was higher or equal as the probability they will go within two days.

Table 5.19: Keeping individuals who understood the probability scale

Sample	all (1)	christmas (2)	nested (3)	outside (4)	christmas OR nested (5)	christmas AND nested (6)
Panel A: Helmet use for long trips on main roads						
UEC medical expenditures (th. INR)	0.005^{+}	0.005	0.005	0.001	0.005	0.005^{+}
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)
UEC fines (hund. INR)	0.011	0.006	0.006	0.011	0.006	0.000
	(0.018)	(0.018)	(0.019)	(0.032)	(0.018)	(0.018)
R^2	0.296	0.280	0.287	0.441	0.290	0.279
Observations	*670*	*629*	*552*	*306*	*647*	*521*
Panel B: Helmet use for short trips on main roads						
UEC medical expenditures (th. INR)	-0.000	-0.000	-0.000	-0.001	-0.000	-0.001
	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
UEC fines (hund. INR)	$0.077^{\star\star\star}$	$0.073^{\star\star\star}$	$0.067^{\star\star\star}$	$0.079^{\star\star\star}$	$0.072^{\star\star\star}$	$0.063^{\star\star\star}$
	(0.018)	(0.018)	(0.014)	(0.038)	(0.018)	(0.014)
R^2	0.261	0.267	0.288	0.352	0.266	0.298
Observations	*673*	*632*	*555*	*308*	*650*	*524*
Panel C: Helmet use for trips in residential neighbordhoods						
UEC medical expenditures (th. INR)	0.001	0.002	0.001	0.005	0.002	0.002
	(0.004)	(0.005)	(0.005)	(0.003)	(0.004)	(0.005)
UEC fines (hund. INR)	$0.049^{\star\star}$	$0.049^{\star\star}$	$0.052^{\star\star}$	$0.050^{\star\star}$	$0.048^{\star\star}$	$0.052^{\star\star}$
	(0.023)	(0.023)	(0.025)	(0.026)	(0.024)	(0.026)
R^2	0.243	0.252	0.253	0.359	0.248	0.267
Observations	*665*	*625*	*548*	*304*	*642*	*518*

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance. Controls are marital status, # of children, head of hh, gender, age, income, education level, contribution to income caste, risk aversion, health insurance, helmet ownership and existence of a superior force. Estimations in column (1) corresponds to regressions presented in Table 5.5.

Appendix G. Probit estimations

Table 5.20: Influence of expectations on helmet use - using unconditional expected costs (UEC)

Helmet use	**on main roads**		**trips in the neighborhoods**
	long trips	**short trips**	
	(1)	(2)	(3)
Coefficients			
UEC medical expenditures (th. INR)	0.042	0.001	0.002
	(0.031)	(0.016)	(0.015)
UEC fines (hund.INR)	0.027	0.359***	0.154*
	(0.117)	(0.123)	(0.084)
Pseudo R^2	0.374	0.342	0.279
Observations	*610*	*660*	*663*
Marginal effects			
UEC medical expenditures (th. INR)	0.008	0.000	0.001
	(0.005)	(0.004)	(0.004)
UEC fines (hund.INR)	0.005	0.090***	0.044**
	(0.021)	(0.030)	(0.023)

Notes: *** 1%, ** 5%, * 10% and $^{+}$ 15% significance.
Probit estimations with circle dummies and clustered standard errors reported in parentheses.
Controls are marital status, # of children, head of household, gender, age, income, education level, contribution to income, Sikh, caste, risk aversion, health insurance and existence of a superior force.
Remark: The difference in the number of observations between probit and linear probability estimations is due to the use of dummies in the former specification: observations being dropped in case of an absence of variation in the variable of interest among respondents belonging to the same area.

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