Monetary valuation of the prevention of road fatalities and serious road injuries

Results of the VALOR project

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Summary

Scope and research question

The VALOR project is the first research initiative in which scientists from four European countries, namely Belgium, France, Germany and the Netherlands, have joined efforts in order to estimate VSL (Value of a Statistical Life), VSSI (Value of a Statistical Serious Injury) and VoT (Value of Time) by applying a common methodology. This study addresses the following research question: "What is the monetary valuation of the prevention of road fatalities and serious road injuries?"

The use of the VALOR outcomes is twofold. Firstly, the VSL and VSSI are an important input for calculating the socio-economic costs of road crashes. Information on these costs is regularly used in road policy-making. For instance, information on the socio-economic burden of road crashes can be used as an input for budget allocation and helps to justify road safety investments. Also, comparisons can be made with the costs of other policy measures. Secondly, the VSL and VSSI are needed for cost-benefit analysis (CBA) of road safety measures or broader infrastructure projects with road safety impacts.

Methodology

This research is based on a preparatory study (Wijnen, et al., 2019) which assessed different methods for the monetary valuation of "non-market goods". As a result, it was decided to use a stated preference method (as opposed to revealed preference) and, more precisely, a stated choice study (as opposed to a contingent valuation study) for estimating the Willingness-To-Pay (WTP) for reducing the risk of fatal and serious injuries in road accidents. Respondents from each participating country were confronted with hypothetical route choices that differ in respect of travel costs, time, and crash risk. The survey was conducted between 22 October and 13 November 2020 and included 8,003 respondents. It comprised 2,005 Belgian respondents, 2,000 French, 2,000 from Germany and 1,998 from the Netherlands. The sample was composed of 3,928 males (49.1%) and 4,075 females (50.9%).

Within the full sample, 2,513 respondents (33.2%) were identified as lexicographic (always choosing the alternative with the best score on a particular attribute, to avoid complexity) and 445 respondents who answered irrational. Both groups were excluded from the main analysis.

VALOR deployed different econometric models (mixed and binomial logit) and correspondingly produced several sets of values, the convergence of which shows the robustness of its results. However, a trade-off between reliability and performance had to be made in order to determine which model to choose. It was decided to use as a reference model the mixed logit with the panel dimension and without interactions.

Results

The main results are as follows: the average VSL was estimated at 6.2 Mill EUR, the VSSI at 950,000 EUR, and the VoT at 16.1 EUR/h. The VSL lies in the range between 5.3 and 7 Mill EUR and the VSSI between 0.8 and 1.1 Mill EUR. Accordingly, the ratio of values between fatalities and injuries is estimated at around 7 to 1.

The experimental protocol appeared to be properly designed, and the reliability of results can be confirmed, particularly as a result of observations made while addressing hypothetical bias and lexicographic behaviour. For instance, with regard to hypothetical bias, the exclusion of 1,900 respondents who did not consider the survey design as realistic did not significantly modify the final estimates (the increases in VSL, VSSI and VoT did not exceed 3%).

Table 1 VALOR Values VSL, VSSI and VoT for four countries

	VSL (in Mill EUR)	VSSI (in Mill EUR)	VoT (in EUR/h)
Average 4 countries	6.2	0.95	16.1
Belgium	5.9	0.9	17.2
France	5.3	0.8	12.9
Germany	7.3	1.1	19.0
The Netherlands	6.3	1.0	16.4

The study revealed some differences between countries. France shows the lowest WTP, while Germany has the highest. The difference between values of these two countries was 38%. Belgium and the Netherlands show quite similar values.

For each country the new estimates of VALOR are considerably higher than earlier official values. Comparing the new estimates of this study with official values of the participating countries is difficult, because of different methodologies used. Earlier academic studies on VSL using WTP show a broad dispersion in estimates. The estimates from VALOR is at the higher end of range of VSL estimates in earlier research.

Interpretation: interactions, COVID effect

The models used in this study permit closer examination of the impact of variables. Correlations with variables such as age, parenthood, having a partner/relatives, income, risk assessment, experience of having accidents, and with participating countries were found.

Secondly, the Covid-19 impact has been taken into account. It was assumed that the lockdown, the reduction of mobility, the prevention measures, as well as high numbers of Covid-19 victims, could affect the preferences of individuals regarding risk and their perception of road safety. However, the impact of the pandemic on the estimated values was found not to be significant since the fraction of respondents showing a sizeable effect is very small.

Three latent variables - "thriftiness", "time pressure" and "risky behaviour" - were introduced in order to gain additional information about the impact of individual preferences on VSL and VSSI. It appeared that attitude to risk is an important factor. VSL and VSSI values revealed in the group of risk-avoiding drivers are almost two times higher than those of the group of risk-takers.

Résumé

Portée de l'étude et question de recherche

Le projet VALOR est la première initiative de recherche à laquelle ont participé des scientifiques de quatre pays européens, à savoir la Belgique, la France, l'Allemagne et les Pays-Bas, pour estimer la VVS (valeur de la vie statistique), la VBG (valeur du blessé grave) et la VT (valeur du temps) en appliquant une méthode commune. Cette étude a pour objectif de répondre à la question de recherche suivante : "Quelle est la valorisation monétaire accordée à l'évitement des décès et des blessures graves résultant des accidents de la route ?"

L'utilisation des résultats de VALOR est double. Premièrement, la VVS et la VBG sont des éléments importants pour calculer les coûts socio-économiques des accidents de la route. Les informations sur ces coûts sont régulièrement utilisées pour l'évaluation des politiques de transport, par exemple à des fins d'arbitrages budgétaires. Elles aident également à justifier des investissements de sécurité routière. Par ailleurs, des comparaisons peuvent être établies avec les coûts de mesures d'autres politiques. Ensuite, la VVS et la VBG sont nécessaires aux analyses coûts-avantages (ACA) des mesures de sécurité routière ou, plus largement, des projets d'infrastructures ayant des impacts sur la sécurité routière.

Méthodologie

Cette recherche repose sur une étude préparatoire (Wijnen, et al., 2019) qui a répertorié les différentes méthodes permettant de valoriser les biens « non-marchands ». En conséquence, il a été décidé de mobiliser la méthode des « préférences déclarées » (par opposition aux « préférences révélées ») et, plus précisément, la méthode des « choix conjoints » (par opposition à la méthode d'évaluation contingente) afin d'estimer le « consentement à payer » (CAP) pour réduire le risque d'accidents mortels et/ou graves de la route. Les répondants des différents pays ont été confrontés à des choix d'itinéraires hypothétiques qui différaient en termes de coûts monétaires, de durée de trajet et de risques d'accidents. Le questionnaire a été réalisé du 22 octobre au 13 novembre 2020 auprès de 8003 participants. L'échantillon comporte 2005 Belges, 2000 Français, 2000 Allemands et 1998 Néerlandais. Il compte 3928 hommes (49,1%) et 4075 femmes (50,9%).

Au sein de cet échantillon, 2513 répondants (33,2%) ont été identifiés comme étant lexicographiques (choisissant systématiquement l'alternative qui favorise un attribut particulier, afin notamment de réduire la complexité) et 445 personnes ont répondu d'une manière irrationnelle. Ces deux groupes ont été retirés de l'analyse principale.

Différents modèles économétriques (logit binomial ou mixte) ont été mis œuvre dans le cadre de VALOR, auxquels sont associées différentes estimations, la convergence des résultats suggérant une robustesse d'ensemble. Toutefois, afin de déterminer le modèle approprié, un arbitrage entre performance et fiabilité a été réalisé, ce qui a conduit à retenir comme modèle de référence, le logit mixte avec une dimension de panel et sans terme d'interaction.

Résultats

Les principaux résultats sont les suivants : la VVS moyenne est estimée à 6,2 Mill EUR, la VBG à 950 000 EUR et la VT à 16,1 EUR/h. Les estimations de la VVS s'établissent entre 5,3 et 7,0 Mill EUR et celles de la VBG entre 0,8 et 1,1 Mill EUR. Il en découle un ratio de 7 à 1 entre les valeurs des accidents mortels et celui des accidents graves.

Le protocole expérimental semble avoir été convenablement élaboré et la fiabilité des résultats est confirmée par les analyses menées pour tester l'existence d'un biais hypothétique et de l'influence des comportements lexicographiques. Par exemple, concernant le biais hypothétique, écarter les 1 900 répondants qui ne considèrent pas le protocole comme réaliste ne conduit pas à une modification significative des estimations finales (l'augmentation de la VVS, la VBG et la VT ne dépasse pas 3 %).

L'étude révèle certaines différences entre les pays. La France est ainsi caractérisée par les plus faibles CAP tandis que l'Allemagne présente les plus fortes valeurs, avec une différence de 38 % pour ces valeurs entre ces deux pays. La Belgique et les Pays-Bas ont des CAP quelque peu similaires.

Table 1 Résultats de VALOR pour la VVS, la VBG et la VT, pour les 4 pays

	VVS (Mill EUR)	VBG (Mill EUR)	VT (EUR/h)
Moyenne des 4 pays	6,2	0,95	16,1
Belgique	5,9	0,9	17,2
France	5,3	0,8	12,9
Allemagne	7,3	1,1	19,0
Pays-Bas	6,3	1,0	16,4

Les estimations issues de VALOR sont, pour chaque pays, considérablement supérieures aux valeurs officielles antérieures. Comparer ces nouvelles estimations avec les valeurs officielles des pays participants reste cependant difficile, en raison notamment des différences dans les méthodologies utilisées. Les études académiques précédentes mobilisant les CAP pour estimer la VVS sont caractérisées par une large dispersion des résultats. Les résultats de VALOR appartiennent ainsi à la borne supérieure des VVS estimées dans les études antérieures.

Interprétations : effets d'interaction, effet COVID

Les modèles développés dans VALOR autorisent une analyse détaillée de l'impact de certaines variables sur les CAP. On observe ainsi des corrélations avec l'âge, la parentalité, être en couple et avoir de la famille, le revenu, l'évaluation du risque, l'expérience passée d'accidents ou le pays du répondant.

Deuxièmement, l'impact de la COVID-19 a été pris en compte. On peut ainsi supposer que les confinements, la baisse de la mobilité, les mesures de prévention ainsi que le nombre important de victimes de la COVID-19 pouvaient avoir impacté les préférences des individus vis-à-vis du risque et leur perception de la sécurité routière. L'influence de la pandémie sur les valeurs estimées n'est cependant pas significative, puisque seule une faible part des répondants est caractérisée par un effet perceptible.

Finalement, trois variables latentes – "être économe", "subir une pression temporelle" et "avoir des comportements risqués" – ont été introduites dans les modèles afin d'obtenir des informations supplémentaires concernant l'impact des préférences individuelles sur la VVS et la VBG. Il ressort que l'attitude vis-à-vis du risque est un facteur important. Les valeurs de la VVS et de la VBG pour le groupe de conducteurs déclarant éviter les risques sont presque deux fois supérieures à celles obtenues pour le groupe d'individus déclarant prendre des risques.

Zusammenfassung

Umfang und Fragestellung

Das Projekt VALOR ist die erste Forschungsinitiative von vier europäischen Ländern, nämlich Belgien, Frankreich, Deutschland und den Niederlanden, um gemeinsam auf Basis einer einheitlichen Methodik VSL (Value of a Statistical Life), VSSI (Value of a Statistical Serious Injury) und VoT (Value of Time) zu schätzen. Die Studie ging dabei von folgender Fragestellung aus: "Wie ist die monetäre Bewertung der Vermeidung von Getöteten und Schwerverletzten im Straßenverkehr?"

Die Ergebnisse von VALOR haben einen zweifachen Nutzen: Erstens leisten VSL und VSSI einen wichtigen Beitrag bei der Berechnung der sozioökonomischen Kosten von Straßenverkehrsunfällen. Diese Kosteninformationen werden regelmäßig für die Verkehrspolitik herangezogen. Zum Beispiel können Informationen über die sozioökonomischen Belastungen durch Straßenverkehrsunfälle bei der Budgetverteilung berücksichtigt und dadurch Investitionen in die Straßenverkehrssicherheit begründet werden. Außerdem wird der Vergleich mit sozioökonomischen Kosten der anderen Probleme des öffentlichen Gesundheitswesens möglich. Zweitens ermöglichen VSL und VSSI die Durchführung von Kosten-Nutzen-Analyse (KNA) von Verkehrssicherheitsmaßnahmen oder von breit angelegten Infrastrukturprojekten mit Einfluss auf die Straßenverkehrssicherheit.

Methodik

Die verwendete Methodik basiert auf einer Vorstudie (Wijnen, et al., 2019), in der unterschiedliche Methoden für die monetäre Bewertung von Nicht-Marktgütern beurteilt wurden. Deren Ergebnis sprach für die Anwendung einer Stated-Preference-Befragung anstelle einer Revealed-Preference-Befragung, genauer gesagt einer Stated-Choice-Studie anstelle einer Contingency-Valuation-Studie, um die Zahlungsbereitschaft (engl. willingness to pay, WTP) für eine Minderung des Risikos von Unfällen mit Getöteten und Schwerverletzten zu ermitteln.

Im Rahmen der Befragung wurden Personen aus den oben genannten Ländern mit der hypothetischen Auswahl zwischen Routenalternativen mit unterschiedlichen Fahrtkosten, Fahrzeiten und Unfallrisiken konfrontiert. Für die vom 22. Oktober bis 13. November 2020 durchgeführte Studie wurden insgesamt 8.003 Personen befragt, darunter 2.005 Teilnehmende in Belgien, 2.000 in Frankreich, 2.000 in Deutschland und 1.998 in den Niederlanden. Die Stichprobe setzte sich aus 3.928 männlichen (49,1%) und 4.075 weiblichen (50.9%) Befragten zusammen.

Bezogen auf die gesamte Stichprobe wiesen 2.513 Befragte (33,2%) eine lexikographische Präferenz auf (d.h. es wurde stets die Routenalternative mit der höchsten Punktzahl für ein bestimmtes Attribut ausgewählt, um so Komplexität zu vermeiden), wogegen 445 Befragte die Entscheidung irrational trafen. Beide Gruppen wurden von der Hauptanalyse ausgeschlossen.

VALOR wendete unterschiedliche ökonometrische Modelle (gemischtes und binomiales Logit) an und erzeugte daher mehrere Wertesätze, deren Konvergenz die Robustheit der Ergebnisse zeigten. Es musste jedoch bei der Auswahl des Modells ein Kompromiss zwischen Zuverlässigkeit und Leistung gemacht werden. Als Referenzmodell wurde dafür das gemischte Logit-Modell mit Panel-Dimension, aber ohne Interaktionen gewählt.

Ergebnisse

Die wesentlichen Ergebnisse lauten: Betrachtet über die vier Länder wurde der durchschnittliche VSL auf 6,2 Mill. EUR, der VSSI auf 950.000 EUR und der VoT auf 16,1 EUR/Std. geschätzt. Der VSL liegt zwischen 5,3 und 7 Mill. EUR und der VSSI zwischen 0,8 and 1,1 Mill. EUR. Entsprechend wird das Kostenverhältnis zwischen Getöteten und Verletzten mit ungefähr 7 zu 1 angegeben.

Das experimentelle Design der Versuchsanordnung erwies sich als geeignet. Die Zuverlässigkeit der Ergebnisse wird insbesondere durch Beobachtungen, die bei der Berücksichtigung von hypothetischer Verzerrung und lexikographischem Verhalten gemacht wurden, gestützt. Hinsichtlich der hypothetischen Verzerrung führte beispielsweise der Ausschluss von 1.900 Befragten, die das Design der Befragung als nicht realistisch einschätzten, zu keiner signifikanten Änderung der Ergebnislage (der Anstieg bei VSL, VSSI und VoT lag bei max. 3%).

Die Studie zeigte gewisse Unterschiede zwischen den Ländern auf. Frankreich zeigt die geringste Zahlungsbereitschaft, wohingegen Deutschland den höchsten WTP-Wert aufweist. Die Werte unterschieden sich zwischen diesen beiden Ländern um 38%. Die für Belgien und die Niederlande ermittelten Werte liegen vergleichsweise dicht beieinander.

Tabelle 1 VALOR-Werte VSL, VSSI und VoT für vier Länder

	VSL (in Mill. EUR)	**VSSI (in Mill. EUR)**	**VoT (in EUR/h)**
Mittelwert 4 Länder	6,2	0,95	16,1
Belgien	5,9	0,9	17,2
Frankreich	5,3	0,8	12,9
Deutschland	7,3	1,1	19,0
die Niederlande	6,3	1,0	16,4

Für jedes der beteiligten Länder sind die in VALOR ermittelten Werte deutlich höher als die bisher offiziell verwendeten Werte für Kosten in Zusammenhang mit Unfällen. Die Anwendung unterschiedlicher Methoden zur Ermittlung dieser Kosten erschwert dabei einen Vergleich der neuen Schätzungen aus dieser Studie mit den offiziellen Werten der teilnehmenden Länder. Frühere wissenschaftliche Untersuchungen zu VSL unter Anwendung von WTP zeigen insgesamt eine hohe Streuung der Schätzungen. VALOR liegt hier im oberen Bereich der VSL-Schätzungen aus früheren Studien.

Interpretation: Interaktionen, COVID-Effekt

Die in dieser Studie angewandten Modelle ermöglichen eine genauere Untersuchung des Einflusses von variablen Faktoren. Es ergaben sich Korrelationen bei Variablen wie Alter, Elternschaft, Familienstand, Einkommen, Risikobewertung, Unfallerfahrung sowie den teilnehmenden Ländern.

Es wurde zwar angenommen, dass Lockdown, Einschränkungen der Mobilität, Präventivmaßnahmen sowie die hohe Zahl der COVID-19-Opfer individuelle Einstellungen hinsichtlich Risiken und sowie der Wahrnehmung der Straßenverkehrssicherheit beeinflussen könnten. Der Einfluss der Auswirkungen der COVID-19-Pandemie auf die Schätzwerte erwies sich jedoch als nicht signifikant.

Drei latente Variablen – „Sparsamkeit", „Zeitdruck" und „riskantes Verhalten" – wurden eingeführt, um zusätzliche Informationen über den Einfluss von individuellen Präferenzen auf VSL und VSSI zu erhalten. Die Risikoeinstellung stellte sich hier als ein wesentlicher Faktor heraus: Die Werte für VSL und VSSI waren für die Personengruppe mit risikovermeidendem Fahrverhalten annähernd zweimal höher als für die Gruppe der Risikobereiten.

Samenvatting

Scope en onderzoeksvraag

Het VALOR-project is een onderzoeksinitiatief waarbij wetenschappers uit vier Europese landen (België, Frankrijk, Duitsland en Nederland) hebben samengewerkt om met een gemeenschappelijke methodologie de VSL (Value of a Statistical Life), VSSI (Value of a Statistical Serious Injury) en VoT (Value of Time) te schatten. De onderzoeksvraag van de studie is: "Wat is de monetaire waardering van het voorkomen van verkeersdoden en ernstig verkeersgewonden?"

De uitkomsten van VALOR hebben twee gebruiksdoeleinden. Ten eerste zijn de VSL en VSSI belangrijk voor de berekening van de sociaaleconomische kosten van verkeersongevallen. Informatie over deze kosten is van nut voor de voorbereiding van beleid. Zo kan informatie over de sociaaleconomische kosten van verkeersongevallen worden gebruikt bij de toewijzing van budgetten en helpt het investeringen in verkeersveiligheid te rechtvaardigen. Ook kunnen hiermee vergelijkingen worden gemaakt met de kosten van andere beleidsmaatregelen. Ten tweede worden de VSL en VSSI gebruikt in kosten-batenanalyses (KBA's) van verkeersveiligheidsmaatregelen of infrastructuurprojecten met verkeersveiligheidseffecten.

Methodologie

Dit onderzoek is gebaseerd op een voorbereidende studie (Wijnen, et al., 2019) waarin verschillende methoden voor de monetaire waardering van *non-market goods* zijn geëvalueerd. Naar aanleiding van de studie is besloten om *stated preference*-methode (in tegenstelling tot *revealed preference*) en een *stated choice*-studie (in tegenstelling tot een *contingent valuation*-studie) te gebruiken voor het schatten van de Willingness-To-Pay (WTP) voor het verminderen op het risico op een dodelijk ongeval en ernstig letsel bij verkeersongevallen. De respondenten uit de deelnemende landen kregen hypothetische routekeuzes voorgelegd die verschillen in reiskosten, tijd en ongevallenrisico. De enquête is uitgevoerd tussen 22 oktober en 13 november 2020 en omvatte 8.003 respondenten. De steekproef is uitgevoerd onder 2.005 respondenten uit België, 2.000 uit Frankrijk, 2.000 uit Duitsland en 1.998 uit Nederland. De steekproef bestond uit 3.928 mannen (49,1%) en 4.075 vrouwen (50,9%).

Binnen de volledige steekproef werden 2.513 respondenten (33,2%) geïdentificeerd als zgn. lexicografische respondenten (zij kiezen voor een route altijd op basis van één kenmerk om de keuze te vereenvoudigen) en 445 respondenten die irrationele antwoorden gaven. Beide groepen werden uitgesloten van de hoofdanalyse.

VALOR gebruikt verschillende econometrische modellen (*mixed logit* en *binomial logit*) die elk verschillende resultaten opleverden. De convergentie van de verschillende resultaten geeft niettemin een indicatie van de robuustheid van de resultaten. Er is besloten het *mixed logit-model* met panel dimensie zónder interacties te gebruiken als referentiemodel.

Resultaten

De belangrijkste resultaten zijn: de gemiddelde VSL is geschat op 6,2 miljoen euro, de VSSI op 950.000 euro en de VoT op 16,1 euro per uur. De VSL ligt tussen 5,3 en 7 miljoen euro en de VSSI tussen 0,8 en 1,1 miljoen euro. De verhouding van de waarden voor een dode en een ernstig gewonde wordt geschat op ongeveer 7 op 1.

Het experiment (protocol) bleek goed te zijn opgezet. De betrouwbaarheid van de resultaten kan worden bevestigd met name ten aanzien van *hypothetical bias* (omdat keuzes gaan over hypothetische situaties) en lexicografisch gedrag. Bijvoorbeeld, wat de *hypothetical bias* betreft, heeft de uitsluiting van 1.900 respondenten die de enquête als niet realistisch beschouwden de schattingen niet significant gewijzigd (de toename van VSL, VSSI en VoT bedroeg niet meer dan 3%).

De studie brengt enkele verschillen tussen landen aan het licht. Frankrijk vertoont de laagste WTP en Duitsland de hoogste. Het verschil tussen de waarden van de landen is 38%. België en Nederland vertonen vrij vergelijkbare waarden.

Tabel 1 VALOR-waarden VSL, VSSI en VoT voor vier landen

	VSL (in mln EUR)	VSSI (in mln EUR)	VoT (in EUR/h)
Gemiddelde 4 landen	6.2	0.95	16.1
België	5.9	0.9	17.2
Frankrijk	5.3	0.8	12.9
Duitsland	7.3	1.1	19.0
Nederland	6.3	1.0	16.4

Voor elk land zijn de nieuwe VALOR-schattingen aanzienlijk hoger dan eerdere officiële waarden. Vergelijking tussen de nieuwe schattingen en de officiële waarden van de deelnemende landen is moeilijk omdat verschillende methodologieën zijn gebruikt. Eerder academisch onderzoek over de VSL op basis van WTP laat een grote spreiding in de schattingen zien. De schattingen van VALOR liggen aan de bovengrens van VSL-schattingen in eerder onderzoek.

Interpretatie: interacties, COVID-effect

De gebruikte modellen maakten verder onderzoek van mogelijk effecten van variabelen mogelijk. Er werden correlaties gevonden met de variabelen leeftijd, ouderschap, het hebben van een partner/familieleden, inkomen, risicobeoordeling, ervaring hebben met ongevallen en met deelnemend land.

Ten tweede is gekeken naar het effect van Covid-19. Er werd verondersteld dat de lockdown, de beperking van de mobiliteit, de preventiemaatregelen en de hoge aantal Covid-19-slachtoffers een invloed zouden hebben op de risicovoorkeuren van individuen en hun perceptie van verkeersveiligheid. Het effect van de pandemie op de schattingen bleek niet significant te zijn. Het aandeel van respondenten die een aanzienlijk effect liet zien was zeer klein.

Drie latente variabelen - zuinigheid, tijdsdruk en risicogedrag - werden geïntroduceerd om extra informatie te bekomen over het effect van individuele voorkeuren op de VSL en VSSI. Houding ten opzichte van risico is een belangrijke factor. De VSL- en VSSI -waarden van de groep risicomijdende bestuurders zijn bijna twee keer zo hoog als die van de groep die bereid is meer risico te nemen.

1 Background

1.1 Study scope and research question

Existing estimates of the socio-economic costs of road crashes are rather outdated and show large variations across (European) countries, mainly due to differences in the methods that are applied. For that reason, several studies on road crash costs, most recently the European SafetyCube project, have recommended to improve the quality and the comparability of the road crash cost estimates in European countries. In 2018 three European institutes took the initiative for a study aimed at developing a common methodology for road crash costing in European countries: the Belgian road safety institute (Vias institute), The German Federal Highway Research Institute (BASt) and the French Institute of Science and Technology for Transport, Development and Networks (IFSTTAR, since 2020 Université Gustave Eiffel). In all three countries, a need is felt to revise approaches to road crash cost estimates that are currently in use.

A preparatory study (Wijnen, et al., 2019)(Wijnen, et al., 2019) ???was conducted to review the methodologies applied in Belgium, France and Germany and to identify the cost components that need revision. The review showed that the priority shall be given to estimation of human costs of fatal and seriously injured road crash victims, because this is a relatively large cost component, not all countries use country-specific estimates, the estimates are generally outdated and/or the estimates are not consistent with the principles of economic welfare theory.

Consequently, it was decided to set up a common valuation study with the purpose of producing human costs estimates applicable for their road crash cost studies and socio-economic cost-benefit analyses. The research question of this study is **"What is the monetary valuation of the prevention of road fatalities and serious road injuries?"**. Apart from the fact that the human costs for serious injuries constitute a large share of the crash costs, the monetary valuation of serious injuries is included in this study because very few investigations have paid attention to serious injuries. Most of the cost studies have been dedicated to fatalities, while serious injuries are, given their large health impact and slow reduction of their numbers in the last decades, gaining more importance in road safety policy (Schoeters, et al., 2020).

The methodology of this valuation study was developed in 2019 as a stated choice survey. In 2020 the questionnaire was tested in different focus groups and by means of a pilot study. Meanwhile the KIM Netherlands Institute for Transport Policy Analysis (Kennisinstituut voor Mobiliteit) joined the project. In October and November 2020 the final survey was implemented in four countries: Belgium, France, Germany and the Netherlands.

1.2 Preparatory study1

The first step in developing the common methodology for estimating the actual socio-economic costs of road crashes was a preparatory study that was conducted in 2018 (Wijnen, et al., 2019). This study examined the methodologies applied at this point in Europe for estimating the costs of road crashes, with particular attention to the methods used in the three project initiating countries (Belgium, France and Germany). Secondly the report focused on methodologies for estimating human costs, aimed at recommending a common method for subsequent studies to determine monetary valuations of (preventing) road fatalities and injuries.

Review of current road crash cost practices

For road crashes, six main cost components can be distinguished: medical costs, production loss, human costs (intangible costs of loss of quality of life and life years), property damage, administrative costs and other costs. The inclusion of these cost components differs considerably between European countries. Casualty-related costs (medical costs, production loss and human costs) are taken into account by most countries, but it is less common to include crash-related costs (property damage and administrative costs). This is reflected in the analysis of the three countries this study concentrates on: in Belgium and France only casualty-related costs are included in the official crash cost estimates, while all main cost components are taken into account in Germany.

[1] From Wijnen, et al., 2019

The review shows that three methodological approaches are available to estimate road crash costs: the restitution cost approach, the human capital approach and the willingness-to-pay (WTP) approach. Each method is aimed at specific cost components: the restitution cost approach is appropriate for estimating medical costs, property damage and administrative costs; the human capital approach is aimed at estimating production loss; and the WTP approach is suitable for estimating human costs. In particular the methods applied for estimating human costs, which is by far the largest cost component in most countries, differ considerably across Europe. About half of the countries adopt the WTP approach, while other countries use the restitution cost approach or the human capital approach.

The availability of estimates of each cost component, the (quality of the) methods used and the recency of the estimates are reviewed in more details for the three participating countries. Both the official national cost estimates and other sources, such as academic studies, have been assessed. This process has revealed several deficiencies in the current cost estimates in each of the three countries, particularly with respect to the human costs. In Germany the (internationally recommended) WTP approach is not applied, while the human costs in France are not country-specific but based on results from other countries. WTP estimates are available in Belgium, but they are not representative.

The updating of the cost estimation methods is also an issue for other cost components in Belgium and Germany, as most of them originate from the beginning of this century. The official cost estimates in Belgium and France do not always include the most recent study results and several cost components are missing, despite the availability such information in several cases. Thus, the quality of the official cost figures could be improved substantially by incorporating this information.

Based on the review of the methods in the three countries and the relative size of the cost components, a prioritization of cost components was made with respect to the need for developing new methods and making new cost estimates. This shows that human costs of fatalities and injuries have the highest priority given the deficiencies in the methods and the large size of these costs.

Methods for estimating human costs

The second part of the preparatory study focuses on methodologies for estimating human costs. The report reviews the theoretical concepts underlying human costs as well as economic valuation methods that can be used to estimate these costs. It leads to recommendations for a common method for subsequent studies to determine monetary valuations of (preventing) road fatalities and injuries.

According to international best practices and economic theory, human costs should be based on an individual WTP approach, which means that human costs are derived from the amount individuals are willing to pay for a reduction of their own crash risk. Two types of methods are available to determine this WTP: stated preference and revealed preference methods. Revealed preference methods derive the WTP from people's actual behaviour and choices concerning safety, in particular consumer purchasing behaviour with respect to safety devices and employment choices concerning jobs with different risk levels. In the stated preference approach questionnaires are used to ask people how much they are willing to pay for (hypothetical) crash rate reductions. Based on a review of both methodologies, it is recommended to apply a stated preference method for the valuation of human costs. The main argument is the much broader applicability of stated preferences methods due to the flexibility of questionnaires. Different kinds of road safety issues can be assessed and the method is not dependent on the availability of data on the amount of money people actually pay to reduce their crash risk. In addition, stated preference methods provide the opportunity to explain small risk reductions and test the respondents' understanding of risk, whereas revealed preference methods assume that individuals correctly understand the changes in (very small) risks associated with their choices.

There are two main types of stated preference methods: contingent valuation and stated choice. The contingent valuation method implies that people are asked in a direct way which amount they are willing to pay for a specified crash risk reduction. Stated choice uses a more indirect way of eliciting people's WTP, by asking them to make a choice between several situations, for example different routes, that differ with respect to the risk level, monetary aspects and mostly one or more other aspects. The inclusion of a monetary aspect, such as travel costs, allows estimating the WTP for a risk level change. The literature shows that the stated choice method is less prone to bias related to using stated preference questionnaires than contingent valuation, because the indirect way of asking people's WTP by applying the stated choice approach reduces several types of bias. Therefore, we recommend using the stated choice method for the valuation of human costs of road fatalities.

Stated choice can also be applied for the valuation of non-fatal risk reduction. A joint survey for both fatalities and injuries can be conducted, which can be attractive for both theoretical (methodological consistency) and practical reasons. However, the experience with applying stated choice to non-fatal risk is very limited, and so there is little evidence about the validity of the method. A good alternative for the valuation of human costs of injuries is the Quality Adjusted Life Years (QALY) approach. QALYs include the measurement of the quality of life loss due to injuries, using indicators for their severity and the duration of the corresponding health loss. This approach offers a great level of detail with respect to health status and thus provides the opportunity to estimate human costs of injuries more precisely. The QALY approach has been applied successfully in the field of public health, but applications to road safety are very limited. As both the stated choice and the QALY method are promising for determining monetary valuations of road injuries, it is recommended to concentrate further research on applying both of these approaches in this area.

2 Methodology

2.1 General method: stated choice survey

A preparatory study (Wijnen, et al., 2019) provided an assessment of different methods for the monetary valuation of non-market 'goods' . Based on this assessment, it was decided to use a stated preference method (as opposed to revealed preference), more precisely a stated choice study (as opposed to a contingent valuation study). It was decided to include both the estimation of the prevention of fatalities and the prevention of serious injuries in the same stated choice survey.

In a stated choice study, respondents have to indicate their preference by making choices in different hypothetical choice sets. As opposed to contingent valuation studies the respondents do not state the amount they are willing to pay directly. Each choice set consists of two or more alternatives that each consist of different attributes and attribute levels. To analyze the stated choice data, assumptions are made about a choice model. The most common choice model is the random utility maximization model (RUM). In this model it is assumed that the respondent maximizes his utility when making decisions. The utility is modelled as a function of the preference weights and the attribute levels. The deterministic part of this function is mostly linearly specified in the parameters but the corresponding logit probabilities relate nonlinear to the observed utility (Traets, Sanchez, & Vandebroek, 2020). Two RUM models are the multinomial logit model (MNL) (McFadden, 1974) and the mixed logit model (ML) (Henscher & Greene, 2003; Train, 2003). The purpose of a stated choice study is to determine the independent influence of the attributes on the utility by pooling the responses from multiple respondents to produce statistically reliable parameter estimates (ChoiceMetrics, 2018).

As it will state in Section 3, the individual WTP values can consequently be estimated by dividing the parameter estimate for risk or time by the parameter estimate for travel cost, which is the marginal rate of substitution between income and risk/time. These parameter estimates reflect the disutility from a higher accident risk, a higher travel time and a higher travel cost. To define the Value Of Statistical Life (VSL), the Value of Statistical Serious Injury (VSSI) the average WTP value is multiplied by the number of trips.

2.2 Sampling

Target population

The target population in a stated preference survey for an economic valuation is the population that is impacted by the change (Pearce & Özdemiroglu, 2002)(Pearce & Özdemiroglu, 2002). In our research, it includes all road users, since it is aimedto determine a general VSL. When designing the valuation scenario, a credible context is needed. To decrease the hypothetical character of the valuation scenario, it was important that a respondent had an experience with the choice context. It was not possible to find a context that was applicable for all road users, thus a context of a car driver on a motorway was decided as generally mostly familiar to road users in participating countries. Besides we wanted to avoid having multiple WTP values for different road users. The target population was therefore defined as the population that has experience with driving a car on a motorway.

Sample frame population

The sample frame population is the population from which the sample will be drawn and should be as close as practically possible to the target population (Pearce & Özdemiroglu, 2002). In our study an internet panel that was collected by an external panel provider (Profacts). This panel consists of people, 18 years or older, that have signed up for being member of an internet panel and that participate in different online surveys. For each country the panel consisted of 100,000 or more possible respondents. Selection questions were included in the survey to test if they were part of the target population. These selection questions are:

Do you have a car driving licence or permit?

- *Yes*
- *A provisional one* ➔ excluded from the sample
- *No* ➔ excluded from the sample

During the past 12 months, how often did you drive a car on a motorway (not as a passenger)?

- *Never* ➔ excluded from the sample
- *A few times a year*
- *A few times a month*
- *1 to 2 days a week*
- *At least 3 days a week*

Sampling method

A sample is drawn from the sample frame. Probability sampling is generally recommended, as this is consistent with statistical theory and allows to correct for sampling bias and to calculate confidence intervals (Pearce & Özdemiroglu, 2002). The sampling was executed by the external panel provider using simple random probability sampling method. Certain characteristics were taken into account by assigning quotas to the sample. These characteristics include age and gender (hard quota) and region (soft quota). The quotas include 12 categories in which age and gender are crossed (18-24, 25-34, 35-44, 45-54, 55-64, 65+, male and female). Next to that soft quota are assigned to the regions in the different countries. The quota are based on the most recent statistics provided by the United Nations (2018) or a national source (Statbel, 2019; CIM 2020; Genesis Census 2011; INSEE 2019; Statline 2019). The quotas are applied to the raw sample, prior to further selection of respondents by means of selection questions. The quota can be found in Appendix 14a.

Sample size

The sample for the pilot survey consisted of 100 respondents for each country, which means 400 in total. The sample for the final survey consisted of 2000 respondents for each country, which means 8000 in total.

2.3 Questionnaire design

The questionnaire is designed based on a literature review of stated choice studies in transport safety[2] and existing surveys such as ESRA (Meesmann, Torfs, & Van den Berghe, 2019). Feedback was given by the project partners at multiple meetings in 2019. Next to that we received feedback from researchers from TU Dresden who implemented a pilot stated choice study in Germany in 2018 (Obermeyer, Hirte, Korneli, Schade, & Friebel, 2020). The questionnaire was tested by small focus groups in each participating country and by a pilot survey of 100 respondents per country.

The questionnaire is originally developed in English (master version), and in a final stage translated to German (DE), French (FR), French (BE), Dutch (BE) and Dutch (NL). A comparison of the different language versions was done to ensure that all questions would be interpreted in the same way.

2.3.1 Valuation scenario

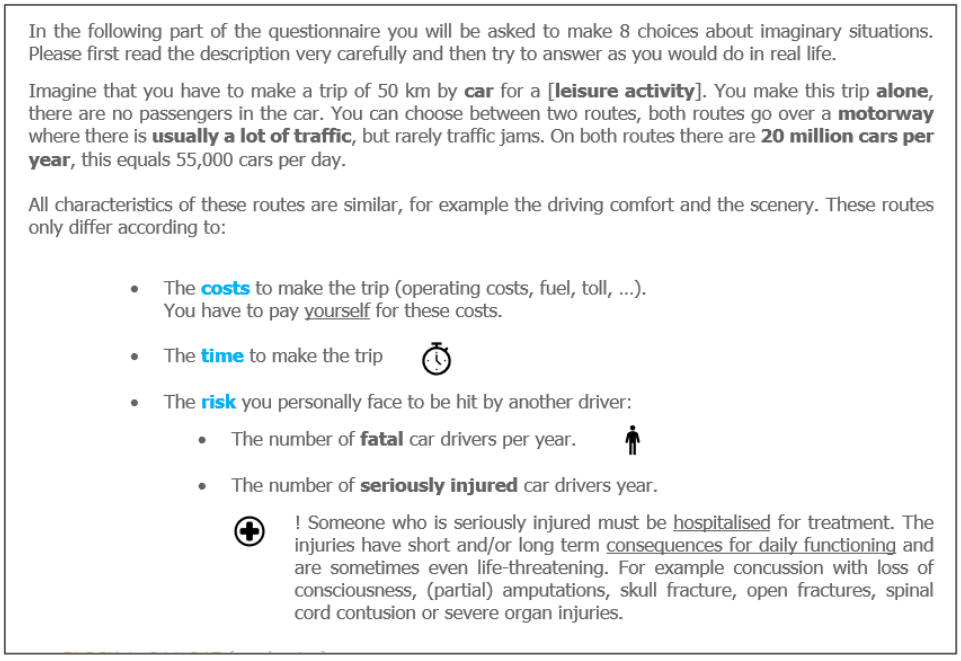
A crucial part of a stated choice survey is the design of the valuation context or valuation scenario. If the valuation scenario is not well designed, respondents give meaningless answers. An appropriate valuation scenario defines and describes the good that is provided (road safety) and the nature of the change in the provision of that good (increase or decrease). Next to that it's important that the valuation scenario is credible and does not elicit strategic behaviour (Pearce & Özdemiroglu, 2002).

A scenario in a stated choice study consists of one choice between several alternatives (road safety situations) which differ with respect to several attributes. Choice modelling is based on the idea that any good can be described in terms of its attributes or characteristics. These attributes include minimally a risk attribute and a cost attribute (the payment vehicle). Other attributes, such as time, can be included to make the scenario more realistic, and to collect more information about preferences. Different levels have to be assigned to the attributes so they can be combined into different scenarios by using an experimental design. From all possible scenarios we created choice sets (groups of scenarios) (§ 2.3.2), that were presented to the respondents and constituted the major part of the questionnaire (Pearce & Özdemiroglu, 2002)(Pearce & Özdemiroglu, 2002).

[2] (Rizzi & Ortúzar, 2003) (Hojman, Ortúzar, & Rizzi, 2005) (Iraguën & Ortúzar, 2004) (Rizzi & Ortúzar, 2006) (De Brabander, 2006) (Henscher D. A., Rose, Ortúzar, & Rizzi, 2009) (Henscher D. A., Rose, Ortúzar, & Rizzi, 2011) (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013) (Antoniou, 2014) (Carlsson, Daruvala, & Jaldell, 2010) (Flügel, et al., 2015) (Flügel, Veisten, Rizzi, Ortùzar, & Elvik, 2019) (González, et al., 2018) (Niroomand & Jenkins, 2016)

In the VALOR-survey a valuation scenario is presented to respondents in two parts. First the context and the attributes are described (Figure 1), next the choice scenarios themselves are presented (Figure 2). Each respondent has to consider 8 scenarios.

Figure 1: Description of the context and the attributes of a valuation scenario of the VALOR-survey.



In the following part of the questionnaire you will be asked to make 8 choices about imaginary situations. Please first read the description very carefully and then try to answer as you would do in real life.

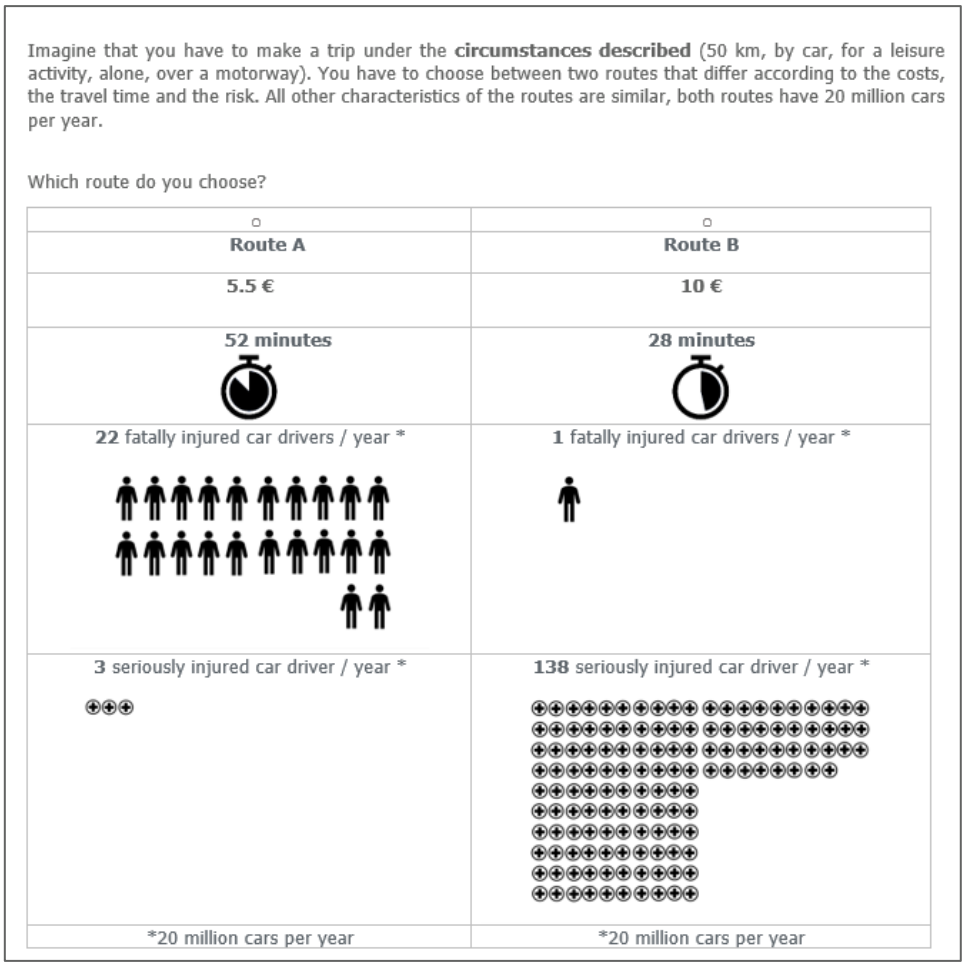
Imagine that you have to make a trip of 50 km by **car** for a [**leisure activity**]. You make this trip **alone**, there are no passengers in the car. You can choose between two routes, both routes go over a **motorway** where there is **usually a lot of traffic**, but rarely traffic jams. On both routes there are **20 million cars per year**, this equals 55,000 cars per day.

All characteristics of these routes are similar, for example the driving comfort and the scenery. These routes only differ according to:

- The **costs** to make the trip (operating costs, fuel, toll, ...).
  You have to pay yourself for these costs.
- The **time** to make the trip
- The **risk** you personally face to be hit by another driver:
  - The number of **fatal** car drivers per year.
  - The number of **seriously injured** car drivers year.

! Someone who is seriously injured must be hospitalised for treatment. The injuries have short and/or long term consequences for daily functioning and are sometimes even life-threatening. For example concussion with loss of consciousness, (partial) amputations, skull fracture, open fractures, spinal cord contusion or severe organ injuries.

Figure 2: Example of a choice scenario in the VALOR-survey.



Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes	**28 minutes**
22 fatally injured car drivers / year *	**1** fatally injured car drivers / year *
3 seriously injured car driver / year *	**138** seriously injured car driver / year *
*20 million cars per year	*20 million cars per year

2.3.1.1 Choice context

Route choice

Stated choice studies in the field of road safety have mainly used route choice scenarios (e.g. Rizzi & Ortúzar, 2003; Iraguën & Ortúzar, 2004; Hojman, Ortúzar, & Rizzi, 2005; De Brabander, 2006; Henscher, Rose, Ortúzar, & Rizzi, 2009; Henscher, Rose, Ortúzar, & Rizzi, 2011; Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013; Niroomand & Jenkins, 2016; González, et al., 2018; Flügel, Veisten, Rizzi, Ortùzar, & Elvik, 2019; Obermeyer, Hirte, Korneli, Schade, & Friebel, 2020), which means a respondent has to make a choice between two routes with different crash risks. Other types of scenarios have been used in contingent valuation studies such as a car choice scenario in which respondents have to state their WTP for vehicle safety devices (e.g. de Blaeij, 2003; Andersson, 2005; Vassanadumrongdee & Matsuoka, 2005). Other scenarios concern choosing a city to live in (eg. Guria, Leung, Jones-Lee, & Loomes, 2005) as well as specific scenarios for motorcyclists (WTP for a safer helmet; Mon, Jomnonkwao, Khampirat, Satiennam, & Ratanavaraha, 2018) and pedestrians (WTP for pedestrian subway; Bhattacharya, Alberini, & Cropper). In the VALOR-study a route choice scenario is developed.

Car driver on a motorway

The scenarios used in stated choice surveys are mostly not relevant for all types of road users. Most of the route choice scenarios in previous stated choice surveys are designed from the perspective of car drivers. There are some examples of stated choice studies that are designed for other road users: pedestrians (Henscher D. A., Rose, Ortúzar, & Rizzi, 2011) and bus passengers (Flügel, Veisten, Rizzi, Ortùzar, & Elvik, 2019). The latter study compared the results with the WTP of car drivers but found no significant difference.

For the VALOR-survey a route choice scenario for car drivers is developed. WTP values are assumed to be the same irrespective of the mode travelled, so the car driver mode is used for several reasons:

- It's still by far the most used travel mode
- Real world payment-vehicles (fuel cost, operating costs, tolls, etc.) exist so the 'ecological validity' of the setting is assumed to be present.
- Using other modes would introduce substantial drawbacks: for public transport the risk is perceived as less controllable by the users, with a responsibility shifted towards the 'system owner'. For walking and cycling no real 'payment vehicles' are present with which most respondents are familiar.

Another important feature of previous stated choice surveys with a route choice context is the definition of the road type. So far studies included a choice context with different types of roads: urban, interurban or motorways. Some of these studies used a specific existing road (e.g. Route 68 in Chile in Rizzi & Ortúzar (2003); TF5 in Tenerife in González, et al. (2018)), other studies asked the respondent about a trip they recently made and use the characteristics of that road for their scenario (e.g. Iraguën & Ortúzar (2004); Veisten, Flügel, Rizzi, Ortúzar, & Elvik (2013)).

The context of the valuation scenario in the VALOR-survey is a car trip of 50 km where the respondent has to choose between two alternative routes, both over a motorway. Since we wanted to avoid that characteristics other than those that were presented as the attributes were taken into account by the respondent, we did not further specify the characteristics of the motorway.

To ensure the realism of the scenario, only respondents for whom this situation is familiar have been selected in the sample, this includes respondents that have a driving license and that have driven at least once over the past 12 months on a motorway.

Trip motive

To increase the realism of the hypothetical choice situation other characteristics of the context can be added. These characteristics can be varied over the alternatives, in which case they become extra attributes (e.g., speed limit and number of speed cameras in Niroomand & Jenkins (2016)), they can be varied over choice sets or they can be varied over respondents (e.g. arrival time in Iraguën & Ortúzar (2004)).

In the VALOR-survey the trip motive was added and varied over respondents. This characteristic was determined based on a previous question in which a respondent was asked what his/her most frequent trip

motive was when driving on a motorway. A respondent could indicate one or two motives from a list[3]. One of the selected motives was randomly chosen to be presented in a scenario. The motives ”other” and “professional trips” were not used since “other” was meaningless to program in the text, and for “professional trips” respondents mostly don’t pay themselves , which is an important condition for a WTP-study. In these cases the trip motive was replaced with another one from the list of available options, if there was no suitable alternative, the motive “leisure activity” was used.

2.3.1.2 Risk presentation

Particular attention should be paid to respondents’ understanding of risk. If risks are explicitly expressed as probabilities (e.g., 5 out of 100,00 car drivers die yearly on a certain road), it is likely that respondents cannot interpret such risks correctly (Rizzi & Ortúzar, 2003). Therefore, most stated choice surveys use absolute values (e.g., number of fatalities per year) instead of probabilities. However, to be able to calculate the value of a statistical life (VSL), it’s necessary to have the probability of a fatal (or serious injury), i.e. the absolute numbers related to an exposure variable. Previous studies calculate the actual risk (probability of dying) afterwards by making assumptions about the traffic volume on the roads that were presented in the scenario (e.g. Henscher, Rose, Ortúzar, & Rizzi (2009)) but do not include this in the scenario that is presented to the respondent. Obermeyer, Hirte, Korneli, Schade, & Friebel (2020) argued that “people should at least be informed about the objective level of risk, even if the concept is difficult for some people to understand” and included therefore both the absolute number of victims per year and the probability (1 victim per number of trips).

In the VALOR-study the risk is presented in absolute values as the number of fatally injured car drivers and seriously injured car drivers per year. Next to that the volume of the total traffic flow (20 million vehicles per year) was indicated, so that respondents had all necessary information and were correctly informed about the objective risk level (number of fatalities or serious injuries per year divided by the annual traffic flow) of the routes. To promote the understanding of the traffic flow, it is explained in scenarios that the traffic flow is similar to the average traffic flow on motorways. In that way respondents have intuitively a more or less correct idea about the number of trips.

The number of trips is based on an estimated average of the real traffic flow on motorways in the four participating countries. This estimation is based on the length of motorways (EUROSTAT[4]) and the number of kilometres driven by vehicles on motorways per year (IRTAD[5]). The average traffic flow on motorways equals to around 20 million per year for the four countries. To make this more familiar to respondents, the traffic situation was further described as “usually a lot of traffic, but rarely traffic jams”. Also, the traffic flow per day was mentioned. This information was repeated for every scenario, and the traffic flow remained constant over all choice sets.

2.3.1.3 Description of the attributes

The alternatives in a stated choice scenario differ with respect to several attributes. Choice modelling is based on the idea that any good can be described in terms of its attributes or characteristics. These attributes include minimally a risk attribute and a cost attribute (the payment vehicle). Other attributes, such as time, can be included to make the scenario more realistic, and to collect more information. As a rule of thumb maximum four to five attributes should be included to avoid that the choice is too complex for the respondents (Pearce & Özdemiroglu, 2002)

In the VALOR-study four attributes were included: the payment vehicle, two risk attributes including the risk of having a fatal injury and the risk of having a serious injury and the travel time.

Payment vehicle

To be able to determine the WTP, the attributes should include at least a risk level and a monetary attribute. The way respondents are (hypothetically) supposed to pay (‘payment vehicle’) can be for example a tax

[3] To go to work; Leisure activities; To go to school; A professional trip (in a work related context, but not with the purpose of going to work); Dropping someone off/picking someone up; Running errands / services (grocery shopping, going to the doctor, to the bank,…); Visiting someone; Vacation; Other

[4] The information on the length of motorways was dated 2010 for Belgium and 2018 for Germany, France and the Netherlands

[5] The information on the number of vehicle kilometres was dated 2017 for Belgium and the Netherlands and 2018 for Germany and France

increase, road toll, fuel cost or bus ticket price, but should be as realistic as possible. The problem with a road toll is that people are not always familiar with it and this can lead to a high aversion which can lead to political voting or lexicographic behaviour (Hess & Rose, Should reference alternatives in pivot design SC surveys be treated differently?, 2009).

In the VALOR-study the payment vehicle is defined as the costs to make the trip (operating costs, fuel, toll, etc.). It is clearly specified that the respondent has to pay himself for the trip. For that reason, the motive of a professional trip is not used in the description of the choice context, since people mostly don't have to pay for the travel costs themselves in these circumstances.

Risk attributes

In the VALOR-survey the risk of being fatally injured is described as the number of fatal car drivers per year, and the risk of being seriously injured as the number of seriously injured car drivers per year. The volume of the traffic flow is mentioned in the description of the context (Figure 1), and is repeated in the scenarios (Figure 2). Thus, respondents have the full information to know their objective individual risk level.

Some studies show that the preference for safety increases when there is a passenger (Rizzi & Ortúzar, 2003). Therefore, it is clearly stated in the choice context (Figure 1) that a respondent has to make the trip alone, to make sure that he/she will only take the WTP for his/her personal risk reduction into account. Next to that it is emphasised in the attribute description that it concerns a "risk to be hit by another driver" you personally face " to avoid that respondents think they can control the risk by driving more carefully.

MAIS 3+ definition

Serious injuries are defined as MAIS3+ injuries, according to the definition that the European Commission established in 2013. The official definition of MAIS3+ injuries are (hospitalized) traffic victims with injuries that have a score of 3 or more on the Abbreviated Injury Scale (AIS) (European Commission, 2013). The AIS scores are developed by the Association for the Advancement of Automotive Medicine (AAAM) and the scale is "an anatomically based, consensus derived, global severity scoring system that classifies an individual injury by body region according to its relative severity on a 6-point scale (1=minor and 6=maximal). The MAIS is the highest (i.e. most severe) AIS code in a patient with multiple injuries." (AAAM, 2020). The scores are determined by a group of experts and are mainly based on the probability of death, but take also consequences of the injuries into account such as permanent impairment, treatment period and energy dissipation (MacKenzie, Steinwachs, & Shankar, 1988).

There exists however no official definition that gives specific information or examples about the impact and the consequences of these injuries for the victims, and it is therefore difficult to use the scores in the valuation scenario for our study. We examined the population of MAIS3+ victims aiming to introduce an operational definition, to illustrate the impact of these injuries on the victims, and to add some examples. The population of MAIS3+ victims is very diverse regarding their injuries and the consequences for their daily functioning. Since most of the MAIS3+ victims are MAIS3, the probability of death is not very high and should not be over-emphasized in the operational definition.

The operational definition therefore included:

- Hospitalisation
- Impact: the injuries have short and/or long-term consequences for daily functioning
- Probability of death: the injuries are sometimes life-threatening

Some examples of injuries are added to the definition, which are derived from the AAAM/EC conversion table for ICD10 to AIS (AIS3+). These include: concussion with loss of consciousness, (partial) amputations, skull fracture, open fractures, spinal cord contusion or severe organ injuries.

Time

Most stated choice studies in road safety include a time attribute. This makes the scenario more realistic since time often plays an important role in route choice. Next to that this attribute can be included for validation motives. For example, de Blaeij (2003) included travel time and determined the value of time in addition to the VSL. The resulting value of time was compared with previous travel time valuation studies to validate the method.

2.3.1.4 Visualisation

According to Wiktor, Louviere, & Swait (1998) the language for communicating the levels is important, and a visual representation of the levels helps the respondent.

In the focus groups we experienced that respondents have difficulties correctly grasping the different levels, and especially the differences between the levels that were presented in the two alternatives of a choice set. Therefore, we included icons to visualise the attributes time, the number of fatalities and the number of serious injuries. The levels of the payment vehicle are not visualised since in real life people are more familiar with comparing costs than with comparing the levels of other attributes.

The levels of time are visualized by marking the time on the clock icon, the levels of the numbers of fatalities and serious injuries are visualized by multiplying the icons (Figure 2). For the pilot study we chose a wheelchair as the icon for seriously injured people. This was corrected in the final survey since a wheelchair represents permanent impairment which is not a very common consequence of MAIS3+ injuries. Therefore, we changed the icon to a cross which represents a hospital, since hospitalization is the most common consequence of MAIS 3+ injuries.

Table 1: Visualisation of the attributes in the valuation scenarios

Attribute	Icon pilot study	Icon final study
Time		
Number of fatally injured car drivers		
Number of seriously injured car drivers		

2.3.2 Experimental design

In a stated choice study, different choice sets are presented to respondents. In each choice set a respondent has to choose between two or more alternatives. The alternatives consist of several attributes that differ in their levels. It's not possible to present all different combinations of attribute levels in the stated choice survey since the number can be very high depending on the number of attributes and the number of attribute levels. In the VALOR-survey there are 2 alternatives with each 4 attributes with 4 different attribute levels, which means there are 256 possible routes and 32,640 combinations of 2 different routes. Therefore, a selection of the choice sets needs to be made, this selection is called an "experimental design" (Traets, Sanchez, & Vandebroek, 2020).

There exist different experimental designs (full factorial design, orthogonal design, efficient design, randomly assigned designs, adaptive designs etc.). The choice of the design has an impact on the statistical power of the parameter estimates (ability to detect statistically significant relationships) and the ability to allow for an independent determination of the impact of each attribute (ChoiceMetrics, 2018).

In orthogonal designs all attributes are uncorrelated so that the parameters can be estimated independently. However, orthogonality is only important when one wants to determine the independent effect of attributes in linear models, while discrete choice models are not linear (Train, 2003 in ChoiceMetrics, 2018).

While orthogonal designs were used at first, now there is an increasing popularity of statistically optimal designs or efficient designs. In these designs the choice sets are selected that force the respondent to make trade-offs to maximize the information that is gained from every choice. This makes the parameter estimates more statistically efficient and minimizes the standard errors (Traets, Sanchez, & Vandebroek, 2020).

2.3.2.1 Efficient design

Efficient experimental designs combine attribute levels into choice sets, in order to generate statistically efficient parameter estimates, thus try minimizing the standard errors. These standard errors can be predicted

by determining an asymptotic variance-covariance matrix based on a guess of the true parameter values. The determinant of the variance-covariance matrix is called the D-error, which is a measure for the inefficiency of the design. The design with the lowest D-error will be chosen as it provides the most statistically efficient parameter estimates (ChoiceMetrics, 2018).

To get a good estimation of the true parameter values, it is necessary to collect additional information in order to define good prior parameter estimates. These can be found by doing a literature review, a pilot survey or by expert judgement and focus groups. When doing a literature review, it's important to critically evaluate the values by looking at the context and the model specifications.

The efficiency of the design depends on the accuracy of the guess of the true parameters. A Bayesian D-efficient design takes the uncertainty of the true value of the parameters into account: in these designs a prior distribution instead of a point estimate is defined. Possible distributions are: (truncated) Normal, Uniform and the Lognormal distribution. The mean and the variance can be calculated by defining for each attribute an upper and lower boundary in between which the true coefficient should be located (Traets, Sanchez, & Vandebroek, 2020).

In the VALOR-survey a Bayesian D-efficient design is used. The design is created in R via the package "idefix" (Traets, Sanchez, & Vandebroek, 2020) which allows to get a DB-efficient design minimizing the D-error. For the pilot survey the design was created by using a point estimate with values from a similar German study conducted in 2018 (Obermeyer, Hirte, Korneli, Schade, & Friebel, 2020). For the final survey the design was created by using a truncated normal distribution and prior estimates details in the next section (§ 2.2).

The design for the pilot survey consisted of 6 choices and the design of the final survey consisted of 14 choices that were divided in two blocks. Next to that we defined a dominant scenario to exclude the irrational respondents (§0), so every respondent has had to deal with 8 choice sets (7 in the pilot study).

2.3.2.2 Prior estimates

There were multiple possibilities to define the prior parameter estimates for the VALOR-survey. For the experimental design of the pilot survey, we used the parameter estimates from a similar study that was conducted in Germany (Obermeyer, Hirte, Korneli, Schade, & Friebel, 2020). Consequently, we could use the parameter estimates from the VALOR-pilot survey for the final survey. However, there were some problems with these estimates: some values were much higher than in the literature, besides there was a possible influence of a non-representative sample and the operational definition of MAIS3+ did not correspond to the actual severity of injuries. Therefore, it was decided to deduct the prior parameter estimates from a literature review.

The prior estimates were used for developing the experimental design (combining the levels of the attributes), as well as for calculating the most optimal differences between the levels of the attributes (to make sure people make trade-offs) (§ 2.3.2.3).

Prior estimate for the Value of a Statistical Life (VSL)

According to the OECD report (OCED, 2012), for transfers between countries, VSL should be adjusted with the difference in Gross Domestic Product (GDP) per capita to the power of an income elasticity of VSL of 0.8, with a sensitivity analysis using 0.4 (with Purchasing Power Parities, preferably by Actual Individual Consumption AIC) as follows:

$$VSL'_p = VSL_s\,(Y_p/\mathrm{Y_s})^{ß}$$

where VSLs is the original VSL estimate from the study context, Ys and Yp are the income levels in the study and policy context, respectively, and ß is the income elasticity of VSL (in terms of WTP for reducing the mortality risk). Besides, updating from USD_{2005} to EUR_{2019} could be approximated using the average Consumer Price Index (CPI) for OECD an EU-27 respectively.

According to the OECD results, the median VSL has been estimated at 3,012,558 USD_{2005} and 3,614,506 USD_{2005} respectively for OECD countries and EU-27 countries. The mean VSL has been estimated at 4 007 9000 USD_{2005} and 4,704,038 USD_{2005} respectively. The value of 3,614,506 USD_{2005} is recommended as a base value for transfers.

According to Eurostat, the Purchasing Power Parity (PPP) in terms of Actual Individual Consumption (AIC) between 2005 USD and 2005 EUR was 1.2581, then the VSL in 2005 was 2 872 988€$_{2005}$. Between 2005 and 2019, the real GDP per capita increased by 16% in EU27. Applying the transfer formula, the VSL in EU-27 would have increased from €2.873$_{2005}$ million in 2005 to €3.238$_{2005}$ million in 2019. According to Eurostat, the Harmonised Index of Consumer Prices (HICP) increased by 28% between 2005 and 2019 and then the VSL in EU-27 should be around €4.144$_{2019}$ million in 2019.

Now we can apply the transfer formula to every country:

Table 2: VSL in EU-27 and in the countries studied in VALOR according to the recommendations of the OECD report

	EU-27	Belgium	France	Germany	The Netherlands
Ratio PPP	1	1.16	1.11	1.07	1.20
VSL (2019)	4.144 Mill EUR	4.667 Mill EUR	4.505 Mill EUR	4.375 Mill EUR	4.795 Mill EUR

Using the results of the OECD report and its recommendations, we obtain VSL ranging from 4.375 Mill EUR for Germany to 4.795 Mill EUR for the Netherlands. The average VSL is **4.586 Mill EUR.** If we assume that the costs of a serious injury can be approximated at around 15% of the VSL, a reasonable prior estimate of **688,000 EURs** could be used.

Prior estimate for the Value of a Statistical Serious Injury (VSSI)

In the HEATCO-project (2006), the VSL to the VSI ratio for participating countries varies between 13.2% and 15.2% with an average value of 14%. For some other Europeans countries, this value amounts to 15%. The SafetyCube research project (Schoeters et al. 2017) investigated in depth the issue of crash costs for a serious injury. The results show a high variability among the different countries depending on the used methodology for estimating the costs, the different components of costs considered and the location of country. The countries from the North of Europe have higher values.

In the expert report prepared for the DG Move (Korzhenevych et al., 2014), the ratio between the unit value of a serious injury and VSL is estimated at 15.1% for Belgium, 13.9% for France, 13.8% for Germany and 13.2% for the Netherlands. In average, the value of this ratio is 14%. Blincoe and his co-authors (2015) estimated a value of 15% for the USA.

First, the estimated ratio is quite consistent among the different studies. It is mainly explained by the kind of anchor effect, because some studies are strongly influenced by prior estimates.

Second, although a serious injury is relatively clearly defined, it causes a large diversity of harmful consequences with which important variability of costs is associated. Consequently, searching for a value for such a ratio necessarily implies a simplification of the diversity of harms and the value has to be considered as a proxy at best.

Taking into full considerations the above elements, conclusion can be made that the value of 15% remains a reasonable and meaningful figure.

Prior estimate for the Value of Time (VoT)

Several European studies on the external costs of transport have proposed a standard European value of time (VoT). The most recent publication is the 'Handbook of external costs of transport' (Van Essen et al., 2019). Their default VoT is based on a study in the UK, which they differentiate by country taking into account relative price differences using purchasing power parities (PPP). They distinguish between business/commuting and other trip motives. Also a previous version of this handbook (Korzhenevych et al., 2014) used a VoT from the UK as default. In the HEATCO-project (Bickel et al., 2006), a meta-analysis of 77 VoT-studies in 30 countries was conducted to determine a standard VoT. A distinction was made between long and short distance trips and between business and non-business trips. The same values were used in the subsequent 'Handbook on estimation of external costs in the transport sector' (Maibach et al., 2008).

The prior VoT estimate used in VALOR study is based on the HEATCO-project, because they are based on a meta-analysis instead of the VoT in one country. The unweighted mean of the VoTs of long/short distance trips and business/non-business trips per country is used. Calculating a weighted mean was not possible due to the lack of data on distance travelled or number of trips by trip length and travel motive. The HEATCO

values for 2002 are updated to price level 2020 using the index of real GDP per capita in the first and second quarter of 2002 and 2020 per country (source: Eurostat), using an elasticity of 0.7 as recommended by HEATCO. The resulting average VoT for the four countries is 11.5 Euro. Table 3 summarizes the results.

Table 3: Value of time (Euro/hour). Source: Bickel et al. (2006) and own calculations

	Commuting		Leisure		Average	
	2002		*2002*		*2020*	
	short	**long**	**short**	**long**	**short**	**long**
Belgium	7.8	9.8	6.4	8.3	8.1	10.5
France	11.0	14.1	9.2	11.8	11.5	13.6
Germany	8.0	10.3	6.8	8.7	8.4	11.3
Netherlands	7.8	9.8	6.5	8.4	8.1	10.7
Average	8.6	11.0	7.2	9.3	9.0	**11.5**

2.3.2.3 Levels of the attributes

Actual values

There are stated choice studies in which the hypothetical choices are pivoted on actual travel behaviour (e.g. Veisten, Flügel, Rizzi, Ortúzar, & Elvik (2013); González, et al. (2018); Niroomand & Jenkins, (2016). In these surveys the respondents are asked about a recent trip, from which the time, cost and sometimes even risk are derived.The main objective is to provide a realistic (and familiar) context for the respondents. However, Hess & Rose (2009) state some issues with "reference point designs": these can induce respondents to exhibit inertia or non-trading behaviour. While this is the norm in real markets, it can cause model estimation problems and does not provide any information about the trade-offs that respondents are willing to make between the various attributes. This inertia effect was also found by González, et al. (2018) where a stated choice study was conducted including an actual trip. For that reason, the choices in the VALOR-survey are not pivoted on actual behaviour.

According to Pearce & Özdemiroglu (2002) the levels of the attributes should include the current situation and realistic levels above and under the current levels. However, the actual risk levels are too small to include them with enough realistic variation in the survey to encourage respondents to make a trade-off. Respondents mostly don't have an idea about the actual risk figures, so presenting higher number of fatalities and serious injuries does not influence the realism of the choice experiment. Respondents however do have a realistic idea about the actual time and – to a lesser extent – cost of a certain trip. As both time and costs can easily increase in a trip (because of congestion, tolls), it would make sense to present a higher time and cost level than the actual one, but it would not make sense to present a lower time and cost level. For these reasons, in the VALOR-study the actual risk, time and cost levels are used as the lowest level that is presented to respondents. The actual values of the attribute levels are presented in Table 4: Calculation of the actual attribute levels of the trip presented in the valuation scenario.

Table 4: Calculation of the actual attribute levels of the trip presented in the valuation scenario

Attribute	Calculation
Travel cost	The travel cost is described as the operating costs, the full and possible toll. We looked into the gas prices and the average gas consumption for a motorway car trip of 50km. On the 1st of October 2020 the gas prices (E10) are 1.22/l (Germany), 1.33/l (Belgium, France) and 1.69/l (Netherlands), which is on average 1.4/l (ANWB, 2020). The average gas consumption for a speed of 100 km/h equals 7.5l (Milieu Centraal, 2020). The gas consumption for 50 km with an average speed of 100 km/h equals 5.25 EUR. When adding extra costs such as maintenance and toll, we estimate the actual travel cost at **6 EUR**.
Travel time	The travel time is defined as the time for a one-way trip. The time is calculated as the time needed for 50 km with an average speed of 100 km/h, which is **30 minutes**.
Number of fatally injured car drivers	The actual number of fatalities for car drivers per 50 km of motorway per year in the participating countries in 2018 was: • 1 (France, Netherlands), • 2 (Germany) and • 3 (Belgium) (European Commission, 2020).
Number of seriously injured car drivers	There are no comparable figures specifically for MAIS3+ victims among car drivers on motorways available for the four countries. The number of serious injuries (according to national definitions) among car drivers on 50 km of motorways per year in 2018 are • 5 (Germany), • 10 (Belgium), • 21 (Netherlands) and • 25 (France) (European Commission, 2020).

Level differences

The attribute level differences were calculated using prior parameter estimates. To increase the likelihood that respondents will make a trade-off by considering all four attributes, we chose a variation of the attribute levels that reflects a utility variation that is similar for all attributes. Taking into account the prior estimates that were calculated for the experimental design (§ 2.3.2.2), we find the attribute levels presented in Table 5. For each attribute there are four levels, which are all presented at least once in the 8 validation scenarios that are presented to the respondents.

Table 5: Attribute levels and corresponding expected variation of utility per level difference according to prior parameter estimates.

	Level 1	Level 2	Level 3	Level 4	Prior estimate	Expected utility variation
Travel cost	5.50	7	8.50	10	/	1.50 EUR
Travel time	28	36	44	52	11.50 EUR/hour	1.53 EUR
Number of fatally injured car drivers	1	8	15	22	4.586 Mill EUR	1.60 EUR
Number of seriously injured car drivers	3	48	93	138	0.688 Mill EUR	1.55 EUR

2.3.3 Other questions

2.3.3.1 Purpose

To ensure that respondents understand the context, are motivated to cooperate and are able to participate in an informed manner the interviewer should explain who they are and that the answers will be treated confidentially (Pearce & Özdemiroglu, 2002).

These elements are all mentioned in the introduction of the VALOR-survey:

"In this questionnaire we will ask you questions regarding your current travel behaviour and general attitudes. We will also ask you to make choices between different routes. This questionnaire is part of a study conducted by [institute], the purpose of the study is to investigate behaviour when choosing a route. There are no right

or wrong answers. Your responses will be treated anonymously and the results will be used for research purposes only. The survey will take approximately 15 minutes."

2.3.3.2 Travel behaviour

In order to test the familiarity of the respondents with the good and to distinguish users from non-users, stated choice surveys mostly include a question about the use of the good (Pearce & Özdemiroglu, 2002). In some stated choice studies (Rizzi & Ortúzar, 2003; Iraguën & Ortúzar, 2004; Hojman, Ortúzar, & Rizzi, 2005; Obermeyer, Hirte, Korneli, Schade, & Friebel, 2020; Henscher D. A., Rose, Ortúzar, & Rizzi, 2011; De Brabander, 2006) information about the travel behaviour is used to design the (context of the) valuation scenarios, to make them more realistic/recognizable.

In the VALOR-survey two questions were included with the purpose to exclude respondents that were not familiar with the valuation scenario from the survey: the possession of a driving license and the frequency with which the respondent has driven a car on the motorway in the past 12 months. Besides, one question on the most frequent motive of a car trip on a motorway was included to design the context of the valuation scenario.

Furthermore, other questions related to travel behaviour were included as a validity check. According to Pearce & Özdemiroglu (2002) "the relationship between the use of a good and the [WTP] values is expected to be positive and to vary directly with the particular degree of use." These questions are about:

- Frequency of the use of certain transport modes, including bicycle, moped, motorcycle, car, light/heavy vehicles truck or public transport.
- Number of kilometres driven in a person car in the past year
- The person who normally pays the costs of car trips for private motives

The hypotheses that can be tested are:

- Frequent car drivers have a higher WTP for safety.
- Respondents who drive more kilometres per year have a higher WTP for safety.
- Respondents who don't pay themselves for their travel costs have a higher WTP for safety and time.

The phrasing of these questions is derived from existing questionnaires such as ESRA (E-Survey of Road users' Attitudes)[6] (Meesmann, Torfs, & Van den Berghe, 2019) and were already tested for comprehensibility.

2.3.3.3 Sociodemographic variables

Information on sociodemographic characteristics is used to test whether the resulting willingness-to-pay values conform to theoretical explanations. A minimum list is age, gender, income and education (Pearce & Özdemiroglu, 2002).

Hypotheses based on sociodemographic information that are tested are:

1. Women reveal higher preference for safety than men (Rizzi & Ortúzar, 2003) (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013)
2. Older respondents reveal higher preference for safety than younger respondents (Rizzi & Ortúzar, 2003) (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013) (Hojman, Ortúzar, & Rizzi, 2005)
3. Respondents with higher education reveal higher preference for safety and time (Viscusi & Evans, 1990) (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013)
4. Respondents with children have a higher preference for safety and time (Veisten, Flügel, Rizzi, Ortúzar, & Elvik, 2013) (Iraguën & Ortúzar, 2004) (Hojman, Ortúzar, & Rizzi, 2005)
5. Respondents with higher income have a smaller disutility of spending money and thus a higher WTP for time and safety (Iraguën & Ortúzar, 2004) (Hojman, Ortúzar, & Rizzi, 2005)

The socio-demographic variables in the VALOR-survey include:

- Age
- Gender

[6] https://www.esranet.eu/

- Residence: postal code
- Education: highest qualification or educational certificate obtained
- Professional occupation, including information, whether their professional education dealt with the transportation of freight or persons
- Having children
- Income: calculated based one two questions
    - The household size (number of persons younger than 14 years and older than 14 years)
    - The household's net monthly income

Since questions about socio-economic characteristics are very personal, they were asked at the end of the questionnaire to avoid a non-response or biased answers.

The questions regarding education and professional occupation are derived from the ESRA-survey (Meesmann, Torfs, & Van den Berghe, 2019).

For the question about the households' net income the EUROSTAT definition of a household is used which means "people that live together and share expenses" (EUROSTAT, 2020). The equivalised disposable income according to EUROSTAT is the total income of a household, after tax and other deductions, that is available for spending or saving per household converted into equalised adults; household members are equalised or made equivalent by weighting each according to their age:

- 1.0 to the first adult;
- 0.5 to the second and each subsequent person aged 14 and over;
- 0.3 to each child aged under 14 (EUROSTAT, 2020).

2.3.3.4 Experience with road crashes

Questions regarding experience with road crashes can also be used as an additional theoretical validity check. In previous studies it was found that respondents that were previously involved in a serious accident reveal higher preference for safety (Iraguën & Ortúzar, 2004) and respondents who themselves, or whose close friends or relatives have recently been victims of a road accident, reveal a higher preference for safety. Both groups do not differ significantly (Haddak, Lefèvre, & Havet, 2016).

In the VALOR-survey two questions on experience with road crashes were included: one about the personal experience, and whether a respondent has any relatives that were involved in a road crash.

2.3.3.5 Attitudes and opinions

Including questions about attitudes regarding the good and examining the relationship between these attitudes and the WTP values can serve as an additional theoretical validity check.

Subjective safety perception

We added a question about subjective safety perception since it is expected to have an influence on the WTP. The hypothesis is that respondents who feel less safe in traffic, would have a higher WTP for safety. The question about subjective safety is derived from the ESRA-survey (Meesmann, Torfs, & Van den Berghe, 2019) and adapted to the valuation scenario of the VALOR-survey.

"How safe or unsafe do you feel when travelling by car on a motorway in [country]? You can indicate your answer on a scale from 0 to 10, where 0 is "very unsafe" and 10 is "very safe". The numbers in between can be used to refine your response."

Changed attitudes since COVID-19

The pilot survey was launched in July 2020 and the final survey in October 2020. Both surveys cover the period in which the COVID-19 pandemic was present in all four countries. To test if the pandemic had an influence on the respondents' attitudes towards road safety, we included two questions that measure the personal importance of road safety and the feeling that road safety has increased or decreased.

"Do you have the feeling that road safety in [country] has decreased, increased or has remained the same in comparison with the period before the outbreak of COVID-19?"

"Has road safety become more, less or equally important to you personally since the outbreak of COVID-19?"

Latent variables

Lastly, the VALOR-survey includes questions about individual attitudes regarding different attributes considered in the stated preferences experiments. We rely on these questions to implement Integrated Choice and Latent Variable (ICLV) models. See Walker (2001) for a general presentation of ICLV models, Bouscasse (2018) for a review of studies that mobilize ICLV approaches in the frame of transport choice analyses or Johansson et al. (2006) for a concrete application on mode choice.

For each travel attribute (time, cost and risk), it is assumed that some hidden attitudes and/or opinions, specific to each individual, could explain differences observed in the data, in the route choices, hence in the VSL and VoT. This heterogeneity is not directly explained by sociodemographic variables (e.g., gender, age, income) or by subjective safety perception. These unobserved variables are expected to have a significant influence on the marginal disutility caused by spending money, spending time in traffic, and facing a physical health risk. This type of model has been applied to investigate heterogeneity in VoT by Abou-Zeid et al. (2010) or Bouscasse and de Lapparent (2019).

The latent variables considered in this research are:

- "Thriftiness", the tendency to save or spend money (expected to have an influence on the cost attribute)
- "Perceived time pressure", the ease of spending more time for some activities over the curse of the day (expected to have an influence on the time attribute)
- "Physical risk-taking behaviour", the likelihood that individuals perform activities that involve physical risks (expected to have an influence on the two risk attributes)

In order to measure latent variables and to add them into the discrete choice model, psychologists advise to use scales that are internationally validated. To assess physical risk-taking behaviour, some questions shown below were borrowed from the 2006 version of the DOSPERT (Domain Specific Risk Taking) Subscale concerning Health/Safety risk which was validated in different countries with different cultures . Other questions have been formulated and by the authors of the VALOR project[7]. Following statements were presented to respondents:

- *"Try out a new extreme sport"*
- *"Driving as a passenger with someone who may have had too much to drink"*
- *"Regularly eating high cholesterol food"*
- *"Driving on a moped as a passenger without a helmet"*
- *"Sunbathing without sunscreen"*
- *"Walking home alone at night in an unsafe area of town"*

For each of these questions, interviewees had to choose a score on a Likert scale in order to describe likelihood of doing the proposed activities (with 1 for "extremely unlikely" and 7 for "extremely likely").

In order to evaluate a thriftiness of the respondents, 6 following statements have been proposed. Some of these are adapted from existing scales: "I am careful with my money" is adapted from the "Money Ethic Scale" (Tang, 1995), "I hesitate to spend my money, even on necessities" from "Money Attitude scale" (Yamauchi & Templer, 1982), "I find it difficult to limit my spending" from the "Spendthrift-Tighwad scale" (Rick et al., 2008), and "I can easily postpone a purchase so that I can save" from the "Tight and Frugal scale" (Lastovicka et al., 1999). Others have been originally developed for the VALOR project and tested by focus groups and in the pilot study.

- *"When I do my shopping, I am on the lookout for potential promotions"*
- *"To me it is important to save as much as possible"*
- *"I hesitate to spend money, even on necessities"*
- *"I am careful with my money"*

[7] The different statements presented in this section have been progressively selected, based on answers from both the focus groups and the pilot surveys. Whereas some questions initially identified have been kept for the final survey others have been removed and replaced.

- *"I find it difficult to limit my spending"*
- *"I can easily postpone a purchase so that I can save".*

Similarly, respondents chose a score ranging between 1 ("strongly disagree") and 7 ("strongly agree") for each item.

Finally, we have considered 6 following statements, some of them from existing scales: "I am often in a hurry", "I always seem to be doing things at the last moment" and "I often try to do more than one thing at a time" from the "Time Attitude Scale for Cross Cultural Research" (Rojas-Mendez et al., 2002), and "I often feel time pressure in my daily life" from a scale concerning perception of time (Ackerman and Gross, 2003). Others have been developed for the VALOR project and tested during by focus groups and in the pilot study.

- *"I am often in a hurry"*
- *"I always seem to be doing things at the last moment"*
- *"I often try to do more than one thing at a time"*
- *"I regularly check what time it is"*
- *"The days are too short to carry out all daily tasks"*
- *"I often feel time pressure in my daily life".*

Answers range between 1 ("strongly disagree") and 7 ("strongly agree").

It is worth noting that the validity of these measurement questions must be examined to be sure that answers are consistent with each other and effectively contribute to obtaining information about the presupposed attitudes and psychological dimensions. In practice, one can calculate Cronbach's alphas (Cronbach, 1951) because this statistic allows identifying similarities in answers' patterns as well as statements that capture phenomenon different than those under investigation. It is the most used measure to assess the reliability of a scale (Peterson, 1994). According to Nunnally (Nunnaly, 1978) a scale with a satisfactory intern consistency has a Cronbach coefficient alpha above 0.7.

2.4 Validity and reliability checks

Next to this "internal" validity check, it is possible to examine the "external" validity of the statements. VALOR-survey includes with this purpose questions about the importance given by respondent to each of the three travel attributes (cost, time, risk of accidents) within the stated preferences exercise. One may expect that people whose answers allow us to consider them as "thrifty" would simultaneously report that the cost attribute is "very important" in the route choice experiments. Irrational behaviour

One of the validity checks that is recommended by Pearce & Özdemiroglu (2002) is to test whether respondents are making rational choices. This can be done by including a dominant scenario in which one alternative is clearly inferior to the other one. In the VALOR-survey the last scenario that is presented contained a dominant alternative. The respondents that chose the inferior alternative, were removed from the sample since they are not showing rational behaviour which is an assumption of the choice model.

2.4.1.1 Lexicographic behaviour

When the respondent always evaluates the alternatives on the basis of the same attribute (or subset of attributes) he is showing lexicographic behaviour. This causes a problem for the modelling since these respondents only provide information about the lower or upper boundary of their value of risk reduction or time whereas the models we used, assume utility maximizing respondents (that make a trade-off, thus have compensatory behaviour). Based on the literature there are different motivations for lexicographic behaviour (Hess, Rose, & Polak, 2010)

- Simplification: these responses do not reflect the actual preferences of the respondents and the respondents are not making any trade-offs, thus do not show utility maximizing behaviour.
- Actual preferences:
    - Genuine lexicographic behaviour: these are respondents that want safety/time at any cost and refuse to make any trade-offs, which is not utility maximizing behaviour.
    - Strategic behaviour, these respondents don't show their actual preferences and are thus not showing utility maximizing behaviour.

- Individual-specific thresholds are not presented, the level differences are too small to make a trade-off. For these respondents the attribute level differences are not adapted to show their upper or lower boundary. These respondents are showing utility maximizing behaviour (Hess, Rose, & Polak, 2010).

Very few stated-choice surveys have investigated the motivation of lexicographic respondents. In most studies all lexicographic respondents were removed from the sample. Elvik (2016) advises however to look into the motivations of lexicographic respondents, because excluding them could cause a bias. There are different ways in which the motivation of lexicographic respondents can be studied. Two of them are included in the VALOR-survey.

Asking directly for the reason of lexicographic behaviour

In the VALOR-survey the respondents that answered lexicographically concerning risk (always chose the alternative with the lowest number of fatalities or serious injuries), time (always chose the alternative with the lowest travel time) or cost (always chose the alternative with the lowest cost) were asked an additional question about the reason for their lexicographic choices.

The question that was presented to the respondents that answered lexicographically concerning risk is:

From your choices it appears that you have always chosen the route with the smallest number of fatalities or serious injuries. What was the reason?

- *The choice was too complex so I focused only on fatalities and/or serious injuries.*
- *I did consider costs and travel time when taking my decision, but the differences in the number of fatalities and/or serious injuries were too big to choose a cheaper or faster route.*
- *I did consider costs and travel time when taking my decision, but the differences in the costs or the travel time were too small to choose a less safe route.*
- *I would always take the safest route, even if the cost or travel time would be (very) high.*
- *I don't know*
- *Other: ___*

If a respondent chose the option "*The choice was too complex so I focused only on fatalities and/or serious injuries"* he/she indicates that his/her motivation is simplification which means that a respondent is not showing utility maximizing behaviour. If a respondent chose the option "*I would always take the safest route, even if the cost or travel time would be (very) high"* he/she is showing genuine lexicographic behaviour, and thus not showing utility maximizing behaviour.

However, respondents that chose the options "*I did consider costs and travel time when taking my decision, but the differences in the number of fatalities and/or serious injuries were too big to choose a cheaper or faster route"* or *"I did consider costs and travel time when taking my decision, but the differences in the costs or the travel time were too small to choose a less safe route"* indicate that their individual-specific thresholds were not presented which means that these respondents are showing utility maximizing behaviour.

Contingent valuation question

An approach that is recommended by Elvik (2016) is to compare two sources of information about preferences. This was done by Sælensminde (2006) who compared a contingent valuation question with the values derived from stated choice questions. If the amount that a respondent is willing to pay for safety or time based on the CV-question is higher than the maximum amount that is given in the stated choice experiment, the respondent shows lexicographic preferences and one can assume that he is not using a simplification strategy.

A closed contingent-valuation question about the value of safety (number of fatalities) and the value of time is included in the VALOR-survey.

Respondents with lexicographic or irrational answers were excluded from the sample used for the econometric analysis in order to reduce potential estimation biases. The procedure used to detect and exclude these respondents is based on the strategy presented above and described in details in the Section 3.2.

2.4.1.2 Hypothetical bias

One of the possible sources of bias problem of stated preference studies is their hypothetical character (Henscher D. A., 2010). Different measures have been taken while designing valuation scenarios to minimize the risk of hypothetical bias which are partly based on feedback from the focus groups and the pilot survey. Aiming to assess the extent of hypothetical bias, a question was added:

Are there parts of the choice situations that you think were not realistic?

- *Yes*
- *No*
  Please explain: _____

2.5 Panel provider

After developing the content of the questionnaire, one single panel provider (www.profacts.be) for the four participating countries was selected based on a public procurement procedure.

One of the selection criteria was that the panel provider had to be able to offer a country-representative panel in each of the participating countries. Representativeness was defined in terms of an correct representation of all relevant age categories (6 categories: 18-24, 25-34, 35-44, 45-54, 55-64, 65+) and gender. The regional distribution of respondents across the different countries at least had to be monitored.

The basic version of the questionnaire was developed by the consortium in English and subsequently translated to the official languages of the four participating countries (German, French, Dutch) by the consortium partners. Particular word choices and nuances were checked and discussed in order to avoid differences between different language versions.

The task of the panel provider was to program the questionnaires in a web environment that was the same for each of the participating countries and languages. Subsequently, the panel provider had to execute the pilot survey and subsequently the final survey in each of the four participating countries. Respondents who participated to the pilot survey were excluded from participation to the final survey. GDPR-compliance was assessed and warranted by the service provider. At the end of the process, the panel provider delivered a dataset of anonymous answers to the consortium.

2.6 Focus groups

Before conducting the main survey, it is important to test the questionnaire. Two types of testing can be distinguished, which can be carried out successively (Pearce & Özdemiroglu, 2002). Firstly, focus groups of 6 to 12 people can be used for initial qualitative tests of the questionnaire, to see if the questions are understood, the wording is adequate, the scenarios are perceived as realistic, the attributes are relevant, etc. Johnston, et al., (2017) recommend using at least 4 to 6 groups.

In February 2020 several focus groups were organized in Belgium, France and Germany to test the wording and the understanding of the questionnaire. There were 11 German participants, 9 Belgian participants and 12 French participants of different backgrounds, ages and gender.

Based on focus groups feedback major changes were applied to the questionnaire:

1 **Number of scenarios**: in the focus groups 10 choice sets were presented to respondents. Feedback was given that there were too many scenarios, which caused fatigue and less reliable answers. It was decided to decrease the number of scenarios to 7.
2 **Dominant scenario**: none of the respondents reported the presence of a choice set with a dominant alternative as disturbing, some did not even notice the dominant scenario. It was decided to keep the dominant scenario.
3 **Description of the scenario**: the description of scenarios was experienced as too long, some respondents did not read or remember all information that was presented. It was decided to shorten the text, put the important elements in bold and to shortly repeat the most important elements for each choice set.

4 **Definition of a serious injury**: the definition of a serious injury was not read carefully by all respondents, so they had very different interpretations. It was decided to put some elements of the definition in bold and to create the possibility to read the definition again in every choice set by hovering over the words "serious injuries". An icon of a wheelchair representing serious injuries was included.
5 **Lack of realism**: some respondents experienced scenarios as not realistic. To respond to this issue, the number of kilometres was added to descriptions of scenarios and an additional question about the realism of the scenarios was included aiming to test hypothetical bias.
6 **Risk perception**: some respondents did not take risk attributes into account because they believe they are safe drivers and the risk is not relevant for them. The description of the risk attributes was therefore changed to "the risk to be hit by another driver you personally face".
7 **Need for visualisation**: some respondents asked for some visual aid to help them to understand the attributes and their levels. Therefore, icons indicating the attribute levels were added for each attribute.
8 **Lexicographic behaviour**: the major part of the respondents answered lexicographically. The reasons for this behaviour that were given by the respondents were: too small differences, simplification of the task, boredom (the choices were too similar) and willingness to be consistent in their choices. It was decided to adapt the attribute levels and the experimental design to increase the differences in the utility levels of each choice set by using a DB-efficient experimental design using good prior parameter estimate distribution. Besides, additional questions about the motivation of lexicographic behaviour were included in the questionnaire.
9 **Latent variables:** based on the feedback of the respondents the formulation of the statements was adapted, and, following the first quantitative analysis in which the Cronbach's Alpha was calculated, some statements were replaced and one was removed aiming to improve the scale.

2.7 Pilot survey

Subsequently, pilot surveys with small samples (typically 25 to 100 respondents) can be conducted. In addition to testing the appropriateness of questionnaire design (similar to the focus group tests), results of the pilot can be analyzed in a simple way to see if the questionnaire is valid and the outcomes are plausible (Pearce & Özdemiroglu, 2002).

Between 6th and 10th of July 2020 a pilot survey was conducted with 100 respondents in each country, 400 in total. The average duration of the survey was 15 minutes and 28 seconds (median 9 minutes and 38 seconds).

The analysis of the pilot survey showed some shortcomings. Additional changes were applied to the questionnaire for the final survey:

10 **Latent variables**: based on the quantitative analysis in which the Cronbach's Alpha is calculated, some statements were replaced to improve the scale.
11 **Influence of risk perception**: The Netherlands showed a lower VSL, probably due to a lower initial risk level or a lower risk perception. A question was added about subjective safety perception.
12 **Overestimation of the value of a serious injury**: The value of a serious injury was much higher than what is found in other SC-studies. A possible cause is that the definition, and the icon of a wheelchair do not represent a typical MAIS3+ victim, but rather a more severe injury. Next to that the attribute levels and their differences are not appropriate and show too little variation. It was decided to change the definition and the icon, and to adapt the attribute levels and the experimental design. Also the number of scenarios was increased to 8 to provide more variation.
13 **Change phrasing of question about household size**: since many respondents appear to not count themselves to the household size, the phrasing of the question was changed to "How many other people live in your household (except yourself)?"
14 **Influence of COVID-19**: we added two extra questions to measure the impact of COVID-19 on the perception of the importance of road safety.

3 Results

3.1 Descriptive analysis

The final survey was conducted between 22nd of October and 13th of November 2020. The average duration of the survey was 14 minutes and 8 seconds (median 10 minutes and 12 seconds). The descriptive analysis presented below refers to the total sample and does not completely match the econometric analysis sample because the latter excludes the irrational and the lexicographic behaviours (see below 3.2.).

3.1.1 General characteristics

The final survey sample includes 8,003 respondents. It comprises 2,005 Belgian respondents, 2,000 French, 2,000 from Germany and 1,998 from the Netherlands. The sample is composed by 3,928 males (49.1 %) and 4,075 females (50.9%).

The representativeness of VALOR national samples with respect to age can be evaluated by comparing them with the distribution of the population in each country.

The French VALOR sample shows an underrepresentation of the females over 69 years, and an overrepresentation of males between 60 and 69 years. if gender is not distinguished, the sample shows a good representativeness except for the two oldest categories.

Table 6: Distribution of the population in France

Gender/Age	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Female 20-29	8.5	7.3	1.2
Female 30-39	9.6	8.4	1.2
Female 40-49	10.6	8.5	2.1
Female 50-59	9.4	8.8	0.6
Female 60-69	10	8.3	1.7
Female > 69	**4**	**11.3**	**-7.3**
Male 20-29	6.8	7.3	-0.5
Male 30-39	6	7.9	-1.9
Male 40-49	7.2	8.3	-1.1
Male 50-59	7.1	8.4	-1.3
Male 60-69	**12.9**	**7.4**	**5.5**
Male > 69	7,9	8.0	-0.1
Total 20-29	15.3	14.6	-0.7
Total 30-39	15.6	16.3	0.7
Total 40-49	17.8	16.8	-1
Total 50-59	16.5	17.2	-0.7
Total 60-69	**22.9**	**15.7**	**7.2**
Total > 69	**11.9**	**19.3**	**7.4**

The Belgian VALOR sample shows a similar pattern: females over 69 are underrepresented while males between 60 and 69 years are overrepresented. An overrepresentation for females between 30 and 39 years is observed. However, if gender isn´t considered for this age category, it is representative. If gender is not considered, people between 60 and 69 years are underrepresented while people over 69 are overrepresented. Except of these two oldest categories the representativeness of the overall sample is correct.

Table 7: Distribution of the population in Belgium

Gender/Age	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Female 20-29	9.7	7.8	1.9
Female 30-39	**11.1**	**8.4**	**2.7**
Female 40-49	9.3	8.4	0.9
Female 50-59	9.1	8.8	0.3
Female 60-69	8.2	7.7	0.5
Female > 69	**3.1**	**10.2**	**-7.1**
Male 20-29	6.1	8	-1.9
Male 30-39	7.5	8.4	-0.9
Male 40-49	6.2	8.5	-2.3
Male 50-59	8.4	9	-0.6
Male 60-69	**13**	**7.4**	**5.6**
Male > 69	8.4	7.5	0.9
Total 20-29	15.8	15.8	-
Total 30-39	18.6	16.8	-1.8
Total 40-49	15.5	16.9	1.4
Total 50-59	17.5	17.8	0.3
Total 60-69	**21.2**	**15.1**	**-6.1**
Total > 69	**11.5**	**17.7**	**6.2**

In the German VALOR sample an overrepresentation of females between 30 and 39 years is observed, similar as in the Belgian sample. The pattern is similar to the French and the Belgian with regard to overrepresentation of males between 60 and 69, underrepresentation of females over 69 and overrepresentation of the group over 69 irrespectively of gender. Except of two oldest categories, the project sample, if gender is not considered, is representative.

Table 8: Distribution of the population in Germany

Gender/Age	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Female 20-29	7.8	6.6	1.2
Female 30-39	**10.8**	**7.7**	**3.1**
Female 40-49	8	7.6	0.4
Female 50-59	10.9	10	0.9
Female 60-69	9	7.9	1.1
Female > 69	**3.8**	**11.3**	**-7.5**
Male 20-29	6.5	7.2	-0.7
Male 30-39	6	8.1	-2.1
Male 40-49	6.3	7.7	-1.4
Male 50-59	10	10	0
Male 60-69	**12.8**	**7.4**	**5.4**
Male > 69	8.2	8.3	-0.1
Total 20-29	14.3	13.8	-0.5
Total 30-39	16.8	15.8	-1
Total 40-49	14.3	15.3	1
Total 50-59	20.9	20	-0.9
Total 60-69	**21.8**	**15.3**	**-6.5**
Total > 69	**12**	**19.6**	**7.6**

The distribution of the Dutch VALOR sample shows an overrepresentation of females between 30 and 39 years, and of males in two age categories: between 60 and 69 years and over 69. An underrepresentation of females over 69 and of males between 40 and 49 years is observed. When gender is disregarded, the category between 30 and 39 years is underrepresented, while the oldest category of population shows a pattern similar to other countries, while the magnitude is less important. In overall, the sample shows a good representativeness.

Table 9: Distribution of the population in the Netherlands

Genre/Age	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Female 20-29 y.	9.1	7.7	1.4
Female 30-39 y.	**10.4**	**7.7**	**2.7**
Female 40-49 y.	9	8.2	0.8
Female 50-59 y.	9.5	9.4	0.1
Female 60-69 y.	8.4	8	0.4
Female > 69 y.	**3.8**	**9.7**	**-5.9**
Male 20-29 y.	7.3	8	-0.7
Male 30-39 y.	8.2	7.8	0.4
Male 40-49 y.	**5.7**	**8.2**	**-2.5**
Male 50-59 y.	8	9.5	-1.5
Male 60-69 y.	**10.3**	**7.8**	**2.5**
Male > 69 y.	**10.3**	**7.9**	**2.4**
Total 20-29 y.	16.4	15.7	-0.7
Total 30-39 y.	**18.6**	**15.5**	**-3.1**
Total 40-49 y.	14.7	16.4	1.7
Total 50-59 y.	17.5	18.9	1.4
Total 60-69 y.	**18.7**	**15.8**	**-2.9**
Total > 69 y.	**14.1**	**17.6**	**3.5**

3.1.2 Geographic characteristics

Tables 10 to 13 provide information concerning the regional origin of responders. The French sample is representative, except for the Outre-Mer. German sample is representative except of Nordrhein-Westfalen, which is overrepresented, the sample distribution is aligned with the population distribution. Belgian and Dutch samples show a good representativeness.

Table 10: Geographic origin of responders for France

Region	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Auvergne-Rhône-Alpes	12,2	12	0,2
Bourgogne-Franche-Comté	4,4	4,1	0,3
Bretagne	5,2	5	0,2
Centre-Val-de-Loire	4	3,8	0,2
Corse	0,7	0,5	0,2
Grand Est	8,7	8,2	0,5
Hauts-de-France	9	8,9	0,1
Île-de-France	18,5	18,3	0,2
Normandie	5,1	4,9	0,2
Nouvelle-Aquitaine	9,2	8,9	0,3
Occitanie	9,2	8,8	0,4
Pays de la Loire	5,9	5,7	0,2
Provence-Alpes-Côte d'Azur	7,9	7,5	0,4
Départements Outre-Mer	**0**	**3,3**	**-3,3**

Table 11: Geographic origin of responders for Belgium

Region	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Flanders	58,2	57,7	0,5
Brussels	9,8	10,6	-0,8
Wallonia	32	31,7	0,3

Table 12: Geographic origin of responders for Germany

Region	VALOR Sample Distribution (%)	Population Distribution (%)	Difference
Schleswig-Holstein	3,6	2,9	0,7
Hamburg	2,2	1,8	0,4
Niedersachsen Stat	9,8	8,0	1,8
Bremen	0,8	0,7	0,1
Nordrhein-Westfalen	**21,1**	**17,9**	**3,2**
Hessen	7,4	6,3	1,1
Rheinland-Pfalz	5,12	4,1	1,0
Baden-Württemberg	13,1	11,1	2,0
Bayern	15,3	13,1	2,2
Saarland	1,2	1,0	0,2
Berlin	4,2	3,7	0,6
Brandenburg	4	2,5	1,5
Mecklenburg-Vorpommern	1	1,6	-0,6
Sachsen	5,4	4,1	1,3
Sachsen-Anhalt	2,9	2,2	0,7
Thüringen	2,9	2,1	0,8

Table 13: Geographic origin of responders for the Netherlands

Region	VALOR Sample Distribution (%)	Population Distribution (%)	Difference (%)
Drenthe	3	2,8	0,2
Flevoland	2,5	2,4	0,1
Friesland	3,8	3,7	0,1
Gelderland	12,1	12,0	0,1
Groningen	3,4	3,4	0
Limburg	6,7	6,4	0,3
Noord-Brabant	14,9	14,7	0,2
Noord-Holland	16,7	16,6	0,1
Overijissel	6,4	6,7	-0,3
Zuid-Holland	21,6	21,3	0,3
Utrecht	7	7,8	-0,8
Zeeland	2,3	2,2	0,1

3.1.3 Purpose of the trip

Table 14 provides the composition of the sample according to the trip motive. 22% of trips have a leisure motive, while 20% - to go to work motive. 16% of trips have a motive of visiting someone, 18% - running errands and services. Vacation trips count to 11% of the total. The motives of 75% of all trips are related to four categories: leisure activities, to go to work, running errands and services and visiting someone. Almost 50% of the motives for trips are related to "personal" motives, while job related activities weight for roughly 23%.

Table 14: Most common motives for a trip on a motorway (all answers)

Purpose	Count	Frequency (%)
To go to work	2,894	19.5
Leisure activities	3,278	22.1
To go to school	420	2.8
A professional trip	580	3.9
Dropping someone off/picking someone up	804	5.4
Running errands/services	2,635	17.8
Visiting someone	2,432	16.4
Vacation	1,665	11.2
Other	124	0.8

3.1.4 Driving habits

Almost 40 % of responders declare never using a bicycle or an e-scooter, more than 55% either never or few times per year. Two countries show different pattern diverging from the average: in the Netherlands 30% of respondents declare to use the above vehicles at least three times per week. On the opposite, France is characterized with a very low use with more of 50 % of respondents declaring never using such vehicles.

Table 15: Frequency of uses of a bicycle, electric bicycle and e-scooter

	Belgium	France	Germany	The Netherlands	Total
Never	**42 %**	**52 %**	39.9 %	21.1 %	38.8 %
Few times per year	17 %	**19.8 %**	16.1 %	12.3 %	16.3 %
Few times per month	15.3 %	13.6 %	16 %	16.8 %	15.4 %
From once to twice per week	11.7 %	9.1 %	15.5 %	**19.4 %**	13.9 %
At least 3 times per week	14 %	5.5 %	12.5 %	**30.4 %**	15.5 %

Almost 90 % of responders declare never driving a moped or scooter. Around 1 % assert that they drive such vehicle at least three times per week. Only the Netherlands departs from this picture. This country shows a lower share of those who answer "never", and a highest one of those who report a regular use.

Table 16: Frequency of use of Moped and scooter

	Belgium	France	Germany	The Netherlands	Total
Never	92 %	90 %	90.7 %	**84 %**	89.2 %
Few times per year	3 %	3.45 %	3.6 %	4.1 %	3.6 %
Few times per month	2.5 %	3.55 %	3.1 %	**6.2 %**	3.8 %
From once to twice per week	1.5 %	1.9 %	1.7 %	3.1 %	2.1 %
At least 3 times per week	1 %	1.1 %	0.9 %	**2.6 %**	1.3 %

Table 17 provides information concerning the use of motorcycles. Almost 90 % of respondents declare they do not use such vehicle at all. The pattern is common to all countries, whereas Belgium shows a lowest use compared to others.

Table 17: Frequency of use of motorcycle (>50cc or >4kw)

	Belgium	France	Germany	The Netherlands	Total
Never	**90.3 %**	87.2 %	88.2 %	85.6 %	87.8 %
Few times per year	2.6 %	3.3 %	3.5 %	4 %	3.3 %
Few times per month	3.5 %	4.5 %	4.2 %	5.7 %	4.5 %
From once to twice per week	2.7 %	3.2 %	2.9 %	3.3 %	3 %
At least 3 times per week	0.9 %	1.8 %	1.2 %	1.4 %	1.4 %

Table 18 provides some information on the frequency of use of passenger cars. Driving a car is the most frequent mode of mobility. Overall, 58% of respondents declare they use a car at least three times per week. The frequencies are highest in Germany and France. The respondents from the Netherlands use cars less frequently, which corresponds with the highest frequency of using a bicycle.

Table 18: Frequency of use of passenger cars

	Belgium	France	Germany	The Netherlands	Total
Never	1.5 %	1 %	1.1 %	0.8 %	1.1 %
Few times per year	5.3 %	7.8 %	**3.5** %	5.9 %	5.6 %
Few times per month	12.3 %	10.9 %	7.8 %	**15.8 %**	11.7 %
From once to twice per week	23.1 %	19.2 %	20.8 %	**28.9 %**	23 %
At least 3 times per week	**42.2 %**	**61.1 %**	**66.8 %**	**48.6 %**	58.6 %

The use of truck is in overall quite weak. Indeed roughly 90 % of responders declare no use at all or few times per year. Germany is characterized by the lowest use of trucks compared with other countries.

Table 19: Frequency of use of trucks

	Belgium	France	Germany	The Netherlands	Total
Never	86.6 %	82.3 %	**92 %**	85.5 %	86.6 %
Few times per year	6.2 %	**9 %**	3.3 %	4.4 %	5.7 %
Few times per month	2.7 %	**3.8 %**	**1.8 %**	3.3 %	2.9 %
From once to twice per week	2 %	2 %	**1.2 %**	**3.8 %**	2.3 %
At least 3 times per week	2.5 %	2.9 %	**1.7 %**	3 %	2.5 %

In overall, 40 % of respondents declare they do not use public transport at all. France shows the highest share of those who don't use public transport at all, but if few-times-per-year users are included, France shows a similar intensity of use as in the other countries. France shows the highest share of those who use public transport at least three times per week, while the Netherlands the lowest one. The use of public transport is quite heterogeneous among the population.

Table 20: Frequency of public transportation

	Belgium	France	Germany	The Netherlands	Total
Never	**38.9 %**	**45.5 %**	**36.7 %**	41.5 %	40.6 %
Few times per year	30.9 %	**23.4 %**	29.6 %	28.8 %	28.2 %
Few times per month	13.6 %	13.6 %	**16.7 %**	15.6 %	14.7 %
From once to twice per week	9 %	7.5%	8.1 %	8.7 %	8.3 %
At least 3 times per week	7.6 %	**10 %**	8.9 %	**5.4 %**	8.2 %

Table 21 presents the frequencies of the use of different mobility modes. The passenger car is the most popular mode (more than 80%). The use of bicycles comes as second (roughly 30%) followed by public transportation (16.5%). Belgian sample is characterized by the lowest frequency of using cars. French respondents report a high frequency of using cars and the lowest with regard to bicycles. German respondents show the highest frequency of using cars and the lowest with regard to trucks. Dutch respondents reveal the particularity of the highest rates of using bicycles, mopeds and trucks, while the frequency of using cars and public transportation is quite low.

Table 21: Frequency of different modes of transportation at least once per week

	Belgium	France	Germany	The Netherlands	Total
Bicycle	25.7 %	**14.6 %**	28 %	**49.4 %**	29.4 %
Moped	2.5 %	3 %	2.6 %	**5.7 %**	3.4 %
Motorcycle	3.8 %	5 %	4.1 %	4.7 %	4.4 %
Passenger car	**65.3 %**	**80.3 %**	**87.6 %**	**77.5 %**	81.6 %
Truck	4.5 %	4.9 %	**2.9 %**	**6.8 %**	4.8 %
Public Transportation	16.6 %	17.5 %	17 %	**14.1 %**	16,5 %

Concerning the kilometers travelled per year,43% of respondents declare a distance less than 10,000 kilometers. 80% declare a distance less than 20,000 kilometers. It is worth noting that France and Germany have the highest frequencies for the interval between 10,000 and 20,000 kilometers per year. These figures have to be considered taking into account highest national frequencies of using cars.

Table 22: Kilometer travelled per year

	Belgium	France	Germany	The Netherlands	Total
< 10,000 km	44.8 %	41.2 %	41.3 %	44.9 %	**43 %**
Between 10,000 km and 20,000 km	35.9 %	**40.2 %**	**41 %**	**33.3 %**	**37.6 %**
Between 20,001 km and 30,0000 km	**9.7 %**	11.3 %	11.6 %	12.3 %	11.2 %
> 30,000km	5.9 %	5 %	4.2 %	5.9 %	5.2 %
Does not know	3.7 %	2.3 %	1.9 %	3.6 %	3 %

3.1.5 Socioeconomic characteristics

Table 23 provides the composition of the sample according to the level of income. 44% of the respondents declare a level of income less than 2,000 EUR. 23% declare a level of income more than 3,000 EUR and 11% more than 4,000 EUR. 13% of respondents declined to provide information on their income.

Table 23: Income per household

Income	Count	Frequency (%)
Less than 1,000 EUR	1,549	19.4
1,000 – 2,000 EUR	1,971	24.6
2,000 – 3,000 EUR	1,573	19.7
3,000 – 4,000 EUR	955	11.9
4,000 – 5,000 EUR	587	7.3
More than EUR 5,000	315	3.9
I don't know	202	2.5
I prefer not to answer	851	10.6

75% of respondents have a secondary education or hold a bachelor's degree or equivalent. 18% hold at least a master's degree (Table 24).

Table 24: Highest qualification or educational certificate

Qualification/education	Count	Frequency (%)
None	43	0.5
Primary education	422	5.3
Secondary education	3,253	40.6
Bachelor's degree or similar	2,817	35.2
Master's degree or higher	1,468	18.3

Tables 25 and 26 provide some information concerning professional occupation. White collar and blue-collar employees represent 45% of the total sample population. Executives weight 10%, while the share of self-employed and independent professionals raises to 6%. 38% of all respondents declare having no occupation, 64% of them are retired. The retired represent 24% of all respondents.

Table 25: Professional occupation

Professional occupation	Count	Frequency (%)
White collar or office employee	2,364	29.5
Blue collar or manual worker	1,211	15.1
Executive	858	10.7
Self-employed/independent professional	501	6.3
Currently no professional occupation	3,069	38.3

Table 26: Reasons given by respondents without a professional occupation

No professional occupation - Reasons	Count	Frequency (%)
Student	332	10.8
Unemployed, looking for a job	213	6.9
Retired	1,966	64.1
Not fit to work	225	7.3
A stay-at-home spouse or parent	279	9.1
Other	54	1.8

61.8% of respondents declare they have children. Almost 15% of respondents are single. A two-person household has been reported most frequently (31% of responses). The households with at least 4 persons represent 25% of the total number, thus, 75% of all households have not more than three persons.

Table 27: Number of people living in the household

Number of persons living in the household excluding the responder	Total	%
0	1,191	14.9 %
1	2,502	31.3 %
2	2,269	28.4 %
3	1,092	13.7 %
4	642	8 %
5	198	2.5 %
At least 6 persons	103	1.2 %

3.1.6 Safety and risk perceptions

When the safety perceptions of driving on motorway of inhabitants of participating countries are compared (Table 28), some specificities emerge. In each country most respondents rate their feeling concerning road safety above the level 6. This proportion raises to 68% by French respondents (the lowest one) and to 87% by Dutch (the highest), with 78% by Germans and 74% by Belgians. A closer look at the distribution of frequencies shows some similarities between France and Belgium for the levels between 5 and 7 (high frequencies), while Germany and the Netherlands are characterized by high frequencies for the levels 8 to 10. The Netherlands is also characterized by lower frequencies for the levels 1 to 3. Distribution of frequencies in Germany and the Netherlands shows a higher level of safety perception for driving on motorway, compared to France and Belgium.

Table 28: Level of feeling of safety when travelling by car on motorway

Level of feeling of safety in the country	France (%)	Belgium (%)	Germany (%)	The Netherlands (%)
0 (very unsafe)	1.4	1	1.1	0.9
1	1.1	0.9	1	0.5
2	1.9	1.8	2.3	1.1
3	4.5	4.2	3.3	1.5
4	6	5.2	3.9	3.3
5	16.9	12.7	10.7	5.9
6	12.3	16.4	9.4	10
7	22.1	26.6	18.2	27.1
8	22.7	21.9	25.8	31.9
9	7.3	6.6	13.6	11.6
10 (very safe)	3.6	2.5	10.8	6.3

Respondents were asked how road safety changed due to the outbreak of Covid-19. In all countries the biggest fraction consists of respondents who consider road safety is at the same level as before the pandemic (from 48% in Belgium to 60% in France). Less than 20% of respondents consider the road safety as decreased, whereas more respondents from France and Belgium answered so than in the Netherlands and in Germany. Less than 30% of respondents declare it has increased. In this category France shows the lowest percentage, while the Netherlands the highest one. If the differences of national percentages of "increased" and "decreased" answers are compared, significant divergences appear. France shows a negative difference, while other countries reveal a positive one, particularly the Netherlands a very large one. The answers from France are controversial, because according to official figures a large reduction of fatalities took place.

Table 29: Perception of Road Safety situation in comparison with the period before the outbreak of COVID-19

Road safety change	France (%)	Belgium (%)	Germany (%)	The Netherlands (%)
Decreased	17.2	17.9	14.1	11.7
Remained the same	59.7	48.2	58.4	50
Increased	15.7	25.6	19.2	29.6
I don't know	7.4	8.3	8.3	8.7

Table 30 provides information concerning the importance of road safety issue for respondents. More than 75% of respondents consider, it remains equally important. It means that road safety preference of respondents did not change due to the Covid-19. While Germany and the Netherlands are associated with higher percentage of "equally important" answers, France and Belgium show higher percentages of "less important". There are some nuances between national results

Table 30: Road Safety importance for respondents since the outbreak of COVID-19

Level of importance	France (%)	Belgium (%)	Germany (%)	The Netherlands (%)
Less important	5.2	4.9	2.2	3.6
Equally important	75.6	78.9	83	80.3
More important	11.7	10.7	11.2	12.3
I don't know	7.4	5.5	3.6	3.9

3.1.7 Personal experiences with road accidents and injuries

Tables 31 to 33 provide information concerning the personal experiences of the respondents with road accidents. Three different types of experiences are concerned here: personal involvement as a victim, personal involvement in a traffic accident, involvement of a relative or a friend. In general, the percentage of those having experience decreases with the worsening of the severity of an accident. Second, there are more respondents having experience as victims than those having experience of only being involved. Third, the highest frequencies are reported with regard to involvement of a friend or relative. 63% of respondents made experience as victims of an accident. The percentage amounts to almost 74% for involvement of a friend/relative. Taking both figures into account, it is eligible to assume that most respondents could have accident experience personally (directly) or indirectly, via being aware of the experience made by relatives or friends.

Table 31: Personal implication as victim in a traffic accident

	Yes (%)	No (%)
Damage only accidents	37.7	63.3
Slightly injured	17.9	82.1
Seriously injured	7.4	92.6

Table 32: Personal implication in a traffic accident where somebody else is a victim

	Yes (%)	No (%)
Slightly injured	12.8	87.2
Seriously injured	6.9	93.6
Died	4.6	95.4

Table 33: Involvement of a relative in a traffic accident

	Yes (%)	No (%)
Slightly injured	40.1	59.9
Seriously injured	18.7	81.3
Died	15.1	84.9

3.2 Lexicographic and irrational behaviours

When an individual faces complex choice situation, in which the exercise of utility maximization is difficult, he/she tends to resort to what Kahneman and Tversky have called "heuristics" (Kahneman and Tversky, 1972). This approach brings together all simple principles of reasoning aimed at reducing the complexity of the decision task. While considering these many lines of reasoning, we have focused on the treatment of irrational and lexicographical responses. Besides, the impact of inconsistent responses was also tackled and the individuals who have shown some "failures" in transitivity[8] have been identified. Because it was impossible, however, to distinguish the respective influences in these mistakes of a real inconsistency against a kind of "learning phenomenon", we have decided not to exclude them from the final analysis sample[9] .

3.2.1 Identification of irrational behaviours

Each respondent had to make route choice in eight scenarios. To ensure that respondents make rational trade-offs, the eighths scenario was identical for all respondents. In this scenario the Route 1 was definitely better than the Route 2. 445 (5.6%) of our 8,003 respondents chose the Route 2. Therefore, it can be estimated that approximately 11% of respondents respond irrationally or randomly when choosing the route and that these responses will skew our estimates. These respondents were excluded from the econometric estimation of the model to avoid a bias.

3.2.2 Identification of lexicographic answers

In seven scenarios respondents had the choice between a Route 1 and a Route 2. Different routes were associated with explicitly different levels of attributes. Thus, in order to decide if a respondent chooses lexicographically, four sequences of seven choices must first be identified, one for each attribute, associated with a lexicographical choice. These sequences can be found in the appendix to the report.

In total, 2,513 (33.2%) out of 7,557 respondents were identified as lexicographic:

- 991 respondents (13.1 %) answered lexicographically in relation to travel time.
- 548 (7.3%) answered lexicographically in relation to travel cost.
- 705 (9.3%) answered lexicographically in relation to the risk of being killed.
- 269 (3.6%) answered lexicographically in relation to the risk of being injured.

The following table provides the breakdown of the lexicographical answers by country:

Table 34: Distribution of lexicographical responses by country and by attribute.

	France	Belgium	Germany	The Netherlands	Total
Time	189	285	232	285	991
Cost	174	147	89	138	548
Risk of death	184	170	185	166	705
Risk of injury	69	62	74	64	269
Total	616	664	580	653	2,513

[8] The scenarios were compared two by two. In some comparisons, alternatives A and B of the first scenario and alternatives C and D of the second scenario were such that: A < D and B > C.
If an individual declares that he considers that A > B then we can deduce that: A > B > C and as D > A we have D > A > B > C which makes it inconsistent to simultaneously prefer A to B and C to D.

[9] Additional analysis (available upon requests) have concluded that 1,088 individuals (13.6 %) could be considered as inconsistent. Importantly, removing these individuals from the final analysis sample does not significantly impact econometric estimates.

Since the number of respondents is the same in each of the four countries, this table allows us to draw several observations:

- The number of lexicographic responses is almost identical for both risk attributes.
- The differences in distribution are mainly concerning the attributes of time and cost.
- Belgium and the Netherlands have more lexicographical responses in relation to time than Germany and especially France.
- France has more lexicographical responses in relation to cost than the other three countries and especially than Germany.
- Belgium and the Netherlands have a very similar distribution of lexicographic responses.

3.2.3 Treatment of lexicographic answers

The lexicographic behaviour or strategy consists in always favouring the choice of the same attribute as associated with the best value, i.e., the lowest in the route choice context in which all four attributes are associated with disutility. A lexicographic behaviour is a source of estimation bias and must be identified. However, does it mean that the respondent necessarily used this heuristic if her/his answers are the same as those of someone who would have used a lexicographic strategy? Indeed, responding virtually lexicographically to all scenarios does not necessarily mean that the respondent has lexicographical preferences. Some are rational and others appear to be irrational or inconsistent with the utility maximization hypothesis. Below there is a list of the identified causes:

- The differences between the levels of different attributes in the experimental design alternatives are too big. This is the only case in which the lexicographic responses can be used for the discrete choice experiment because the individual considered each of the options, but variations in one attribute resulted in bigger utility variations than the utility benefit derived from the variation in other attributes in each of scenarios. Since the experimental design was balanced on the basis of prior estimates, individuals who would report this reasoning, must necessarily have a significantly higher than average value for the attribute they preferred. To ensure this, a contingent valuation question was asked to estimate the WTP and to reduce the considered attribute (see below).
- Not all attributes are considered by a respondent in order to simplify the trade-off. This type of strategy biases the results by attributing zero utility to the attributes not considered.
- A respondent does not conceive increasing an attribute by a small amount, even if the level of other attributes will be very significantly lower. In this case, the WTP to reduce the level of that attribute is theoretically infinite.

In order to separate these three reasons, respondents identified by means of lexicographic sequence were asked to choose one of the following explanations:

1) "The choice was too complex, so I focused only on this attribute."

2) "I also considered the other attributes, but the variation in this attribute was too great relative to the other attributes."

3) "I would always take the path with the lowest level of this attribute, even if the levels of the other attributes were very high."

Based on these responses, the respondents who answered 1) and 3) were excluded from the main analysis and an additional test for those who answered 2) was undertaken. Contingent evaluation type questions were thus added aiming to further distinguish lexicographic responses due to simplification strategies from lexicographic responses related to relatively strong preferences for an attribute.

The method put forward by Saelensminde (2006) was applied. It consists in comparing by means of contingent valuation the WTP values of individuals revealing a lexicographic sequence with the WTP values of individuals revealing a non-lexicographic sequence. According to this method, contingent valuation results enable to identify respondents revealing their real preferences through a lexicographic sequence since they should have a significantly higher WTP than the average of non-lexicographic individuals. Respondents who had revealed a lexicographic sequence while applying a simplification strategy should have a WTP not higher than the average. In addition, it was controlled whether respondents who give a high importance to a single attribute asserted that the attribute in question was considered as important or very important thank to a supplementary question.

Table 35: Distribution of reasons given for responding lexicographically.

Reasons \ Attributes	Time	Cost	Risk of death	Risk of injury	Total
Simplification	105	77	149	39	370
Too strong variation of the preferred attribute	244	112	153	66	575
Too little variation in other attributes	110	73	38	25	246
No compromise on the attribute is possible	493	242	340	128	1,203
Other	27	19	4	1	51
I don't know	12	25	21	10	68

Among those initially excluded from the main analysis there were 370 respondents (14.7%) who admitted simplifying the arbitration, 1,203 respondents (47.9%) who theoretically consider the utility of the attribute as infinite, and 119 respondents (4.7%) who gave other reasons or did not know. At this stage, 821 respondents (32.7%) remained. The latter preferred a specific attribute because it was associated with variations in utility that were a priori bigger than the sum of the variations in the utilities of the other attributes. In theory, these individuals must attach a great importance to the attribute in question in route arbitration and have a significantly higher WTP for this attribute than the rest of the respondents.

Table 36: Reported importance in route choice in relation to the attribute as the origin of lexicographic responses.

	Time	Cost	Risk of death	Risk of injury	Total
Unimportant	2	2	5	1	10
Rather unimportant	5	6	8	6	25
Rather important	56	54	55	32	197
Important	291	123	123	52	589

At the end of this verification 35 respondents, who gave low importance to the attribute they had consistently favoured in their choice of routes, were removed. For remaining 786 respondents a comparison of their individual WTP for the attribute they systematically favoured, determined by contingent valuation, with the WTP of the population of respondents without a lexicographical sequence for the same attribute was made. This treatment could only be applied to the time and the risk of death attributes because the length of the questionnaire was constrained. 177 respondents considered as behaving lexicographically in relation to cost (out of 548 initially) and the 84 respondents considered as behaving lexicographically in relation to the risk of injury (out of 269 initially) were kept in the sample.

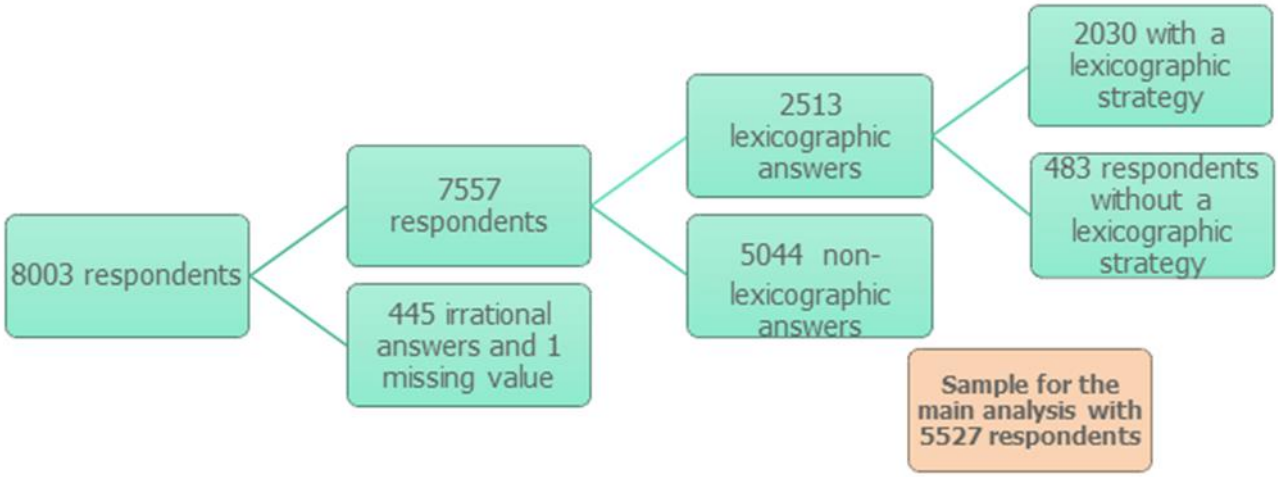
Table 37 comparison of willingness to pay between non-lexicographic respondents and respondents with lexicographic responses not due to oversimplification or irrationality.

	Time	Risk of death
Non-Lexicographic Average	17,7€/hour	10,5M€
Lexicographic Average	14,8€/hour	14,8M€
Lexicographic respondents above	103	119
Lexicographic respondents below	244	59

The above steps allowed to identify among the initial sub-group of 2,513 individuals 4,83l respondents with virtually lexicographic answers but without a lexicographic strategy. These respondents have responded virtually lexicographically with a high probability because of their strong preference for one of the four attributes and hence could be considered as non-lexicographic.

In the econometric modelling that followed, only the sample of 5,527 rational and non-lexicographic respondents was considered. Here is a diagram showing the steps done while moving from the initial sample to the one used for the econometric analysis:

Figure 3: Identification of the sample used for the empirical analysis.



3.2.4 Representativeness of the analysis sample

Since the econometric analysis was conducted on a subsample of the initial base sample, characteristics of these two samples are compared in the Table 38.

Table 38: Comparison of sociodemographic variables between the base sample and the analysis sample.

Variables	Base Sample (8,003 respondents)	Analysis Sample (5,527 respondents)	Difference
Belgium	25%	24.8%	-0.2%
France	25%	25.1%	+0.1%
Germany	25%	26%	+1%
Netherlands	25%	24.1%	-0.9%
Female	49.1%	48.5%	-0.6%
Age			
18-19	1.7%	1.7%	0%
20-29	15.2%	15.1%	-0.1%
30-39	17.1%	16.6%	-0.5%
40-49	15.3%	15.3%	0%
50-59	17.8%	17.5%	-0.3%
60-69	20.8%	21%	+0.2%
> 69	12.1%	12.8%	+0.7%
Travelling distance			
< 10,000 km	43.1%	43.9%	+0.8%
Between 10,000 km and 20,000 km	40.5%	40.3%	-0.2%
Between 20,001 km and 30,0000 km	11.2%	10.8%	-0.4%
> 30,000km	5.2%	5%	-0.2%
Income			
Less than 1,000 EUR	3.9%	3.9%	0%
1,000 – 2,000 EUR	19.4%	19.2%	-0.2%
2,000 – 3,000 EUR	24.6%	24.7%	+0.1%
3,000 – 4,000 EUR	32.8%	32.8%	0%
4,000 – 5,000 EUR	11.9%	12.4%	+0.5%
More than 5,000 EUR	7.4%	7%	-0.4%
Average Income per capita (EUR)	1760.3EUR	1762.3EUR	+2.0EUR (+0.1%)
White collar or office employee	29.5%	29.7%	+0.2%
Blue collar or manual worker	15.1%	14.8%	-0.3%
Executive	10.7%	10.4%	-0.3%
Self-employed/independent professional	6.3%	6.3%	0%
Currently no professional occupation	38.3%	38.8%	+0.5%

Although the analysis sample is 31 % smaller than the base sample, their compositions are very similar in terms of socio-demographic variables. The analysis sample contains 0.9 % fewer Dutch and 1% more Germans; 0.9 % more over 59 years old; 0.8 % more people travelling less than 10,000 km per year. The differences in wages are very small, with an average wage 0.1 % higher in the analysis sample. The socio-professional classes are almost identical, with 0.5 % more people without a professional activity in the analysis sample. All in all, the characteristics of the base and analysis samples are not significantly different.

3.3 Econometric modelling

3.3.1 The benchmark model

As explained in the Section 2, the VALOR-survey aims at eliciting VSL and VSSI by applying stated choice experiment that offers variable travel attributes of alternative hypothetical routes. The empirical analysis is based on the canonical random utility model (RUM), which can be specified as:

$$U_{nj} = V_{nj}(X_j, Z_n) + \varepsilon_{nj} \quad (1)$$

Where V_{nj} represents the decision maker's n's deterministic utility, a function of the route j attributes to X_j and of his/her individual characteristics Z_n. The term ε_{nj} is unknown and randomly distributed.

In line with the experimental protocol, the vector X_j includes the yearly number of fatal (f_j) and severe (I_j) accidents on the route j as well as the (per trip) travel time (t_j) and money expenditures (c_j):

$$V_{nj} = \alpha + \beta f_j + \gamma I_j + \theta c_j + \rho t_j + \varphi Z_n \quad (2)$$

Given this simple and linear specification, the different preferences parameters (β, γ, θ and ρ) describe the different marginal disutilities of the different travel attributes.

In the case individual n would favor the proposed route 1 over the alternative 2, the probability (P_{1n}) of observing this choice is:

$$P_{1n} = \mathrm{P}(\beta(f_1 - f_2) + \gamma(I_1 - I_2) + \theta(c_1 - c_2) + \rho(t_1 - t_2) > \varepsilon_{n1} - \varepsilon_{n2}) \quad (3)$$

Individual characteristics entered into the vector vanish because they remain constant across alternatives.

Assuming that error terms are IID Type 1 extreme value distributed, a logit model can be determined as follows:

$$P_{1n} = \frac{\exp(\sigma_n V_{n1})}{\exp(\sigma_n V_{n1}) + \exp(\sigma_n V_{n2})} \quad (4)$$

Where $\sigma_n$is a scale parameter normalized to 1.

The strategy in VALOR is to view VSL and the VSSI as WTPs. Therefore, they are computed as marginal rates of substitution between reduced risks of road accidents and increased money expenditures, multiplied by the traffic flow considered in the choice experiments (20Mill/year), see Veisten, Flügel, Rizzi, Ortúzar, & Elvik (2013):

$$VoSL = 20\,M \times \frac{\beta}{\theta} \quad ; \quad VoSI = 20\,M \times \frac{\gamma}{\theta} \quad (5)$$

Another indirect output of the VALOR-survey is to provide the estimates of the VoT:

$$VoT = 60 \times \frac{\rho}{\theta} \quad (6)$$

3.3.2 Introducing individual heterogeneity

In addition of technical limitations (e.g., independency of error terms, IIA property), the simple logit model has a major drawback: it assumes that individuals are characterized by homogeneous and similar preferences. In other words, it supposes that the individuals put the same values on road safety (and on travel time savings). In order to allow the marginal disutilities to differ between respondents, one can alternatively use the mixed logit approach (Sillano & Ortuzar, 2005; Train, 2003).

The basic idea behind this model is to add a random component, specific to the respondent n, into the structure of individuals' preferences. Considering e.g. the marginal disutility of fatal accidents, it becomes:

$$\beta_n = \bar{\beta} + \varepsilon_n^{\beta} \quad (7)$$

Where $\bar{\beta}$ is the constant part of marginal disutility of fatal accidents and ε_n^{β} is the random part that differs among the N individuals.

Given this heterogeneity in parameters, VSL, VSSI and VoT may be estimated at the respondent-level, depending on the assumptions made about the "nature" (i.e., stochastic or deterministic) of the different marginal disutilities. Second, the modeler can consider different statistical laws to characterize the distribution of random coefficients (e.g., normal, log-normal, zero-bounded triangular, etc.). Third, the mixed logit model also allows for dependencies in errors terms of the RUM (ε_{nj} in equation (1)). This is particularly useful in the frame of the VALOR-survey because each respondent was confronted with several choice experiments. This modeling framework makes it possible to consider the panel structure of the data and to introduce one (unobserved) individual effect correlated across rounds.

The second - and more traditional (see Rizzi & Ortuzar, 2003) - way to introduce individual heterogeneity in estimated values for road safety (and travel time savings) consists in interacting the marginal disutility of trips' attributes with respondents' observed characteristics (in the vector). Still considering the risk of fatal accidents:

$$\beta_n = \beta_0 + \beta_1 Z_n \quad (8)$$

Where β_0 is the constant part of marginal disutility of fatal accidents and β_1 is a sensitivity premium that will reduce/increase the final value of β_n, depending on its sign, its size and its significance.

It is important that this strategy can be used to investigate potential effects of respondents' observable peculiarities (gender, age, income, occupational status) as well as travel habits (trip motive, intensity of driving on highways, past experiences of accidents) or stated perceptions (post-COVID road safety). The vector Z_n can include also the nationality of respondents, thus allowing to investigate the stability of VSL and VSSI between Belgium, Germany, France and the Netherlands. Second, it is worth noting that each travel attribute can be interacted with several variables simultaneously in order to isolate the respective influence of the considered characteristics (e.g., old people may be more sensitive to the risk of a road accident, but elderly people may also be richer and that could influence individual preferences in this respect). Third, averages for VSL, VSSI and VoT are (again) found at the individual level, by crossing significant parameters with the relevant personal characteristics. Fourth, it is possible to assume that individual heterogeneity in preferences parameters is partly random and partly due to observable differences, so that both the mixed logit model and the interaction approach can be combined:

$$\beta_n = \tilde{\beta} + \beta_1 Z_n + \varepsilon_n^{\beta} \quad (9)$$

Given the huge variety of potential models, the choice of the "best" specification will depend in practice on a trade-off at the discretion of the modeler between statistical information criterion (e.g., AIC, BIC, final log-likelihood) and the intellectual consistency of results.

3.3.3 Integrating heterogeneity linked to attitudes and opinions

As explained in the previous section, the VALOR-survey additionally includes some questions aimed at capturing individuals' attitudes and opinions regarding their willingness to increase at the margin their money expenditures, their time consumption or their risky behaviour. For instance, two individuals having exactly the same characteristics (gender, age, wealth, occupational status, number of children, etc.) may perceive their daily agendas very differently. Whereas one can feel him/herself as "rich in time" and deals with the many tasks she/he has to perform over the curse of the day, the second one may view him/herself as "time pressured". Such latent variable is hardly observable, but it may influence individuals' trade-offs in hypothetical route choices.

In order to take into account this kind of heterogeneity in VSL, VSSI (and VoT), "Integrated Choice and Latent Variable" (ICLV) models are considered (Walker, 2001; Bouscasse, 2018, Johansson et al., 2006). The basic intuition behind this approach is to add a vector of latent variables ($\delta_n{}^*$) in the RUM:

$$U_{nj} = V_{nj}(X_j, Z_n, \delta_n{}^*) + \varepsilon_{nj} \quad (10)$$

In line with the previous section, we conjecture the existence of three different and unobservable latent variables. The first one mirrors the more or less "thrifty" nature of the respondent n ($G_n{}^*$); the second one her/his perceived "time pressure" ($P_n{}^*$) and the last one her/his attitude towards "risky behaviours" ($R_n{}^*$).

Moreover, latent variables are here supposed to enter the deterministic part of the utility (V_{nj}) in interaction with the travel attributes considered in the choice experiments:

$$V_{nj} = \alpha + (\beta_0 + \beta_1 {R_n}^*) f_j + (\gamma_0 + \gamma_1 {R_n}^*) I_j + (\theta_0 + \theta_1 {G_n}^*) c_j + (\rho_0 + \rho_1 {P_n}^*) t_j + \varphi Z_n \quad (11)$$

Given this specification, latent variables will leverage the different marginal disutilities, hence estimates of VSL, VSSI and VoT. A similar approach was proposed by de Lapparent and Bouscasse (2019) to make vary the VoT in public transport with respect to the perceived level of comfort. We here postulate that people who are more prone to behave dangerously will suffer less from risks of accidents ($\beta_1 > 0$ and $\gamma_1 > 0$); that individuals, who consider themselves as time pressured, will have one higher marginal disutility of travel duration ($\rho_1 < 0$); and that those who are thriftier will be less satisfied with increased money costs ($\theta_1 < 0$). All in all, these differences in preferences will impact the ratios in equations (5) and (6).

Three latent variables are not observed directly. Instead, it is assumed that they are generated by a linear combination of the individual n's characteristics (with the subscript q representing the considered latent variable):

$${\delta_{n,q}}^* = \omega_{nq} Z_{nq} + \epsilon_{nq} \quad (12)$$

Where ϵ_{nq} are error terms for the latent variable ${\delta_{n,q}}^*$ and for the individual n. The vector ω_{nq} is made of parameters to be estimated.

Moreover, the varying attitudes and opinions hidden behind each latent variable condition individuals' answers to the different questions asked in order to measure and approximate the latent variable. As explained in the previous section, the interviewees were confronted with 6 statements per latent variable for which they have had to report their agreement on a 0-7 Likert scale.

Formally, answers to the P_q statements allow to approximate - with the help of ordered probit or OLS - the latent variable ${\pi_{n,P_q}}^*$ which is itself linked to the attitude or opinion of interest ${\delta_{n,q}}^*$:

$${\pi_{n,P_q}}^* = \alpha_{P_q} + \tau_{P_q} {\delta_{n,q}}^* + \upsilon_{n,P_q} \quad (13)$$

First latent variables are investigated and equations (12) and (13) are estimated jointly by applying a structural equation modelling framework. Once the different latent variables predicted, they are then integrated into the discrete choice experiments, in a sequential manner (Johansson et al., 2006). Second, it is worth noting that the potential effects of the three latent variables on the discrete choice model results may be considered either separately or jointly. Lastly, the implementation of ICLV model in the frame of the VALOR-survey is exploratory and aims, essentially, at identifying directions for further research.

3.4 Application and results

3.4.1 Binomial logit model

To apply a standard MLM, the "mlogit" package (Croissant, 2019) available under R was used. The results are based on the analysis sample of 5,527 respondents, which has been comprised by excluding 445 irrational respondents, 2,030 lexicographical responses, and one missing value from the base sample.

Assuming that the choice was homogeneous between individuals and that it depended solely on the level of the four attributes (cost, time, risk of injury, risk of death), the following results are obtained:

Table 39: Result of the application of the simple MLM to the analysis sample.

Coefficients	Global sample (5,527 respondents)
Cost	-0.1483***
Time	-0.042***
Risk of death	-0.047***
Risk of injury	-0.008***
VSL	6.29 Mill EUR
VSSI	1.02 Mill EUR
VoT	17.0 EUR/h
AIC	51,619
Log-likelihood	-25,805

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

All coefficients are highly significant with negative sign. This is logical because the coefficients represent the marginal utility associated with the cost, duration, and risk attributes, as explained in the previous section. The ratio between the coefficient of a specific non-monetary attribute and the coefficient of the monetary attribute gives the estimated average WTP to reduce the quantity of the specific attribute. According to this benchmark model, the average VSL is 6.3 Mill EUR, the average VSSI is around 1.0 Mill EUR and the mean VOT is 17.0EUR/hour.

3.4.2 Mixed logit model without interaction

As explained above, a first method to consider preference heterogeneity is to measure the unobserved heterogeneity using a mixed logit model where an error term is introduced in the writing of the coefficients. The distribution law of the error terms must be determined. It is assumed here that the cost coefficient is fixed to avoid having positive marginal utilities for all respondents. Moreover, this choice simplifies the calculation of the WTP distribution for each non-monetary attribute[10]. The distributions of the random terms associated with the risk attributes are assumed to follow triangular laws bounded in zero[11]. Besides, for the distribution of the time-related random term, the Normal law was preferred[12]. Since each respondent considers successively seven trade-offs, the panel dimension has been taken into account. The Results are presented in the Table 40:

[10] Indeed, with a distribution for the monetary attribute, the calculation of the ratio of marginal utilities would have been a ratio between two distributions, which is not simple to manipulate.

[11] This distribution is bounded in zero on the right and twice the mean on the left. It allows having no positive coefficients. It was preferred to the log-normal distribution because, since the latter is bounded on the left but not on the right, the mean coefficients obtained were pulled upwards by the extreme values.

[12] It was preferred over the triangular distribution because the latter led to erroneous results, mainly when we started to introduce interactions (see 3.4.3). It also provides us with better score in terms of log-likelihood (-24,362) and AIC criterion (48,734) than with only normal distributions (log-likelihood = -27,033 and AIC = 54,079) or only zero boundary triangular distributions (log-likelihood = -24,716 and AIC = 49,439)

Table 40: Results of the application of the MLMM with panel dimension, with triangular distributions bounded at zero for risk attributes and a normal distribution for time, to the global sample.

Coefficients	Global sample (5,527 respondents)
Cost	-0.240***
Time	-0.065***
Risk of death	-0.074***
Risk of injury	-0.011***
VSL *[Min, Median, Max]* *St. deviation*	6.19Mill EUR *[3.21, 6.20, 8.98]* *0.86 Mill EUR0*
VSSI *[Min, Median, Max]* *St. deviation*	0.95 Mill EUR0 *[0.43, 0.95, 1.37]* *0.19 Mill EUR0*
VoT *[Min, Median, Max]* *St. deviation*	16.1 EUR/h *[-6.8, 14.7, 36.6]* *12.9 EUR/h*
AIC	48,734
Log-likelihood	-24,362

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

All coefficients remain negative and significant and the log likelihood and the AIC criterion are improving significantly. Another difference to the previous model is the slight decrease in each of the WTP. The VoT decreased by 75 cents per hour (-4 %), the value of avoided death decreased by around 100,000 EUR (-2 %) and the VSSI decreased by about 70,000 EUR (-7 %).

There were the following values obtained: an average VSL of 6.19 Mill EUR with a minimum value of 3.21 Mill EUR and a maximum value of 8.98 Mill EUR, and an average VSSI of 0.95 Mill EUR with a minimum value of 0.43 Mill EUR and a maximum value of 1.37 Mill EUR. The average time value is 16.1 EUR/hour with a minimum value of -6.8 EUR/h and a maximum value of 36.6 EUR/h. The VoT negative values (2% of respondents) may seem surprising. This can be explained by the fact that a Normal distribution of the random parameter of the time attribute was applied.

Table 41: Results of the application of the MLMM with panel dimension, with triangular distributions bounded at zero for risk attributes and a normal distribution for time, for every country, from global sample of every country.

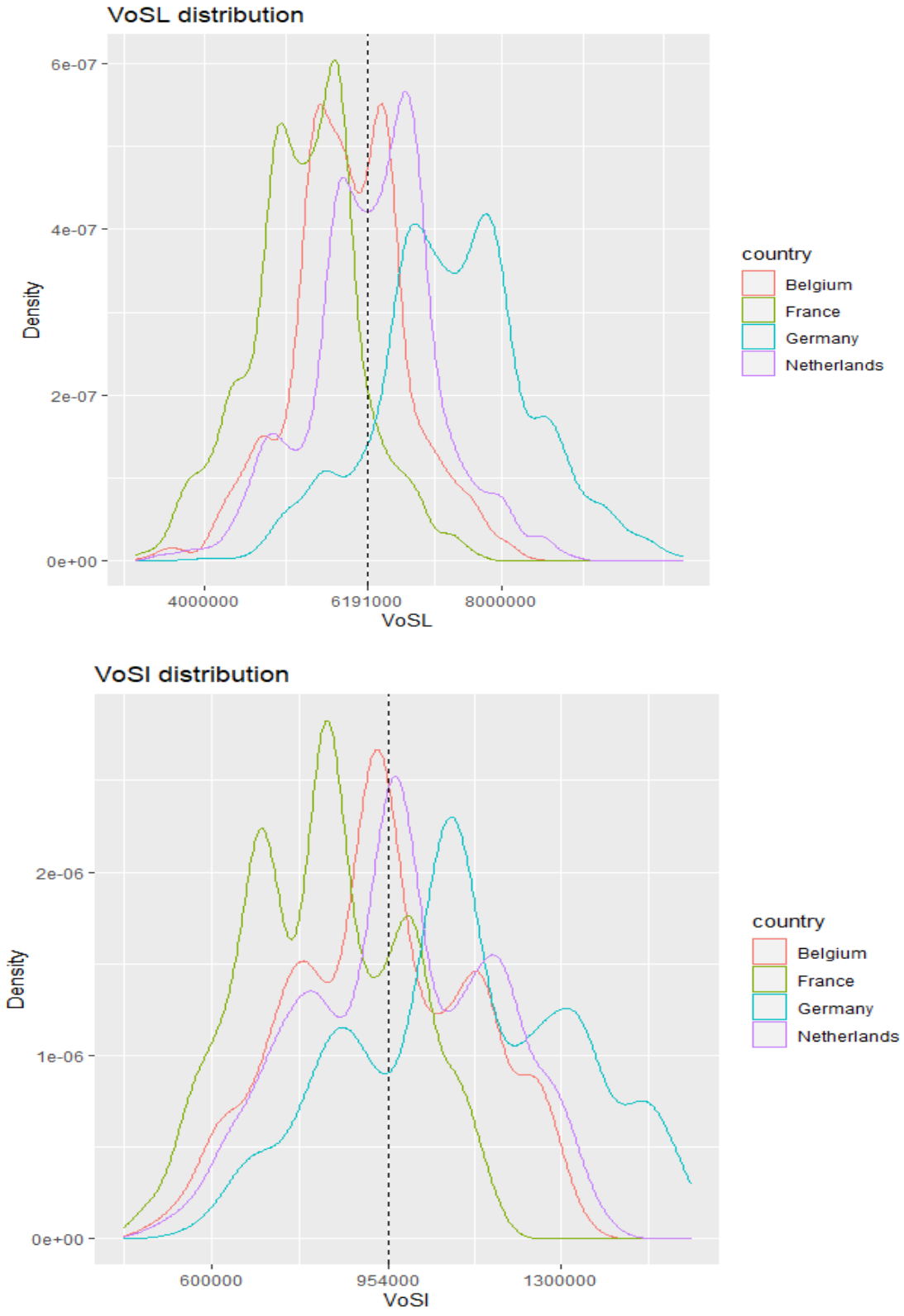
Coefficients	Belgium (1,368 respondents)	France (1,385 respondents)	Germany (1,441 respondents)	Netherlands (1,333 respondents)
Cost	-0.241***	-0.263***	-0.223***	-0.232***
Time	-0.069***	-0.057***	-0.071***	-0.064***
Risk of death	-0.072***	-0.071***	-0.082***	-0.073***
Risk of injury	-0.011***	-0.011***	-0.012***	-0.011***
VSL *[Min, Median, Max]* *St. deviation*	5.94 Mill EUR *[3.12, 5.92, 8.44]* *EUR0.79M*	5.35 Mill EUR *[3.07, 5.38, 7.69]* *EUR0.76M*	7.35 Mill EUR *[3.78, 7.34, 10.44]* *EUR1.04M*	6.29 Mill EUR *[3.38, 6.35, 8.95]* *EUR0.87M*
VSSI *[Min, Median, Max]* *St. deviation*	0.94 Mill EUR *[0.48, 0.94, 1.33]* *0.19 Mill EUR*	0.83 Mill EUR *[0.42, 0.83, 1.16]* *0.19 Mill EUR*	1.10 Mill EUR *[0.55, 1.09, 1.56]* *0.23 Mill EUR*	EUR 0.98M *[0.48, 0.97, 1.37]* *0.19 Mill EUR*
VoT *[Min, Median, Max]* *St. deviation*	17.2 EUR/h *[-7.1, 16.3, 37.3]* *10.9 EUR/h*	12.9 EUR/h *[-4.4, 12.2, 29.5]* *8.1 EUR/h*	19.0 EUR/h *[-8.6, 17.2, 41.9]* *12.4 EUR/h*	16.4 EUR/h *[-5.8, 14.6, 35.9]* *10.0 EUR/h*
AIC	12,029	12,433	12,396	11,788
Log-likelihood	-6,010	-6,212	-6,193	-5,889

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

The same econometric model was applied separately on each country-specific sample. Corresponding results are shown in Table 41. A Wilcoxon-Mann-Whitney test was performed and allows to conclude that distributions of WTPs differ significantly between countries. It is observed that German respondents show the largest VSL (7.3 Mill EUR), VSSI (1.1 Mill EUR) and VoT (19.0 EUR/h). By contrast, French show the lowest values (5.4

Mill EUR, 0.8 Mill EUR and 12.9 EUR/h respectively), with individuals from the Netherlands and from Belgium reporting WTPs in between of French and German values. These results are logical when looking at the different marginal disutilities. German respondents are characterized by the lowest parameters for the travel time and for the risks of accidents whereas they have the highest (i.e., the closest to zero) coefficient for the cost attribute. Diametrically different results were obtained for French people.

Figure 4: Distribution of estimated individual willingness to pay for a death and a serious injury in the 4 countries



The individual VSL and VSSI distributions on these figures are not normal and are marked by peaks and dips. This shape has to be explained with the fact that in the experimental design each attribute varies only between four levels and over seven scenarios. As a result, the variability of the obtained values is limited and individual values are concentrated around certain artificial threshold values, determined by the experimental design. However, these concentrations have little impact on the mean and still make it possible to observe the range of values.

3.4.3 Mixed logit model with interactions

After having measured the unobserved heterogeneity by using a random term in preferences' parameters, the observable heterogeneity has been assessed by additionally introducing a list of variables, putting them in interaction with each of the four attributes:

- Age
- Gender
- Household income per capita[13]
- Distance driven in the past 12 months
- Assessment of the safety of freeways in the country concerned
- Personal experience with road accidents
- The knowledge of relatives who have experienced road accidents
- The country
- The reason for the trip is broken down into three sub-categories according to respondents' habits: constrained activities, leisure, and other activities.
- Having or not having children
- Who normally pays the cost of the car trips for private motives: the respondent, the employer, or partner/relatives.
- Perception of the evolution of road safety since the outbreak of COVID-19: decreased, remained the same, or increased
- Evolution of the personal importance for road safety since the outbreak of COVID-19: less important, equally important, or more important.

To identify significant interactions, we tested these 13 variables (there are 31 classes with 21 classes compared with 10 references) in interactions with the 4 attributes, i.e., 84 interactions were analysed. We still apply mixed logit models, assuming the same distribution laws of random terms (time and risks of accidents) as before. The coefficients associated with the significant attributes and interactions of this model are presented in the Table 42.

Table 42: Coefficients and significant interactions of the mixed logit model with interactions, with panel dimension, zero-bounded triangular distribution for risk attributes and normal distribution for time attribute, to the main analysis sample from every country.

Coefficients	Sample 1 All countries (5,527)	Sample 1 Belgium (1,368)	Sample 1 France (1,385)	Sample 1 Germany (1,441)	Sample 1 Netherlands (1,333)
Cost	-0.368***	-0.260***	-0.286***	-0.448***	-0.236***
Time	-0.070***	-0.054***	-0.065***	-0.100***	-0.056***
Risk of death	-0.115***	-0.099***	-0.106***	-0.125***	-0.120***
Risk of injury	-0.015***	-0.012***	-0.013***	-0.016***	-0.015***
Cost x age	+++	0	0	+++	0
Cost x parent	+	0	+++	0	0
Cost x constrained motives	+++	0	0	0	+++
Cost x gender[14]	+++	+++	0	+++	0
Cost x household income	+++	0	0	+++	0
Cost x France	---	X	X	X	X
Cost x other motives	0	0	0	-	0

[13] Household members are equalised or made equivalent by weighting each according to their age: 1.0 to the first adult, 0.5 to the second and each subsequent person aged 14 and over and 0.3 to each child aged under 14.
[14] The variable is a dichotomous variable that takes the value 0 for women and 1 for men.

Cost x employer	+++	0	0	0	+
Cost x partner/relatives	+++	++	0	0	+
Time x age	+++	0	+++	+++	0
Time x household income	---	---	0	0	---
Time x France	+++	X	X	X	X
Time x parent	+	0	0	0	+++
Time x distance 10000/20000km	---	0	--	0	0
Time x other motives	---	0	--	-	-
Risk of death x age	---	---	---	0	---
Risk of death x risk assessment	+++	+++	+++	+++	+++
Risk of death x material accident	---	0	--	-	0
Risk of death x Belgium[15]	+++	X	X	X	X
Risk of death x France	+++	X	X	X	X
Risk of death x constrained motives	+++	0	0	0	+++
Risk of death x other motives	0	0	0	--	0
Risk of death x road safety more important	---	0	0	-	0
Risk of death x road safety less important	+	0	++	0	0
Risk of injury x gender	0	0	0	--	--
Risk of injury x age	---	---	---	0	---
Risk of injury x risk assessment	+++	+++	+++	+++	+++
Risk of injury x constrained motives	+++	0	0	0	+++
Risk of injury x other motives	0	--	0	--	0
Risk of injury x road safety more important	0	+	0	0	0
Risk of injury x road safety less important	+++	+	+	0	0
AIC	47,895	11,884	12,245	12,146	11,615
Log-likelihood	-23,921	-5,927	-6,107	-6,055	-5,789

Signification codes: *** < 0.001, ** < 0.01, * < 0.05
-: significant and negatively correlated
+: significant and positively correlated
0: not significant
X: not applicable

As the result of this exercise, the following 26 significant interactions were selected:

- Gender and travel cost, which is very significant and positive, meaning that being male reduces the disutility associated with travel cost.
- Household income and the cost of travel is significant and positive, which means that when household income increases, the disutility associated with the cost of travel decreases.
- Age and risk of death and injury, which are highly significant and negative, meaning that with age, the disutility associated with a risk of death or injury increases.

[15] The country variables are dichotomous and Germany is referenced.

- Assessment of the safety of motorways in the respondent's country and the risk of death and injury are very significant and positive interactions. Respondents who consider motorways in their country to be safer have on average a lower disutility associated with accident risks.
- The personal experience of road accidents with only material damage and the risk of death attribute is significant and negative which means that a person who has had a road accident with only material damage attaches more disutility to the risk of death than those who have never had such accident.
- With respect to countries, four significant interactions were identified. Living in Belgium is associated with a lower disutility of the risk of death (very significant) than in other countries. Living in France is associated with lower disutility with respect to travel time, risk of death and injury (all these interactions are very significant).
- Trip motive and travel time have an expected interaction. People having a constraining trip motive have a bigger disutility with respect to travel time than those having a leisure motive. Also, respondents who reported "other activities" motive have a higher disutility with respect to travel time than those travelling for leisure. This latter disutility remains, however, significantly lower than that of people travelling for constrained reasons, which is consistent with the theory on the value of time.
- A constraining trip motive also interacts significantly and positively with the risk of injury, which means that people travelling under constraints are less afraid of the risk of serious injury. This could be explained partially by the fact that individuals travelling for work-related reasons often have a corresponding insurance coverage.
- Having a child significantly and positively interacts with the time attribute. It appears that having children reduces the travel time disutility.
- As explained in the Section 3.d.iii., for 4% of respondents, who place less importance on road safety the outbreak of COVID-19, the risk of injury and death is less frightening. For 11% of respondents who place more importance on road safety after begin of pandemic, the risk of death is more frightening.
- Those who generally do not bear their personal car trip costs themselves (13%) perceive the cost burden as less inconvenient than those paying (87%) themselves. In addition, those whose employer pays (5%) report lower disutility of costs than those whose partner or relatives pay (8%).

Table 43: Effects of certain variables on WTPs, in the mixed logit model with interactions, with panel dimension, zero-bounded triangular distribution for risk attributes and normal distribution for time attribute, to the global sample.

Analysis Sample (5,527 respondents)			
Variables	**VSL**	**VSSI**	**VoT**
Male	+15%	+15%	+15%
Female	-12%	-12%	-12%
High income[1]	+10%	+10%	+23%
Low income[2]	-7%	-7%	-15%
Young people[3]	-22%	-25%	1%
Old people[4]	+26%	+29%	-1%
Low risk assessment[5]	+25%	+20%	0%
High risk assessment[6]	-20%	-16%	0%
Employer pays for private car trip	+30%	+30%	+30%
Partner/relatives pays for private car trip	+22%	+22%	+22%
Respondents pays for private car trip	-3%	-3%	-3%
Road safety less important since COVID-19	-14%	-21%	0%
Road safety equally important since COVID-19	-1%	+1%	0%
Road safety more important since COVID-19	+12%	+1%	0%

[1] We attributed the 9th decile associated with an income ratio of 3,000 EUR to the high-income category.
[2] We attributed the 1st decile associated with an income ratio of 833 EUR to the low-income category.
[3] The young people category is associated with an age of 25 years.
[4] The old people category is associated with an age of 70 years.
[5] We attributed the 9th decile associated with a rating of 10/11 to the low risk assessment category.
[6] We attributed the 1st decile associated with a rating of 5/11 to the high-risk assessment category.

Respective influences of these variables on WTPs are shown in the Table 43. Focusing on the whole analysis sample, it appears that the subjective risk assessment as well as the age of respondents are important characteristics with effects on VSL and VSSI that exceed +/-20% of the mean values. Moreover, respondents considering road safety as less important after the COVID-19 crisis begun, report substantially reduced VSSI (-21%).

Since it makes the marginal disutility of the travel costs closer to null, it is noticeable that individuals who do not bear the corresponding expenditures themselves are more willing to pay to reduce accident risks, as well as travel times. Finally, we see that wealthy individuals have a 23% higher VoT than an average respondent. Similar patterns at the country level are observed (and shown in Appendix), whereas some variables show larger impacts (e.g., gender and income in Germany).

3.4.4 Test of the impact of the hypothetical bias

In the questionnaire, respondents were asked whether scenarios seemed realistic to them. To test the impact of the hypothetical bias, statistical models were compared between the whole analysis sample and the same sample excluding respondents who thought, scenarios were unrealistic. 1,908 individuals (34.5%) from 5,527 respondents of the analysis sample considered scenarios as unrealistic. Aiming to address this phenomenon, the results of the Mixed Logit Model without interaction have been compared between the whole analysis sample and the sample excluding possibly biased respondents.

Table 44: Comparison of the application of the MLMM with panel dimension, with triangular distributions bounded at zero for risk attributes and a normal distribution for time, between analysis sample and analysis sample cleaned from hypothetical bias.

Coefficients	Analysis sample (5,527 respondents)	Analysis sample cleaned from hypothetical bias (3,619 respondents)
Cost	-0.240***	-0.220***
Time	-0.065***	-0.060***
Risk of death	-0.074***	-0.070***
Risk of injury	-0.011***	-0.010***
VSL *[Min, Median, Max]* *St. deviation*	6.19 Mill EUR *[3.21, 6.20, 8.98]* *0.86 Mill EUR*	6.40 Mill EUR *[3.34, 6.40, 9.08]* *0.88 Mill EUR*
VSSI *[Min, Median, Max]* *St. deviation*	0.95 Mill EUR *[0.43, 0.95, 1.37]* *0.19 Mill EUR*	0.97 Mill EUR *[0.49, 0.97, 1.36]* *0.18 Mill EUR*
VoT *[Min, Median, Max]* *St. deviation*	16.1 EUR/h *[-6.8, 14.7, 36.6]* *12.9 EUR/h*	16.3 EUR /h *[-8.3, 14.6, 38.4]* *11.2 EUR /h*
Adjusted AIC	48,734	48,924
Adjusted Log-likelihood[16]	-24,362	-24,455

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

Table 45: Comparison of distributions between analysis sample (AS) and analysis sample cleaned from hypothetical bias (ASC) using Wilcoxon-Mann-Whitney

AS \ ASC	VSL	VSSI	VoT
VSL/ VSSI/ VoT	=	=	≠

Excluding respondents who considered the scenarios to be unrealistic has a minor impact on the results. Indeed, the average WTPs of time, serious injury, and fatality increase by 1.5, 2.1 and 3.3% respectively. Furthermore, using the Wilcoxon-Mann-Whitney test, it can be concluded that the distributions of VSL and VSSI come from similar populations but that the distributions of VoT come from different populations. One can conclude from this robustness test that the answers (and central estimates) are probably not affected by any hypothetical bias.

3.4.5 Synthesis

Although all models generated similar results, a trade-off between reliability and performance had to be made in order to determine which model to choose. While the binomial logit model has the advantage of being simple and quick to use, it does not consider heterogeneity of preferences, which makes it less efficient. On the other hand, the mixed logit with interactions allows the introduction of a multitude of sources of heterogeneity through the 26 significant interactions that have been identified in our case, but this leads to a decrease in the reliability of the results and to increasing complexity of the model. Thus, it was decided to apply the mixed logit with panel dimension and without interaction as a reference model. The model generated the following values: the average VSL was estimated at 6.2 Mill EUR, the VSSI at 950,000 EUR and the VoT at 16.1 EUR/h.

[16] Since the sizes of the two samples are different and the log likelihood decreases linearly with sample size, the log likelihood must be adjusted for the difference in size. In each case, we multiplied the log likelihood of Model 1* by 1.53 because the whole analysis sample is 1.53 times the size of another sample.

3.5 Integrated choice and latent variables models

3.5.1 Descriptive statistics

Tables 47 to 49 show descriptive statistics for the individuals' answers to the different questions that have been asked in order to approximate the latent variables "thriftiness", "time pressure" and "risky behaviours". At this stage, we consider the base sample of 8,003 interviewees, as explained in the section 3.a.

Regarding statements used to capture the thrifty nature of respondents, we see that "*I am careful with my money*" received the best average score (5.3) whereas "*I find it difficult to limit my spending*" got the lowest mean value (3.1). Somehow logically, these two answers also exhibit the biggest categories for the extremes of the distributions.

Table 46: Statements for "thrifty" (1="strongly disagree" and 7="strongly agree")

	Average	% of 1-2	% of 6-7
When I do my shopping, I am on the lookout for potential promotions	5.1	6.7	38.6
To me it is important to save as much as possible	4.7	6.9	28.6
I hesitate to spend money, even on necessities	3.7	23.9	14.1
I am careful with my money	5.3	3.3	45.3
I find it difficult to limit my spending	3.1	39.2	7.1
I can easily postpone a purchase so that I can save	4.8	7.9	30.6

Looking then at the questions that will be used to approximate the time pressure felt by individuals, only small differences between the different statements were observed. Thus, the gap in averages between the one ranked at the first place (4.5 for "*I often try to do more than one thing at a time*") and the one at the last place (3.6 for "*I always seem to be doing things at the last moment*") is not that pronounced. A similar observation can be made for the relative shares of minimal and maximal categories.

Table 47: Statements for "time pressure" (1="strongly disagree" and 7="strongly agree")

	Average	% of 1-2	% of 6-7
I am often in a hurry	3.9	21.0	14.7
I always seem to be doing things at the last moment	3.6	26.6	12.5
I often try to do more than one thing at a time	4.5	11.4	22.6
I regularly check what time it is	4.0	20.5	17.0
The days are too short to carry out all daily tasks	4.0	19.7	18.7
I often feel time pressure in my daily life	3.9	22.9	16.7

Finally, the most common risky behaviour reported by individuals is "*Regularly eating high cholesterol food*" (with an average score of 3.5) whereas the habit that received the less support is "*Driving on a moped as a passenger without a helmet*" (mean score of 1.9). Regarding the share of upper vs. lower categories, most of interviewees state they are unlikely to perform the proposed risky activities.

Table 48: Statements for "risky behaviours" (1="extremely unlikely" and 7="extremely likely")

	Average	% of 1-2	% of 6-7
Try out a new extreme sport	2.3	63.5	5.9
Driving as a passenger with someone who may have had too much to drink	2.0	73.3	3.5
Regularly eating high cholesterol food	3.5	26.8	9.8
Driving on a moped as a passenger without a helmet	1.9	76.6	3.4
Sunbathing without sunscreen	3.4	37.0	13.9
Walking home alone at night in an unsafe area of town	3.0	44.0	9.5

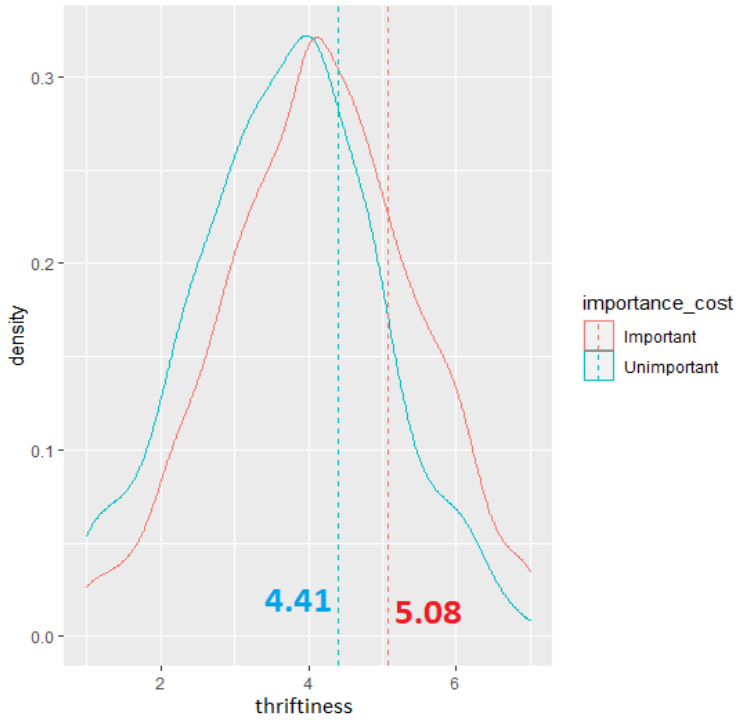
3.5.2 Validity tests

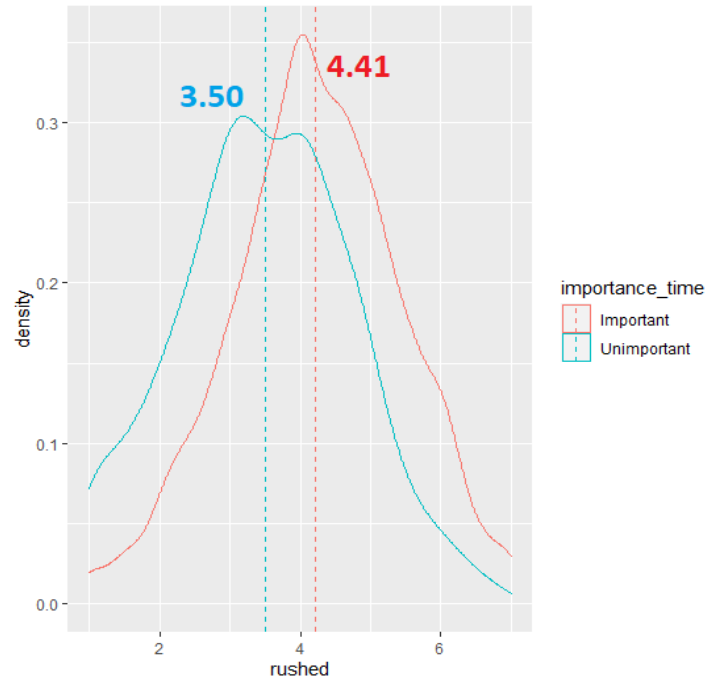
Table 49: Results of the test of the internal consistency and external validity of attitudinal scales.

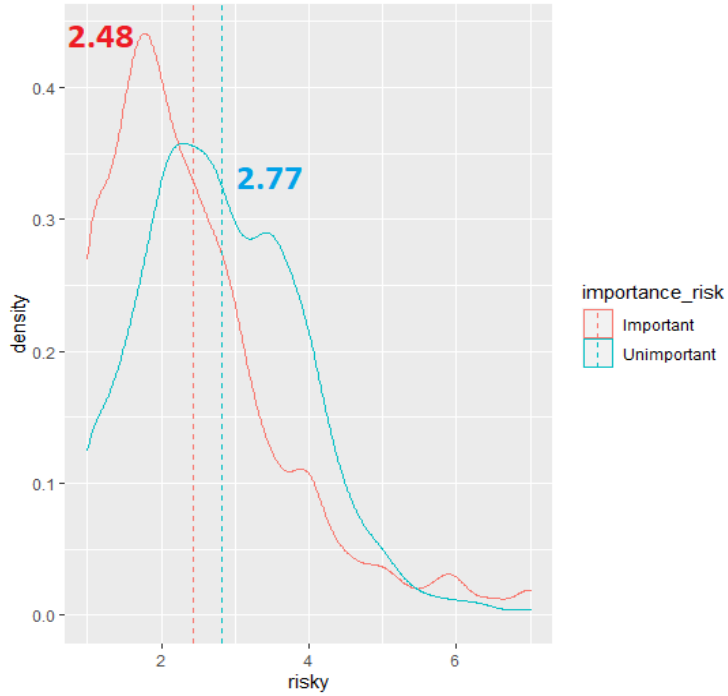
	Thriftiness	Time pressure	Risky behaviours
Final Cronbach's alpha	0.76	0.83	0.77
Statement that has been removed	*I find it difficult to limit my spending*	None	None
Average score if attribute as "important"	5.1	4.4	2.5
Average score if attribute as "unimportant"	4.4	3.5	2.8

Cronbach's alpha coefficient made it possible to validate the internal consistency of each of the three scales by removing only one of the 18 items from the "thriftiness" scale. The external validity of a scale was confirmed by showing that individuals who gave importance to an attribute and those who didn't logically report distinctly different mean scores. Even if the gap between mean values is not that pronounced, especially for "risky behaviours" (2.5 vs 2.8, see Table 50), Wilcoxon-Mann-Whitney tests let us to conclude that the distributions are significantly different across groups. Figures 5 to 7 below illustrate the corresponding distributions.

Figure 5, Figure 6 and Figure 7: Distribution of the different attitudinal scales







3.5.3 Econometric results

In line with the presentation of ICLV model in the Section 3C, the three latent variables were estimated with the help of structural equation modelling, here based on ordered probit models. Results are presented in the following table. For the sake of comparison with other econometric estimates, the sample of 5,527 rational and non-lexicographic individuals was considered.

It appears that men are thriftier and more in the rush than women. Surprisingly, they are also less prone to report risky behaviours, *ceteris paribus*. Old people are thriftier and less in the rush, also less prone to take risky behaviours. Belgians are more in the rush than others, more prone to take risky behaviours and they feel more constrained by their monetary budget than Germans and Dutch, but French are even thriftier. Employees are, in general, thriftier than others, more in the rush and less prone to take risky behaviours. Finally, parents declare themselves more in a rush.

Table 50: Socioeconomic determinants of the three latent variables

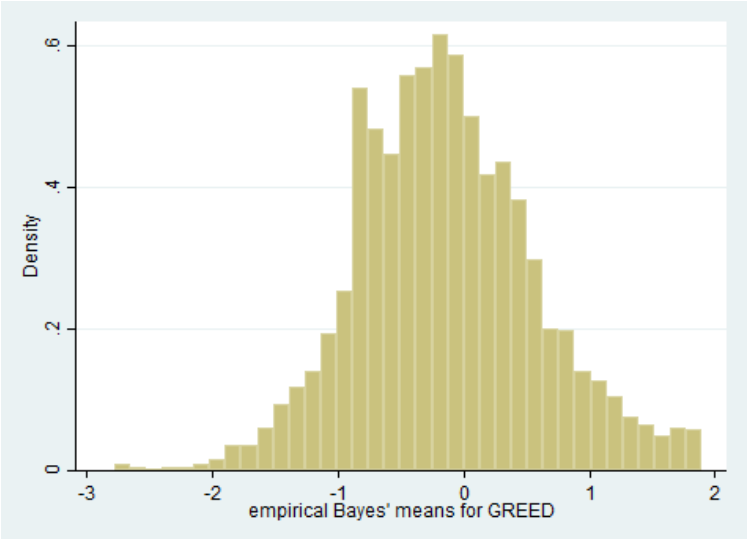
	Thrifty	Rush	Risky
Male	0.204***	0.407***	-0.486***
Income per capita	-0.000***	-0.000	0.000
Age	0.002**	-0.029***	-0.031***
France (wrt Belgium)	0.068*	-0.147***	-0.134***
Germany (wrt Belgium)	-0.208***	-0.428***	-0.301***
The Netherlands (wrt Belgium)	-0.094***	-0.408***	-0.084**
Blue collar (wrt employee)	-0.132***	-0.132**	0.096**
Executive (wrt employee)	-0.135***	0.053	0.125**
Self-employed (wrt employee)	-0.207***	-0.268***	0.100
No occupation (wrt employee)	-0.116***	-0.642***	-0.056
Being a parent	0.006	0.223***	0.037
Final log-Likelihood	-43,946	-53,734	-47,884

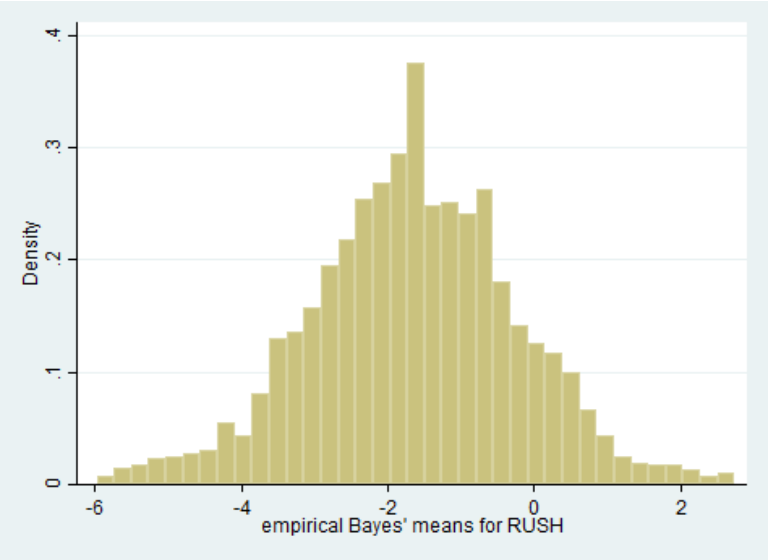
Signification codes: *** < 0.001, ** < 0.01, * < 0.05

Regarding the measurement equations and the influence of the latent variables on the proposed items (see equation (13)), results (not reported here) suggest that the "thriftier" the respondent, the larger the score given to "*I'm careful with my money*" and the lower the score to "*I hesitate to spend money, even on necessities*". Second, the more "time pressured" the respondent, the largest impact she/he reported for "*I often feel time pressure in my daily life*" and the lowest for "*I always seem to be doing things at the last moment*". Finally, the "riskier" the individuals' behaviour, the largest score given to "*Driving on a moped as a passenger without a helmet*" and the smallest score given to "*Regularly eating high cholesterol food*".

The distributions of the three predicted latent variables are shown below and the following table depicts mean values and standard deviations (in brackets). It appears that French people are the "thriftiest" ones. Belgium people feel more in the rush and tend to take more risk than others. By contrast, German people are less thrifty, less prone to behave risky and less in the rush. Latent variables are characterized by large standard deviations, especially the one related to the feeling of time pressure.

Figure 8, Figure 9 and Figure 10: Distribution of the three predicted latent variables





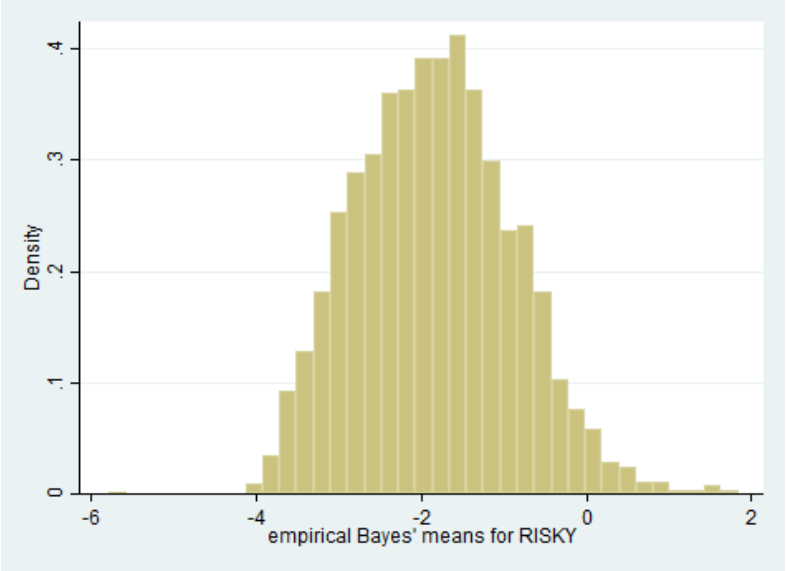


Table 51: Predictions of the three latent variables (standard deviations in brackets)

	Thrifty	Rush	Risky
Whole sample	-0.140 (0.724)	-1.639 (1.425)	-1.835 (0.953)
France	-0.005 (0.771)	-1.515 (1.388)	-1.840 (0.960)
Belgium	-0.081 (0.717)	-1.404 (1.391)	-1.702 (0.894)
Germany	-0.274 (0.684)	-1.845 (1.480)	-2.030 (0.949)
The Netherlands	-0.194 (0.696)	-1.787 (1.387)	-1.756 (0.974)

In a second step, the predicted latent variables interacted with the relevant route choice's attributes for producing mixed logit estimates (see equation (11)). It is worth noting that results of five specifications presented below are not directly comparable with those from previous sections because Stata13 (the software used to implement the ICLV model) does not allow considering zero-bounded triangular distribution for the coefficients related to "time", "risks of death" and "risks of injury". Instead, normal distributions for these parameters are supposed whilst (still) assuming a fixed coefficient for the cost attribute.

Specifications (2) to (4) confirm that introducing the latent variables separately is relevant and improves the understanding of the stated discrete choices experiments because the final log-likelihood increases with respect to specification (1). Moreover, ICLV model delivered intuitive findings: people who are thriftier also highlight a largest marginal disutility of money expenditures. Similarly, people who feel more time pressure, reveal a larger negative marginal disutility of the travel time. Finally, individuals who are more prone to behave risky fear accident risks (both fatal and serious injury risk) less. In our opinion, the best estimate is the one in which the three latent variables are considered jointly, it is presented in the column (5).

Table 52: Results of the ICLV model

	(1)	(2)	(3)	(4)	(5)
Cost	-0.208***	-0.216***	-0.208***	-0.209***	-0.218***
Time	-0.059***	-0.059***	-0.067***	-0.059***	-0.066***
Risk of death	-0.065***	-0.066***	-0.065***	-0.039***	-0.039***
Risk of injury	-0.010***	-0.011***	-0.010***	-0.007***	-0.007***
Cost * thrifty	-	-0.051***	-	-	-0.059***
Time * rush	-	-	-0.005***	-	-0.004***
Risk of death * risky	-	-	-	0.014***	0.015***
Risk of injury * risky	-	-	-	0.002***	0.002***
Log-Likelihood	-24,224	-24,170	-24,204	-24,082	-23,991

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

In order to illustrate the impact of attitudes and opinions VSL, VSSI and VoT, binary variables were introduced depending on if the respondent has reported a predicted latent variable below/above the sample average. Thus, respondents belonging to the "rush low & thrifty high category" have a predicted value for the "rush" latent variable below the sample mean and they are thriftier than an average individual within our sample. The results show that respondents who don't feel time pressured and who are not inclined to increase their monetary expenditures to the margin are logically characterized by a low VoT, especially as compared to those feeling themselves in the rush and who are not thrifty (13.5 EUR/h vs 21.5 EUR/h). Whereas the former group is slightly more composed of Dutch people, the latter comprises relatively more individuals from Belgium. Similarly, the attitudes and opinions towards risky behaviour leverage VSL and VSSI. Individuals who are less prone to behave risky and who are not thrifty are willing to pay 8.8 Mill EUR/saved life, with a lot of Germans within this group. By contrast, respondents who "like" risky behaviours and "dislike" spending money exhibit a very low VSL of 4.6 Mill EUR, with a larger proportion of Belgium people in this group.

Table 53: Impacts of attitudes and opinions on WTPs

	Whole sample	Rush low & thrifty high	Rush high & thrifty low	Risky high & thrifty high	Risky low & thrifty low	Risky high & rush high	Risky low & rush low
VSL (Mill EUR)	6.57	6.01	6.86	4.56	8.80	5.24	7.83
VSSI (Mill EUR)	1.05	0.96	1.11	0.74	1.40	0.85	1.25
VoT (EUR/h)	17.6	13.5	21.5	15.5	19.2	18.9	16.0
Observations	5,527	1,135	1,254	1,173	1,343	1,654	1,705
France	25.1%	25.4%	21.1%	28.6%	20.5%	25.5%	22.5%
Belgium	24.8%	23.6%	27.9%	30.3%	20.8%	30.5%	20.4%
Germany	26.1%	24.4%	26.6%	16.9%	35.3%	20.1%	32.4%
The Netherlands	24.1%	26.6%	24.4%	24.1%	23.4%	23.9%	24.8%

All in all, the results of the ICLV model are very promising, even if they must be confirmed by further research and supported by alternative econometric specifications, regarding the distribution laws of random parameters in the mixed logit and/or the analyses of the measurement equations. These findings confirm that unobserved individual heterogeneity - here captured with the use of latent variables - significantly impacts WTPs and may help understanding some of the observed differences. For instance, the higher share of German people in the "risky low & thrifty low" category is consistent with results of the mixed logit presented in the Section 3d ii. It may be the case that high averages of VSL and VoT found for Germany are explained by the over-representation, as compared to other countries, of people who are not "thrifty" and who are not prone to behave risky.

4 Discussion

4.1 Estimated values

The set of estimated values includes the Value of statistical life (VSL), the Value of a statistical serious injury (VSSI), and the Value of time (VoT). By applying two different models (mixed logit and binomial) and excluding lexicographic and non-rational answers, the project team generated two sets of estimates for each value. Since the mixed logit model takes into account the panel dimension of the data, it represents the theoretically preferred modelling approach.

The **VSL** for the sample, including the data on the four countries and generated with the mixed logit model, is **6.19 Mill EUR**. The value for the VSSI is **0.95 Mill EUR**. Hence, the **cost ratio between fatalities and injuries** is estimated at around 1 to 7**.** The **VoT** amounts to **16.1 EUR** per hour.

While the mixed logit model with panel dimension takes account of the heterogeneous preferences of respondents, the estimated values are quite close to the outcomes of the binomial model (6.29 Mill EUR for VSL, 1.02 Mill EUR for VSSI, and 17.0 EUR for VoT respectively). This convergence suggests that the estimates are robust.

The reliability of results can be confirmed also by observations made while addressing hypothetical bias and lexicographic behaviour. With regard to hypothetical bias, the exclusion of 1,900 respondents who did not consider the survey design as realistic did not significantly modify the final estimates: the increases in VSL, VSSI and VoT do not exceed 3%.

The application of the mixed logit model to the sample of 7,557 respondents *including* lexicographic respondents yielded results very similar to those of the sample omitting lexicographic answers: 6.3 Mill EUR for VSL, 0.8 Mill EUR for VSSI, and 16.3 EUR/h for VoT (see appendix). The confidence intervals of the two samples above are nearly equal and the distribution of individual values is not significantly different. Some differences can be observed: however, they remain limited. Therefore, it can be concluded that the experimental protocol was properly designed.

4.2 Estimated values per country

VSL, VSSI and VoT have been generated also for each participating country applying the mixed logit model.

France shows the lowest values, while Germany shows the highest. The difference between the values of these two countries was as high as 38%.

Belgium and The Netherlands show quite similar values.

The model revealed for **Germany** the **VSL of 7.3 Mill EUR** (within the range of minimum 6.3 Mill EUR and maximum 8.3 Mill EUR), **the VSSI of 1.1 Mill EUR** (0.7-1.3), **and the VoT of 19.0 EUR**.

The values for **France** are respectively **5.3 Mill EUR** (4.6-6 Mill EUR range)**, 0.8 Mill EUR** (0.6-1 Mill EUR), **and 12.9 EUR.**

The values for **Belgium** are **5.9 Mill EUR** (5.1-6.7 Mill EUR)**, 0.9 Mill EUR** (0.7-1 Mill EUR), **and 17.0 EUR.**

The values for **the Netherlands** are **6.3 Mill EUR** (5.5-7.1 Mill EUR)**, 1 Mill** (0.8-1.1 Mill EUR), **and 16.4 EUR.**

In principle, none of the differences between the four countries can be explained by systematic differences between the samples since the same selection procedure for each country was applied.

4.3 Impact of variables

4.3.1 Interaction effects

The modelling made it possible to examine some interaction effects in terms of growing or decreasing loss of utility, which has to be considered as a marginal effect from the point of view of economic analysis.

Three types of interaction could be considered: with cost, time, and risk. Interaction with age can be identified for cost, time and risk. Being older reduces the disutility related to costs (value attached to money) and to time (value attached to time): the older road users are, the less is the disutility for them related to time and cost compared with other (younger) respondents. Probably, there are weaker constraints regarding time : the elderly show an increase of disutility related to risk of death and risk of injury, probably due to general risk aversion.

Being a parent is associated with interaction effects related to cost and time. The disutility of cost and time is reduced in this case, suggesting that timing horizon and attitude to money are modified when one has a family. There is also an interaction effect between having a partner/relatives and cost: having a social relationship modifies the value attached to money.

The model identifies also some interaction effects between income and cost and income and time. The respondents with higher incomes report additional disutility of time compared to those with lower incomes. On the other hand, high income respondents report reduced disutility of cost, probably because they are less constrained by income limits.

VALOR research revealed some national peculiarities. The disutility of cost is higher for French road users, suggesting that the same amount of money for using safer toll-collect highways yields higher disutility compared to respondents from other countries, and this could explain partly why the French values are lower compared to other countries. It should be noticed here that France currently is the only one of the four participating countries in which most motorways are toll roads, which could explain why French citizens are more sensitive about the cost-dimension of trips. National effects are also found for France and Belgium concerning the risk of death: this interaction effect suggests a reduction of disutility and could be explained to some extent by differences in risk perception. An interaction effect with regard to time is also identified with France: the disutility of time for French road users is lower compared with other countries. Thus, France shows interaction effects with all three experiment attributes: cost, time, and risk, which could be a potential explanation for the difference between the sets of values for France and other countries.

Risk assessment also shows an interaction effect with risk. A lower risk assessment - which is probably occurring because individuals consider themselves as being better at managing risk - is associated with less disutility of risk of being dead or injured in a road crash.

There was an interaction effect related to the experience of having observed material damage, and this increases the disutility of risk of death.

4.3.2 Effect of Covid Pandemic

It was assumed that the lockdown, the reduction of mobility, the prevention measures, and the high numbers of Covid victims could affect the preferences of individuals regarding risk and their perception of road safety. Lines of questioning which reflect this assumption have been included in the questionnaire.

About 15% of respondents answered that the Covid pandemic had changed their perception of road safety. Most respondents answered that the Covid pandemic had no impact on their perception of road safety.

73% of respondents declaring a change in perception felt that road safety had become more important (a complementary effect or awareness effect of the importance of good health), while 27% reported that road safety was a less important issue (a substitution effect or a relative effect).

Concerning respondents who declared the increasing importance of road safety due to Covid, the consequences of their changed attitude remain limited: +6.5% for VSL and +1% for VSSI.

Respondents reporting a decreasing importance of road safety due to Covid demonstrated significantly weaker WTP: -20% for VSL and –23% for VSSI.

To sum up, the impact of the Covid pandemic on the estimated values within the whole sample is not significant, since the fraction of respondents reporting sizeable effects is very small.

4.3.3 Effects associated with individual characteristics

The individual characteristics of respondents can affect VSL and VSSI.

Some general patterns common to all four countries were identified, but with varying intensity from country to country and depending on the type of injury (fatal or serious).

The gender of a respondent has an effect on both values. Being male implies a higher value (positive effect) for VSL and VSSI, while being female implies lower values (negative effect) compared to males. For Belgium and the Netherlands, the effects of gender are quite similar, with a deviation of around 10% (positive for males and negative for females). Germany shows a greater effect of around +37% for males and -22% for females. No effect was identified for France.

The age of a respondent also yields an effect. Being young implies lower values, while being older pushes up the values. Regarding differences between countries, in Belgium and France young drivers show a VSL 17% lower than the mean of the all-countries sample and a VSSI 20-24% lower than the mean value. The Netherlands shows 11% lower VSL and 17% lower VSSI. In Germany, young drivers reveal an even larger VSL reduction of 30% while the elderly demonstrate a significantly higher VSL (52% over the mean value). The positive effect of higher age has been observed also in other countries.

The perception of risk is a significant variable. The respondents in each country who reveal a low risk assessment show a large reduction in the VSL and the VSSI compared to the mean value of the national sample: -28% for France and Belgium, -20% for the Netherlands, and -16% for Germany for VSL; -20% for France and Belgium, -16% for the Netherlands, and -13% for Germany for VSSI. In all four countries, high risk assessment respondents show higher values: in Belgium, France and Germany 25% more for VSL and 35% more for VSSI, in the Netherlands 10% for VSL and 28% for VSSI.

Beyond the general patterns, some specific effects on VSL were identified. For France, being a parent has a positive effect of 10%[17]. In all countries, the income variable plays a significant role with a positive effect of 10% for the highest income category and a negative effect of 7% for the lowest income category. In Germany, these effects are even greater, with a positive effect of 30% for the highest income category and a negative effect of 13% for the lowest income category.

To sum up, **age, sex, income, and risk assessment are significant factors** which influence the valorisation of a statistical life and of a serious injury.

4.3.4 Impact of latent variables

The latent variables "thriftiness", "time pressure" and "risky behaviour" were introduced in order to assess unobserved heterogeneity in responses relating to individual attitudes and opinions regarding time, money and risk. These variables were embedded in the model so as to provide additional information about the impact of individual preferences on VSL and VSSI.

On average, **an individual inclined to take risks assesses the VSL by 26% less and VSSI by 22% less** than the mean values of the sample.

On average, **an individual inclined to avoid risks assesses the VSL by 42% more and VSSI by 47% more** than the mean values of the sample.

Consequently, the difference of values between these types of road users is estimated as a factor of 1.9.

[17] The impact of being a parent on the VSL value raises an issue related to the third part effect or externality and its consequences for adjusting the estimatation of such a value. The results of the model shows the individual takes into consideration the potential effect of his/her decision for the relatives. It suggest the individual decision could consider other dimensions than personal ones. However, the present estimate of the VSL remains an individual value based on individual choices, so that there is no ground for adjusting the estimated value. In the case there would be an impact on a third part because of the damages borne by the road accident victim, it could be assumed it is the role of judge to decide if compensation is needed and to apraise its amount.

Even though these results, found with Integrated Choice and Latent Variables models, are fairly consistent with other estimates, further research should be undertaken to confirm these findings, and we advise the use of WTP results, varying with respect to attitudes and opinions, for establishing official values with a caution.

4.4 Comparison with other academic studies

De Blaeij (2002) produced a meta-analysis of studies on the VSL embracing ca. 90 research reports and articles from many countries. The VSL values revealed in these studies show very broad dispersion, lying in a range between 200.000 and 11 Mill USD. Rune Elvik (2016) reports on research results ranging between less than 1 Mill and 50 Mill USD (price level 2000).

OECD has published in 2012 the report "Mortality Risk Valuation in Environment, Health and Transport Policies" offering a meta-analysis of 856 mean VSL estimates from hundreds of surveyed studies. The values fall in the range from less than 1 Mill USD to over 20 Mill USD (2005 prices). The values recommended by this study are currently being used by several countries for official estimates of the socio-economic costs of road accidents.

Bahamonde-Birke et al. (2015) give an overview of WTP-methods and VSLs as estimated in WTP-studies in several countries. The VSLs found in six European stated choice studies range from 1,153 to 7,124 USD (price level 2005), or 945 to 5,839 EUR (using the Eurostat purchasing power parity US-EU27). In a Spanish study, a VSL of 30 million USD (2005) was established. If we regard this as an outlier and take inflation into account (18% in the EU 2005-2019, based on OECD GDP deflator), we can conclude that the VSL figuring in this study is at the higher end of the range of VSL estimates found in similar studies in other countries.

Wijnen (2021) gives an overview of WTP-estimates of preventing serious injuries as found in the literature, including six stated choice studies. The VSIs show wide variation: from 1% to 47% of the VSL. Clearly, the value found in the VALOR study (16%) is within this range and consistent with values recommended in European studies on the external costs of transport (e.g. van Essen et al., 2019)

In the Netherlands, de Blaeij (2003) undertook research on VSL applying the WTP concept. She employed different models: one based on car choices and one based on a route choice approach similar to this study. The car choice model estimated the VSL between 3.6 to 10 Mill EUR depending on the specification of the model. The route choice model provided a value ranging between 1.9 and 2.3 Mill EUR for the binary model depending on inclusion or exclusion of lexicographic answers. More elaborated models estimated the value in a range from 1 to 11.4 Mill EUR. A VSL of 2.1 Mill EUR (2001 prices) was suggested as the best estimate (Wesemann, De Blaeij and Rietveld, 2005).

If similar models are compared, de Blaej's estimates show higher dispersion than the VALOR results, according to which the VSL recommended for practical application amounts to 6.2 Mill EUR, lying in the range between 5.3 and 7 Mill EUR.

In Germany, the main studies available on the social costs of accidents apply a combination of human capital and restitution approaches, so that the figures cannot be directly compared with VALOR results (Wijnen et al. 2019a). The restitution approach generally results in lower values when compared with the WTP approach (Wijnen et al. 2019b). However, the WTP approach is considered to be the best theory for estimating the human costs of accidents and the VSL.

Obermeyer and his co-authors (2019) presented in a conference paper a methodology for assessing a WTP using a route choice. Similar to the VALOR concept, some scenarios were proposed on different subjects: the authors estimated values of statistical life (3.6 Mill EUR/ 3.1-4.1 Mill EUR range), serious injury (0.44 Mill EUR/ 0.3-0.6 Mill EUR), serious injury (0.2 Mill EUR/ 0.17-0.3 Mill EUR), and slight injury (0.15 Mill EUR/ 0.01-0.2 Mill EUR). VALOR produced higher values for Germany with 7.4 Mill EUR for VSL and 1 Mill EUR for VSSI. The VSSI is also higher relative to the VSL (16% of VSL) as compared to the findings of Obermeyer et al. (6-12%). One explanation for this discrepancy is the application in VALOR of a VSL reference value of 4.6 Mill EUR taken for modelling from the OECD report on mortality risk valuation (2012).

In Belgium, de Brabander and his co-authors (2007) provided some estimates for the value of statistical life, for serious injury, and for slight injury using the WTP approach. The estimated VSL value amounted to 2.3 Mill EUR and the VSSI to 0.7 Mill EUR. VALOR estimates for Belgium are 2.5 higher for VSL with 5.9 Mill EUR and equal for VSSI with 0.9 Mill EUR (taking into account price level differences). The ratio VSSI/VSL is much lower as compared to the results of De Brabander (2007).

There are no estimates of VSL based on the WTP approach in France. The last VSL estimate was provided in the Quinet report (2013), in which data for 2010 were used. The methodology is based mainly on transferring values from the OECD report. The VSL was estimated at 3 Mill EUR and the VSSI at 0.45 Mill EUR. Those values are 10 years old and cannot be directly compared with VALOR results due to different methodologies. VALOR recommends the VSL of 5.3 Mill EUR for France, 1,8 times higher than the old value. The VALOR VSSI for France is 0.8 Mill EUR, which is roughly two times higher.

Except in the Netherlands where a common methodology is used, the approaches deployed by researchers in participating countries are quite different. For each country the estimates of VALOR are considerably higher than figures published in available reports. It should be noted that VALOR estimates are aligned with the state-of-the-art econometric computer-based modelling and that the previous estimates have to be updated.

The differences in results are a familiar phenomenon in WTP research and have several reasons:

- Methodology, where its practical application (formulation of questions, communication to respondents, etc.) plays an important role
- GDP per capita
- Price level
- Changes in income
- Measures to increase awareness in the population
- Input values (prior estimates, traffic volume, etc.)
- Baseline risk
- Definition of serious injury.

4.5 Comparison with official values of participating countries

Comparing the estimates in this study with official values applied in policy-making in participating countries is a difficult exercise, because these values are based on different methodologies (willingness-to-pay-approach, restitution approach, human capital loss, transfer value) and are subject to political guidance. The differences between academic purposes and societal and political aims have also to be considered. However, comparison remains possible and is useful in demonstrating the extent of changes that would be brought by applying alternative evaluation methods.

In the Netherlands, the official VSL amounts to 2.8 Mill EUR (price level 2018) and the VSSI to 0.3 Mio EUR. Dutch values can be directly compared with VALOR results thanks to the homogeneity of the methodology (WTP). The VALOR VSL for the Netherlands is three times higher than the official Dutch figure, and the VSSI is also almost three times higher.

Official values for Belgium are provided by Vias institute (2020). The figures were produced by the SafetyCube European research project. The VSL amounts to 2.7 Mill EUR, the VSSI and the value of a slight injury are estimated respectively at 0.34 and 0.03 Mill EUR. The VALOR values for Belgium are 2.2 times higher for VSL and 2.7 times higher for VSSI.

German official values of social costs of a casualty and a serious injury (data from 2018, published 2020) are 1.12 Mill EUR and 0.12 Mill EUR respectively. The values cannot be directly compared with VALOR results due to differences in approach to costs assessment: in Germany a combination of restitution costs and human capital loss is applied for this purpose. VALOR suggests a VSL which is seven times higher than the social costs of a casualty, while the VSSI is 10 times higher than the social costs of serious injury.

In France, the VSL was estimated at 3.4 Mill EUR in 2019 while the value of a serious injury amounts to 0.43 Mill EUR. As for the other participating countries, these figures are well below VALOR estimates which are 1.6 times higher for VSL and 1.9 times higher for VSSI. Comparisons with VALOR results are valid since France uses VSL values derived from transfer of values from OECD data.

To sum up, the extent of the gap between some official national values and VALOR results depends mainly on the methodology used for determining the official values, but also on other determinants such as the baseline risk, the input values, income and price levels. This is especially clear in case of Germany, which shows the lowest official values compared to other countries but the highest values according to VALOR estimates. In the case of France, the opposite effect can be observed: the gap is the smallest, in that the official values are the highest while VALOR values the lowest. This can be explained again by methodological differences.

However, in both cases the assumption can be made that national specificities in attitudes play a significant role.

An important and paradoxical observation in relation to the comparisons above is that the country having the lowest official values (Germany) presents the highest values when estimated by applying individual stated choices, while the country having the highest official values (France) has the lowest from the individuals' perspective.

Table 54: Comparison of official and VALOR values (Mill EUR)

	VSL official	VSL VALOR	VSSI official	VSSI VALOR
The Netherlands (2018)	2.8	6.3	0.3	1.0
Germany (2018)	1.1 (social economic costs)	7.3	0.1 (social economic costs)	1.1
Belgium (2020)	2.7	5.9	0.3	0.9
France (2019)	3.4	5.3	0.4	0.8

4.6 Methodology

When the values generated in different studies and applied in different countries are compared, methodological considerations are crucial. For example, the main reason for the substantial discrepancy between the results of the VALOR study and estimations of costs of fatalities and injuries in Germany is the difference in methodology, above all the non-application of the WTP concept for the assessment of human costs.

The WTP is a well-established concept in economics. It is a widely shared opinion among economists that the monetary value of safety should reflect the preferences of those affected by a policy measure (de Blaeij, 2002), and this justifies the deployment of the WTP methodology.

The WTP has been recommended as the theoretically solid and most appropriate approach for assessing the human costs of road casualties by COST 313 Action, in which twelve European countries took part (Alfaro et alia, 1994). According to its recommendations, human costs should be considered as a part of total accident costs that also include restitution and human capital loss costs.

Assessing values for statistical life and serious injury is a difficult and complex issue, because it is quite challenging for respondents to articulate these values and to fully understand what a serious injury means. It is questionable if individuals can rationally assess the monetary value of suffering or recovery problems when they have never been experienced and there is supposedly a preference for not experiencing such trauma.

Stated choice questionnaires deal with situations in which trade-offs concerning money, time and probability of being injured or killed are suggested. A probability gamble is not a neutral approach. However, it is a better approach than confronting people with a real life or death situation.

The social and individual contexts of a respondent's decision have to be considered as well as the impact of the scenario parameters: amount of money, duration in minutes, and number of victims. It is assumed that the context and the magnitude of these parameters have an impact on the results.

There are some well-known challenges in the practical application of the stated choice method in estimating the WTP and they have to be taken into consideration:

- The ability of individuals to monetize the value of life
- The hypothetical nature of the experiment
- Behavioural bias
- Protest answers
- Respondents' propensity to ignore income considerations.

Over time researchers have developed instruments to address these challenges. In this study, considerable efforts were made to eliminate the influence of lexicographic behaviour (Section 3.b.iii.). The expert team has also addressed hypothetical bias (Section 3.d.iv.) when developing the models.

It is imperative that respondents are presented with adequate and precise information about the assumed initial risk level and subsequent changes in the risk level (de Blaeij, 2002). Aiming at appropriate presentation of routes, the questionnaire was tested with focus groups and a pilot study was carried out. Other studies

have been analysed, exchanges with colleagues have taken place, and best practices have been considered for developing and improving the questionnaire.

With regard to randomly set cost, time and risk parameters used in the questionnaire, VALOR made substantial efforts to apply realistic values (Section 2.c.ii.3.). For future research VALOR would recommend a study on the sensitivity of results with regard to chosen parameters.

A reference value of VSL applied for the model has an influence on the magnitude of the result values. VALOR applied a value of 4.6 Mill EUR (recommended by OECD (2012), which is higher than the reference values considered in participating countries so far. For example, according to available information the HEATCO value generated in 2006 under conditions using the same limits described above is still used as a reference.

4.7 How to use the results of this study

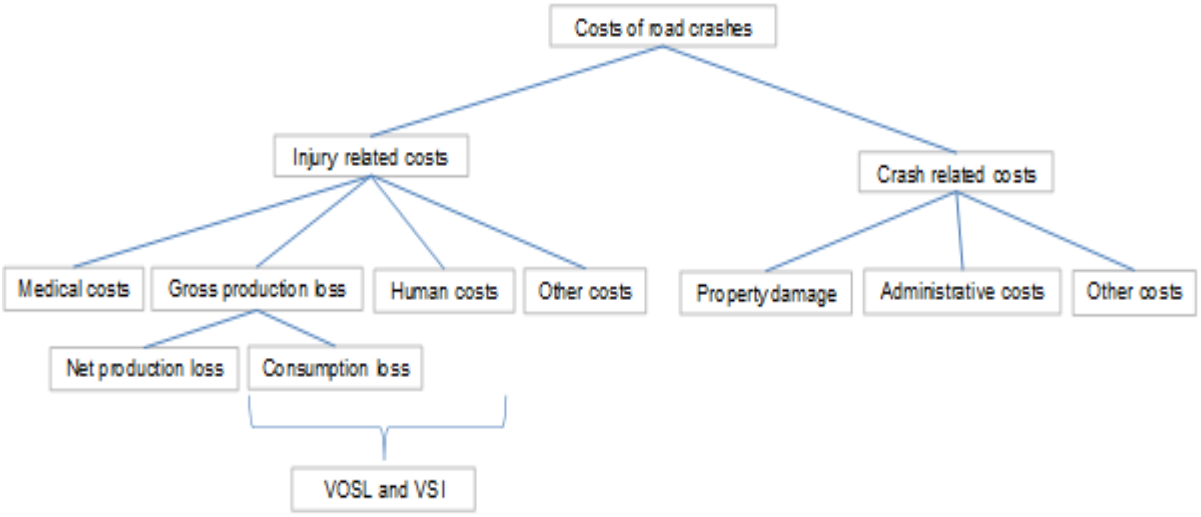
The results of this study can be used for two main purposes in policy-oriented research and applications.

Firstly, the VSL and VSSI are an important input for calculating the socio-economic costs of road crashes. Information on these costs is regularly used in road policy-making. For example, the socio-economic costs are regarded as a high-level outcome indicator for road safety management (Bliss & Breene, 2009). National road safety policy documents often include this indicator, as well as international reports on road safety in individual countries such as the ITF Road Safety Annual Report (ITF, 2017) and the Global status report on road safety (WHO, 2015). Information on the socio-economic burden of road crashes can be used as an input for budget allocation and helps to justify road safety investments. Also, comparisons can be made with costs of other policy measures. For example, in the Netherlands costs of road crashes are estimated to be four to five times higher than congestion costs (17.1 Bill EUR versus 3.3 to 4.3 Bill EUR in 2018; KiM, 2019).

These socio-economic costs of road crashes consist of six main cost components (Wijnen et al., 2019): medical costs, production and consumption loss, human costs, property damage (such as damage to vehicles and infrastructure), administrative costs, and other costs. Administrative costs include the costs of emergency services, insurance costs, and legal costs, while other costs include, among others, costs of congestion resulting from crashes and costs of vehicle unavailability. Human costs are the intangible costs of loss of lives and quality of life. Reviews show that human costs take up a major share of road crash costs. For example, human costs amount to 54-94% of the costs per fatality and 51-91% of the costs per serious injury in European countries that use the WTP approach (Wijnen et al., 2019).

The VSL and VSSI as determined in this study are an important element of the costs of road crashes, since they reflect the human costs related to fatalities and serious injuries as well as consumption loss (Evans, 2001; Wijnen et al., 2009). Usually, the loss of consumption resulting from road casualties is included in the calculation of production loss (known as 'gross production loss'), and therefore consumption loss should be deducted from the VSL to arrive at the human costs. This is illustrated by figure 11.

Figure 11: Road crash cost components and relation with VSL and VSI (based on Wijnen et al., 2019 and Wijnen et al., 2009).



Secondly, the VSL and VSSI are needed for cost-benefit analysis (CBA) of road safety measures or broader transport projects with road safety impacts. In CBA, estimates of the socio-economic costs per casualty or per crash are used to translate casualty reductions into monetary benefits (which are equal to the road crash cost savings). The outcomes of CBA of road safety measures show whether the socio-economic return is positive or negative, which can support decision-making about road safety investments and prioritizing road safety measures. In broader transport projects, such as infrastructure investments, different impacts are included in CBA, for example travel time savings, environmental impacts, and safety impacts. In the framework of CBA, the different impacts are traded off on the basis on monetary valuations.

Since human costs, and thereby the VSL and VSSI, are essential elements of the socio-economic cost, the VSL and VSSI have an important impact on the results of CBA. Higher VSL and VSSI estimates translate into greater safety benefits, and thus into more favourable benefit-cost ratios (if there is a positive impact on road safety). In general, most road safety investments are found to be (very) cost-beneficial (Daniels et al., 2019). This is partly explained by the fact that the socio-economic costs of road crashes, and therefore the benefits of safety improvements, are usually high.

5 Conclusions and Recommendations

5.1 Outcomes

VALOR provides several important outcomes:

- It is the first research initiative in which four European countries, namely Belgium, France, Germany and the Netherlands have united their efforts to investigate the issue applying a common methodology.
- VALOR has deployed different models and correspondingly produced several sets of values, the convergence of which shows the robustness of its results.
- VALOR suggests common VSL, VSSI and VoT values for the four participating countries as well as estimates for each country:

	VSL (in Mill EUR)	VSSI (in Mill EUR)	VoT (in EUR/h)
Four countries	6.19	0.95	16.1
Belgium	5.94	0.94	17.2
France	5.35	0.83	12.9
Germany	7.35	1.10	19.0
The Netherlands	6.29	0.98	16.4

- VALOR investigated interaction effects between individual characteristics and the marginal disutility of experiment attributes (costs, risk, and time). Significant interaction effects have been revealed between income and costs, as well between income and time; age has interaction effects with all three attributes; being a parent shows interaction with cost and time; some national peculiarities were observed; finally, there is an interaction effect between having experience of material accident damage and risk. More details on interaction effects are given in Section 4.b.i. above.
- Individual socio-demographic characteristics affect VSL and VSSI. In Belgium, Germany and the Netherlands, males reveal higher VSL and VSSI than females, in all four countries young drivers demonstrate VSL and VSSI lower and elderly higher than the mean value. In France, parents show 10% higher values than childless persons. Finally, in Germany, income plays a significant role: the highest income category has an increasing effect of 30% on VSL/VSSI and the lowest income category having a negative effect of 13%.
- Risk assessment significantly influences VSL and VSSI: in all four countries, high risk assessment respondents show higher values than persons who tend to low risk assessment.
- VALOR investigated the impact of the Covid pandemic on road safety perception and the individual importance of road safety for respondents. It appears that the pandemic has had no significant impact on these issues since the fraction of respondents showing a sizeable effect is very small.
- Nevertheless, it is worth noting that respondents declaring road safety to have become less important due to the Covid pandemic reveal decreasing VSL and VSSI (reductions by 20% and 23% respectively) while those declaring it to have become a more important issue than before the pandemic reveal a VSL increase by 7%.
- Latent variables "thriftiness", "time pressure" and "risky behaviour" were embedded in the model in order to investigate the influence of individual attitudes to money, time and risk on VSL and VSSI. Attitude to risk is an important factor. VSL and VSSI values revealed in risk-avoiding drivers are almost two times higher than those of risk takers.

5.2 Recommendations

Scientists have produced many VSL estimates which have until now approached the issue from an academic standpoint. When awarding public funding for research, governments and publicity obviously expect outputs in the form of strategic and operational recommendations. Such estimates and recommendations are to be considered as inputs for developing or revising relevant official values, a task which remains indeed the prerogative of decision-makers.

The VALOR research group recommends:

1. To apply the overall "four countries" VSL and VSSI for international purposes. Adopting a common value makes sense considering those countries' similar living standards, the extent of cross-border transport activities and human interactions, as well as the deep and growing cooperation within the European Union and at bilateral levels. The overall values are particularly appropriate for cross-border investments, regional projects, and European corridors.
2. To retain the scope to choose between common and national values for country-specific purposes, since most investments in infrastructure, education and awareness-building, law enforcement etc. are the prerogative of Member States. The national values should be applied for national projects and for the assessment of the socio-economic cost of road crashes.
3. The common VSL could be established at 6 Mill EUR, while the VSSI could be set at 1 Mill EUR.
4. To consider the 1 to 6 cost ratio of fatalities to serious injuries as an important indicator in order to give due attention to the prevention of harmful non-fatal road accidents.
5. To adopt VALOR VSL and VSSI estimates for updating calculations of the socio-economic costs of road crashes in the four participating countries. They can be included in national guidelines for conducting CBA of transport projects.
6. The results of this research may be useful for other countries which do not have their own country-specific estimates of the VSL and VSSI based on a WTP-method. These results can serve as a good source for value transfer (Freeman et al. 2014) applying GDP and price level adjustments.
7. To apply consistently the MAIS 3+ definition of serious injuries in estimating the VSSI.
8. To use VALOR methodology and results for WTP projects involving a wider range of European countries.
9. Finally, the results of this study can be incorporated in European studies on the external costs of transport, aiming to update currently used values of road crash costs. The latest study (van Essen, 2019) uses a VSL found in a meta-analysis of OECD countries (including non-European countries) and a VSSI which is based on a study from the late 1990s (EMCT, 1998).

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Appendix

a. Quota used to select the sample

Table 55: Quotas regarding age, gender, language and region used in the sample selection of the pilot and final survey for Belgium

BELGIUM: QUOTA AGE 18+		
Description	**% of the Quota**	**Source**
18-24	10,12%	Statbel 2019
25-34	16,18%	Statbel 2019
35-44	16,22%	Statbel 2019
45-54	17,31%	Statbel 2019
55-64	16,45%	Statbel 2019
65 or +	23,73%	Statbel 2019

BELGIUM: QUOTA GENDER		
Description	**% of the Quota**	**Source**
Males	49,23%	Statbel 2019
Females	50,77%	Statbel 2019
Other	0,00%	Statbel 2019

BELGIUM: QUOTA LANGUAGE		
Description	**% of the Quota**	**Source**
NL	55,58%	CIM 2020
FR	44,42%	CIM 2020

BELGIUM: SOFT QUOTA PROVINCE		
Description	**% of the Quota**	**Source**
Antwerpen	16,25%	Statbel 2019
Brussels Hoofdstedelijk gewest	10,57%	Statbel 2019
Henegouwen	11,76%	Statbel 2019
Limburg	7,65%	Statbel 2019
Luik	9,68%	Statbel 2019
Luxemburg	2,49%	Statbel 2019
Namen	4,32%	Statbel 2019
Oost-Vlaanderen	13,25%	Statbel 2019
Vlaams-Brabant	10,03%	Statbel 2019
Waals-Brabant	3,53%	Statbel 2019
West-Vlaanderen	10,46%	Statbel 2019

Table 56: Quotas regarding age, gender and region used in the sample selection of the pilot and final survey for Germany

GERMANY: QUOTA AGE 18+		
Description	**% of the Quota**	**Source**
18-24	9,12%	UN Data 2018
25-34	15,29%	UN Data 2018
35-44	14,37%	UN Data 2018
45-54	18,65%	UN Data 2018
55-64	17,01%	UN Data 2018

65 or +	25,56%	UN Data 2018

GERMANY: QUOTA GENDER		
Description	**% of the Quota**	**Source**
Males	48,92%	UN Data 2018
Females	51,08%	UN Data 2018
Other	0,00%	UN Data 2018

GERMANY: SOFT QUOTA FEDERAL STATE		
Description	**% of the Quota**	**Source**
Schleswig-Holstein	3,46%	Genesis Census 2011
Hamburg	2,14%	Genesis Census 2011
Niedersachsen	9,57%	Genesis Census 2011
Bremen	0,82%	Genesis Census 2011
Nordrhein-Westfalen	21,70%	Genesis Census 2011
Hessen	7,40%	Genesis Census 2011
Rheinland-Pfalz	4,96%	Genesis Census 2011
Baden-W^{n}rttemberg	12,87%	Genesis Census 2011
Bayern	15,33%	Genesis Census 2011
Saarland	1,27%	Genesis Census 2011
Berlin	4,17%	Genesis Census 2011
Brandenburg	3,16%	Genesis Census 2011
Mecklenburg-Vorpommern	2,08%	Genesis Census 2011
Sachsen	5,24%	Genesis Census 2011
Sachsen-Anhalt	2,98%	Genesis Census 2011
Thüringen	2,83%	Genesis Census 2011

Table 57: Quotas regarding age, gender, language and region used in the sample selection of the pilot and final survey for France

FRANCE: QUOTA AGE 18+		
Description	**% of the Quota**	**Source**
18-24	10,23%	UN Data 2018
25-34	14,94%	UN Data 2018
35-44	15,84%	UN Data 2018
45-54	17,16%	UN Data 2018
55-64	16,05%	UN Data 2018
65 or +	25,78%	UN Data 2018

FRANCE: QUOTA GENDER		
Description	**% of the Quota**	**Source**
Males	47,64%	UN Data 2018
Females	52,36%	UN Data 2018
Other	0,00%	UN Data 2018

FRANCE: SOFT QUOTA REGION		
Description	**% of the Quota**	**Source**
Auvergne-Rhône-Alpes	11,93%	INSEE 2019
Bourgogne-Franche-Comté	4,25%	INSEE 2019
Bretagne	5,03%	INSEE 2019
Centre-Val-de-Loire	3,86%	INSEE 2019
Corse	0,54%	INSEE 2019
Grand Est	8,37%	INSEE 2019
Hauts-de-France	8,73%	INSEE 2019
Île-de-France	17,91%	INSEE 2019
Normandie	4,97%	INSEE 2019
Nouvelle-Aquitaine	9,22%	INSEE 2019
Occitanie	9,00%	INSEE 2019
Pays de la Loire	5,61%	INSEE 2019
Provence-Alpes-Côte d'Azur	7,71%	INSEE 2019
Départements outre-mer	2,87%	INSEE 2019
Île de Clipperton	0%	

Table 58: Quotas regarding age, gender, language and region used in the sample selection of the pilot and final survey for the Netherlands

NETHERLANDS: QUOTA AGE 18+		
Description	**% of the Quota**	**Source**
18-24	10,83%	UN Data 2018
25-34	15,65%	UN Data 2018
35-44	14,96%	UN Data 2018
45-54	18,48%	
55-64	16,61%	UN Data 2018
65 or +	23,48%	UN Data 2018

NETHERLANDS: QUOTA GENDER		
Description	**% of the Quota**	**Source**
Males	49,25%	UN Data 2018
Females	50,75%	UN Data 2019
Other	0,00%	UN Data 2020

NETHERLANDS: SOFT QUOTA PROVINCE		
Description	**% of the Quota**	**Source**
Groningen (PV)	3,37%	StatLine 2019
Fryslân (PV)	3,73%	StatLine 2019
Drenthe (PV)	2,84%	StatLine 2019
Overijssel (PV)	6,68%	StatLine 2019
Flevoland (PV)	2,43%	StatLine 2019
Gelderland (PV)	11,98%	StatLine 2019
Utrecht (PV)	7,78%	StatLine 2019
Noord-Holland (PV)	16,54%	StatLine 2019
Zuid-Holland (PV)	21,31%	StatLine 2019
Zeeland (PV)	2,20%	StatLine 2019
Noord-Brabant (PV)	14,72%	StatLine 2019
Limburg (PV)	6,42%	StatLine 2019

b. Questionnaire pilot survey

Each question (indicated by Q#.) on a separate page

Q1. In this questionnaire we will ask you questions regarding your current travel behaviour and general attitudes. We will also ask you to make choices between different routes. This questionnaire is part of a study conducted by [], the purpose of the study is to investigate behaviour when choosing a route. There are no right or wrong answers. Your responses will be treated anonymously and the results will be used for research purposes only. The survey will take approximately 20 minutes.

Q2. Do you have a car driving license or permit?

- Yes
- A provisional license ➔ end of survey
- No ➔ end of survey

Q3. During the past 12 months, how often did you use each of the following transport modes in Belgium? How often did you …?

	Never	A few times a year	A few times a month	1 to 2 days a week	At least 3 days a week
cycle (non-electric) cycle or an electric bicycle/e-bike/pedelec/e-scooter					
drive a moped (≤ 50 cc or ≤ 4 kW)					
drive a motorcycle (> 50 cc and > 4 kW)					
drive a car					
drive a light/heavy vehicles truck					
use public transport (train, bus, tram, metro)					

Q4. How many kilometres did you drive a person car yourself last year? Try to make an estimation.

- Less than 10,000 km
- Between 10,000 and 20,000 km
- Between 20,001 and 30,000 km
- More than 30,000 km
- I really don't know

Q5. During the past 12 months, how often did you drive a car on a motorway (not as a passenger)?

- Never ➔ end of survey
- A few times a year
- A few times a month
- 1 to 2 days a week
- At least 3 days a week

Q6. What is the most frequent purpose of your trip if you drive on a motorway? [maximum 2 choices]

- ☐ To go to work
- ☐ Leisure activities
- ☐ To go to school
- ☐ A professional trip (in a work related context, but not going to work)
- ☐ Dropping someone off/picking someone up
- ☐ Running errands / services (grocery shopping, going to the doctor, to the bank,…)
- ☐ Visiting someone
- ☐ Vacation
- Other ____ (fill in)

Q7. Who normally pays the costs of your car trips for private purposes? (operating costs, fuel, tolls, insurance,…)

- Me
- My employer
- My partner or relatives
- Other ____ (fill in)

Q8. In the following part of the questionnaire you will be asked to make 7 choices about imaginary situations. Please first read the description very carefully and then try to answer as you would do in real life.

Q9, Q10 & Q11 are shown on the same page, but the respondent has to click "next" before he can see Q10 and again for Q11.

The trip purpose in Q9 changes according to responses in Q6. Only an option that is indicated as a frequent purpose by the respondent can be shown in Q9. When a respondent has indicated 2 options, one of them is chosen at randomly. When a respondent has chosen "A professional trip (in a work related context, but not going to work)", then the other option is shown, if no other option is shown, the option "leisure activities" is shown. If "other" is chosen in Q6, then "leisure activities" is shown.

Q9. Imagine that you have to make a trip of 50 km by **car** for a [**leisure activity**]. You make this trip **alone**, there are no passengers in the car. You can choose between two routes, both routes go over a **motorway** where there is **usually a lot of traffic**, but rarely traffic jams. On both routes there are **20 million cars per year**, this equals 55,000 cars per day.

Q10. All characteristics of these routes are similar, for example the driving comfort and the scenery. These routes only differ according to:

- The **costs** to make the trip (operating costs, fuel, toll, …).
  You have to pay yourself for these costs.
- The **time** to make the trip 
- The **risk** you personally face to be hit by another driver:
  - The number of **fatal** car drivers per year. 
  - The number of **seriously injured** car drivers year.

! A serious injury can lead to vital (life threatening) consequences and you need treatment in an hospital. The injuries might cause short or long term consequences on your daily functioning (skull fracture, open fractures, liver fracture, perforated lung or other massive internal injuries…).

In Q11 to Q17, the respondent has to be able to see the definition of serious injuries (above) by hovering over the text.

Q11. Which route do you choose?

Q12. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

Which route do you choose?

Route A	Route B
8 €	**10 €**
40 minutes 	**50 minutes** 
21 fatal car drivers / year* 	**1** fatal car driver / year* 
23 seriously injured car drivers / year* 	**3** seriously injured car drivers / year* 

*20 million cars per year

Q13. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

Which route do you choose?

Route A	Route B
8 €	**10 €**
50 minutes 	**30 minutes** 
21 fatal car drivers / year* 	**11** fatal car driver / year* 
43 seriously injured car drivers / year* 	**23** seriously injured car drivers / year* 

*20 million cars per year

Q14. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

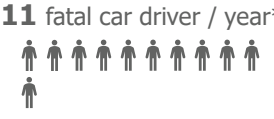
Which route do you choose?

Route A	**Route B**
8 €	**6 €**
30 minutes 	**50 minutes** 
21 fatal car drivers / year* 	**11** fatal car driver / year* 
23 seriously injured car drivers / year* 	**3** seriously injured car drivers / year*

*20 million cars per year

Q15. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

Which route do you choose?

Route A	**Route B**
10 €	**6 €**
30 minutes 	**40 minutes** 
1 fatal car drivers / year* 	**11** fatal car driver / year* 
43 seriously injured car drivers / year* 	**3** seriously injured car drivers / year*

*20 million cars per year

Q16. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

Which route do you choose?

Route A	**Route B**
8 €	**8 €**
40 minutes	**50 minutes**
21 fatal car drivers / year*	**21** fatal car driver / year*
23 seriously injured car drivers / year*	**43** seriously injured car drivers / year*

*20 million cars per year

Q17. Imagine again that you have to make a trip under the **same circumstances** (50 km, by car, for a leisure activity, alone, over a motorway). All other characteristics of the routes are similar, both routes have 20 million cars per year. Only the time, cost and risk is different.

Which route do you choose?

Route A	**Route B**
10 €	**6 €**
40 minutes	**30 minutes**
1 fatal car drivers / year*	**11** fatal car driver / year*
3 seriously injured car drivers / year*	**43** seriously injured car drivers / year*

*20 million cars per year

Q18. How sure were you of having chosen the best routes for you personally?

- Very unsure
- rather unsure
- rather sure
- very sure
- I cannot judge that

Q19. How important were the characteristics of the routes to you for your selection?

	Unimportant	Rather unimportant	Rather important	Important
Number of fatalities per year				
Number of serious injuries per year				
Travel cost				
Travel time				

If number of fatalities = "rather unimportant" or "unimportant"

Q20. Why was the number of fatalities less important for you when making your choice?

- ☐ The number of fatalities is in general not relevant for me when deciding which route to take
- ☐ The differences in the number of fatalities between the two routes were too small
- ☐ The differences in other characteristics between the two routes were too big:
  - ☐ Time
  - ☐ Cost
  - ☐ Number of serious injuries
- ☐ The choice was too complex so I focused only on other characteristics:
  - ☐ Time
  - ☐ Cost
  - ☐ Number of serious injuries
- ☐ Other: ____

If number of serious injuries = "rather unimportant" or "unimportant"

Q21. Why was the number of serious injuries less important for you when making your choice?

- ☐ The number of serious injuries is in general not relevant for me when deciding which route to take
- ☐ The differences in the number of serious injuries between the two routes were too small
- ☐ The differences in other characteristics between the two routes were too big:
  - ☐ Time
  - ☐ Cost
  - ☐ Number of fatalities
- ☐ The choice was too complex so I focused only on other characteristics:
  - ☐ Time
  - ☐ Cost
  - ☐ Number of fatalities
- ☐ Other: ____

If travel time = "rather unimportant" or "unimportant"

Q22. Why was the travel time less important for you when making your choice?

- ☐ The travel time is in general not relevant for me when deciding which route to take
- ☐ The differences in the travel time between the two routes were too small
- ☐ The differences in other characteristics between the two routes were too big:
  - ☐ Cost
  - ☐ Number of fatalities
  - ☐ Number of serious injuries

- ☐ The choice was too complex so I focused only on other characteristics:
  - ☐ Cost
  - ☐ Number of fatalities
  - ☐ Number of serious injuries
- ☐ Other: ____

If travel cost = "rather unimportant" or "unimportant"

Q23. Why was the travel cost less important for you when making your choice?

- ☐ The travel cost is in general not relevant for me when deciding which route to take
- ☐ The differences in the travel cost between the two routes were too small
- ☐ The differences in other characteristics between the two routes were too big:
  - ☐ Time
  - ☐ Number of fatalities
  - ☐ Number of serious injuries
- ☐ The choice was too complex so I focused only on other characteristics:
  - ☐ Time
  - ☐ Number of fatalities
  - ☐ Number of serious injuries
- ☐ Other: ____

Q24. Are there parts of the choice situations that you think were not realistic?

- Yes
- No

  Please explain: _____

Q25. What is the maximum amount you would be willing to pay extra to take a route that has 1 fatality instead of 21 fatalities per year? (there are 20 million cars per year)

[Dropdown list]

- 0€
- 1€
- 2€
- 3€
- 4€
- 5€
- 6€
- 7€
- 8€
- More than 8€

Q26. What is the maximum amount you would be willing to pay extra to take a route that takes 30 minutes instead of 50 minutes?

[Dropdown list]

- 0€
- 1€
- 2€
- 3€
- 4€
- 5€
- 6€
- 7€
- 8€
- More than 8€

Q27. The following questions are about your personal experience with road accidents.

Q28. Have you ever been involved in a road accident in which …

	Yes	No
There was only material damage		
You were slightly injured		
Someone else was slightly injured		
You were severely injured		
Someone else was severely injured		
Someone else died		

Q29. Has anyone close to you (a relative or friend) ever been involved in a road accident and …

	Yes	No
Got slightly injured		
Got severely injured		
Died		

Q30. In the next part of the questionnaire we will ask you some questions about your general attitudes. There are no right or wrong answers. Please indicate in the table to what extent you agree or disagree with the statements.

Q31. For each of the following statements, please indicate the extent to which you agree with the statement.

	Stronly eisagree	Disagree	Rather disagree	Neither agree or	Rather agree	Agree	Strongly agree
When I do my shopping, I am on the lookout for potential promotions.							
To me it is important to save as much as possible.							
When the service is good, I usually give tips in restaurants or cafes.							
I hesitate to spend money, even on necessities.							
If I had at some point additional income, I would rather spend it than save.							
I often buy things I did not plan to buy.							

Q32. For each of the following statements, please indicate the extent to which you agree with the statement.

	Stronly eisagree	Disagree	Rather disagree	Neither agree or disagree	Rather agree	Agree	Strongly agree
I am often in a hurry.							
During the course of the day, I can easily do all the activities I have planned.							
I get easily annoyed when I have to wait because my appointment is late.							
I always seem to be doing things at the last moment.							
I often try to do more than one thing at a time.							
I am constantly looking at my watch.							

Q33. For each of the following statements, please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation

	Extremely unlikely	Moderately unlikely	Somewhat unlikely	Not sure	Somewhat likely	Moderately likely	Extremely likely
Try out a new extreme sport.							
Driving as a passenger with someone who may have had too much to drink.							
Visiting someone who has the flu.							
Driving on a moped as a passenger without a helmet.							
Sunbathing without sunscreen.							
Walking home alone at night in an unsafe area of town.							

Q34. The survey is almost finished. The following questions have nothing to do with your travel behaviour or general attitudes, but they are important background information. There are no good or bad answers.

Q35. Are you
- Male
- Female
- Other

Q36. In which year were you born?
Dropdown menu (1900 – 2002)

Q37. What is the highest qualification or educational certificate that you have obtained?
- None
- Primary education
- Secondary education
- Bachelor's degree or similar
- Master's degree or higher

Q38. Which of the following terms best describes your current professional occupation?

- white collar or office worker (excluding executive)/ employee (public or private sector) ➔ **Erreur ! Source du renvoi introuvable.**a
- blue collar or manual worker/worker ➔ **Erreur ! Source du renvoi introuvable.**a
- executive ➔ **Erreur ! Source du renvoi introuvable.**a
- self-employed/independent professional ➔ **Erreur ! Source du renvoi introuvable.**a
- currently no professional occupation ➔ **Erreur ! Source du renvoi introuvable.**b

Erreur ! Source du renvoi introuvable.a. Is your professional occupation to transport freight or persons? (taxi, bus, truck driver, courier, mailman, food delivery,…)

- yes
- no

Erreur ! Source du renvoi introuvable.b. You stated that you currently have no professional occupation. Which of the following terms best describes your current situation? I am …

- a student
- unemployed, looking for a job
- retired
- not fit to work
- a stay-at-home spouse or parent
- other

Q39. Do you have children?

- Yes
- No

Q40. How many people live in your household (**including yourself**)? A household means all persons, family members or not, who live on the same address and share household expenses ?

- Persons of 14 year and older : ___
- Persons younger than 14: ___
- Total: [calculated field]

Q41. What is your household's net monthly income?

To determine this income you add up the net salaries of all your household's members (i.e. what each person receives each month), plus other income such as family allowance, social benefits, pensions, allowances, income from real estate or movable property or a trade, unemployment benefits, etc. When you add them all up, to which category does your entire household's net income for last month belong?

Remember that this question relates to **all the members** of your household.

- Less than EUR 1,000
- EUR 1,000 – 2,000
- EUR 2,000 – 3,000
- EUR 3,000 – 4,000
- EUR 4,000 – 5,000
- More than EUR 5,000
- I don't know
- I prefer not to answer

Q42. What is the postal code of the municipality in which you live? ____

Q43. Would you like to comment on this survey or add something for a better understanding of your answers? Did you notice anything negative during your participation in this survey? Were the questions not clear at one point or were you uncomfortable with the answers? _____

c. Experimental design pilot survey

		Cost	Time	Fatalities	Serious injuries
Q11	A	6	50	21	43
	B	10	50	11	3
Q12	A	10	30	21	43
	B	6	50	21	3
Q13	A	6	30	11	43
	B	10	50	1	3
Q14	A	8	30	21	3
	B	6	40	1	23
Q15	A	10	30	1	43
	B	6	50	21	23
Q16	A	10	50	1	43
	B	8	40	21	3
Q17	A	8	40	11	23
	B	10	40	21	43

d. Questionnaire final survey

Q0. Country (not shown)
- Belgium
- France
- Germany
- Netherlands

Q1. Kies uw taal/ Choisissez votre language. (only in Belgium)
- Nederlands
- Frans

Q2. What is the postal code of the municipality in which you live? ____

Q3. Are you
- Male
- Female
- Other

Q4. In which year were you born? _____

Q5. Do you have a car driving license or permit?
- Yes
- A provisional license ➔ end of survey
- No ➔ end of survey

Q6. During the past 12 months, how often did you drive a car on a motorway (not as a passenger)?
- Never ➔ end of survey
- A few times a year
- A few times a month
- 1 to 2 days a week
- At least 3 days a week

INTRO

In this questionnaire we will ask you questions regarding your current travel behaviour and general attitudes. We will also ask you to make choices between different routes. This questionnaire is part of a study conducted by [institute], the purpose of the study is to investigate behaviour when choosing a route. There are no right or wrong answers. Your responses will be treated anonymously and the results will be used for research purposes only. The survey will take approximately 15 minutes.

Q7. During the past 12 months, how often did you use each of the following transport modes in Belgium? How often did you …?

	Never	A few times a year	A few times a month	1 to 2 days a week	At least 3 days a week
cycle (non-electric) cycle or an electric bicycle/e-bike/pedelec/e-scooter					
drive a moped (≤ 50 cc or ≤ 4 kW)					
drive a motorcycle (> 50 cc and > 4 kW)					
drive a car					
drive a light/heavy vehicles truck					
use public transport (train, bus, tram, metro)					

Q8. How many kilometres did you drive a person car yourself last year? Try to make an estimation.

- Less than 10,000 km
- Between 10,000 and 20,000 km
- Between 20,001 and 30,000 km
- More than 30,000 km
- I really don't know

Q9. What is the most frequent purpose of your trip if you drive on a motorway? Please indicate minimum 1 and maximum 2 reasons. [maximum 2 choices]

- ☐ To go to work
- ☐ Leisure activities
- ☐ To go to school
- ☐ A professional trip (in a work related context, but not with the purpose of going to work)
- ☐ Dropping someone off/picking someone up
- ☐ Running errands / services (grocery shopping, going to the doctor, to the bank,…)
- ☐ Visiting someone
- ☐ Vacation
- ☐ Other ____ (fill in)

Q10. Who normally pays the costs of your car trips for private purposes? (operating costs, fuel, tolls, insurance,…)

- Me
- My employer
- My partner or relatives
- Other ____ (fill in)

INTRO

In the following part of the questionnaire you will be asked to make 8 choices about imaginary situations. Please first read the description very carefully and then try to answer as you would do in real life.

The trip purpose in Q9 changes according to responses in Q6. Only an option that is indicated as a frequent purpose by the respondent can be shown in Q9. When a respondent has indicated 2 options, one of them is chosen at randomly. When a respondent has chosen "A professional trip (in a work related context, but not going to work)", then the other option is shown, if no other option is shown, the option "leisure activities" is shown. If "other" is chosen in Q6, then "leisure activities" is shown.

Imagine that you have to make a trip of 50 km by **car** for a [**leisure activity**]. You make this trip **alone**, there are no passengers in the car. You can choose between two routes, both routes go over a **motorway** where there is **usually a lot of traffic**, but rarely traffic jams. On both routes there are **20 million cars per year**, this equals 55,000 cars per day.

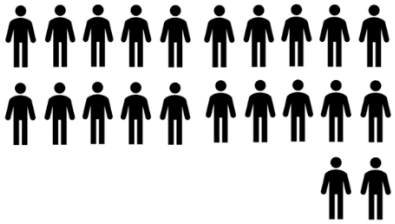
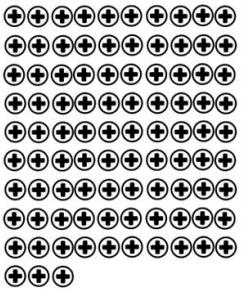
All characteristics of these routes are similar, for example the driving comfort and the scenery. These routes only differ according to:

- The **costs** to make the trip (operating costs, fuel, toll, …).
  You have to pay yourself for these costs.
- The **time** to make the trip 
- The **risk** you personally face to be hit by another driver:
  - The number of **fatal** car drivers per year. 
  - The number of **seriously injured** car drivers year.

! Someone who is seriously injured must be hospitalised for treatment. The injuries have short and/or long term consequences for daily functioning and are sometimes even life-threatening. For example concussion with loss of consciousness, (partial) amputations, skull fracture, open fractures, spinal cord contusion or severe organ injuries.

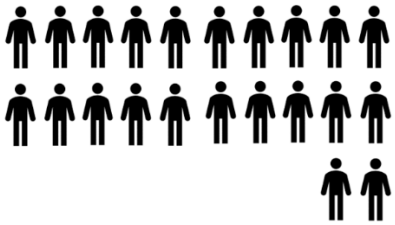
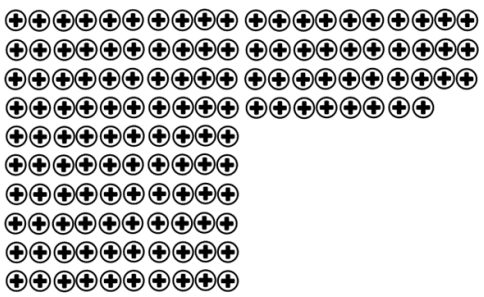
BLOCK 1: **Erreur ! Source du renvoi introuvable.-Erreur ! Source du renvoi introuvable.** (randomize)

Q11. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.
Which route do you choose?

○	○
Route A	**Route B**
10 €	**5.5 €**
52 minutes 	**28 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
3 seriously injured car driver / year * 	**93** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

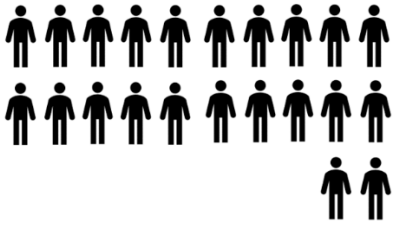
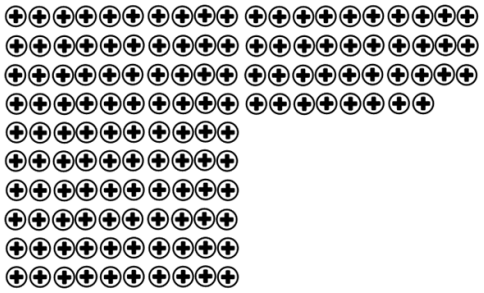
Q12. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
7 €	**10 €**
28 minutes 	**52 minutes** 
22 fatally injured car drivers / year * 	**1** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year *
*20 million cars per year	*20 million cars per year

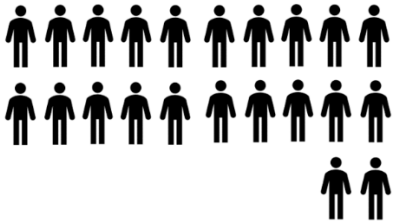
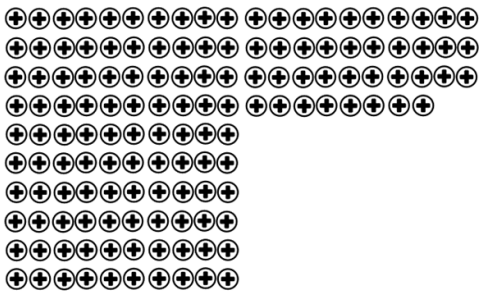
Q13. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes 	**28 minutes** 
22 fatally injured car drivers / year * 	**1** fatally injured car drivers / year * 
3 seriously injured car driver / year * 	**138** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

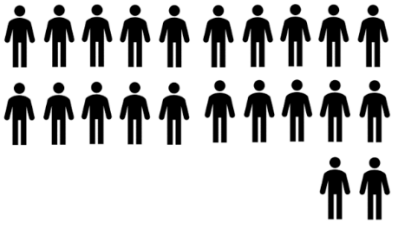
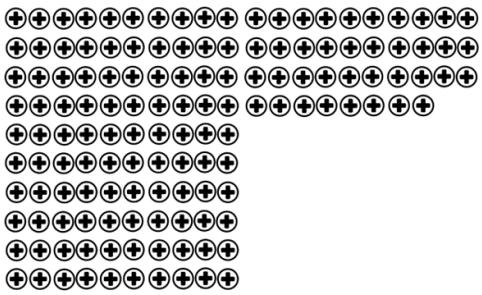
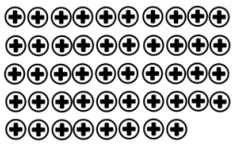
Q14. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
8.5 €	**7 €**
28 minutes 	**44 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

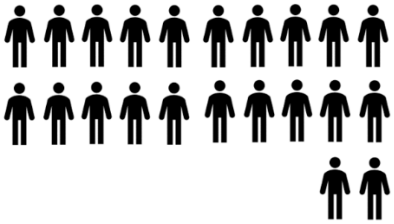
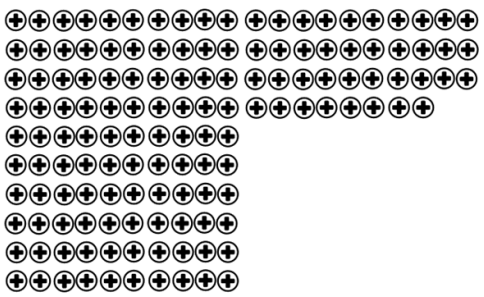
Q15. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes 	**28 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**48** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

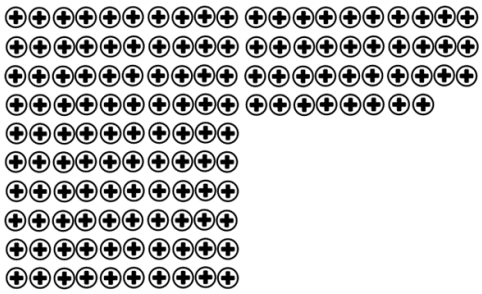
Q16. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
10 €	**5.5 €**
52 minutes 	**44 minutes** 
15 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
3 seriously injured car driver / year * 	**138** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

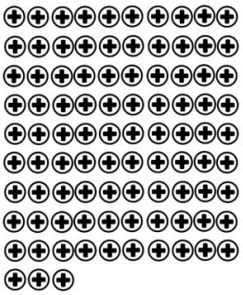
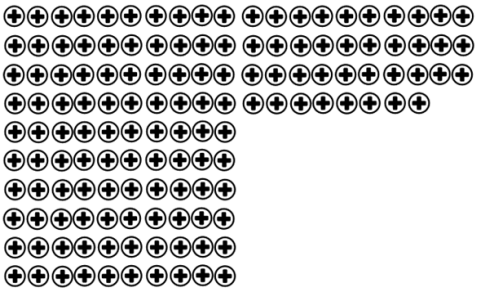
Q17. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
10 €	**5.5 €**
28 minutes 	**52 minutes** 
8 fatally injured car drivers / year * 	**15** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year *
*20 million cars per year	*20 million cars per year

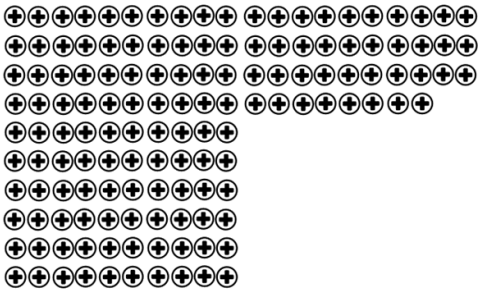
BLOCK 2: **Erreur ! Source du renvoi introuvable.-Erreur ! Source du renvoi introuvable.** (randomize)

Q18. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.
Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes 	**36 minutes** 
22 fatally injured car drivers / year * 	**1** fatally injured car drivers / year * 
93 seriously injured car driver / year * 	**138** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

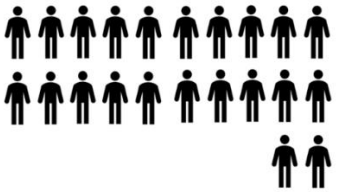
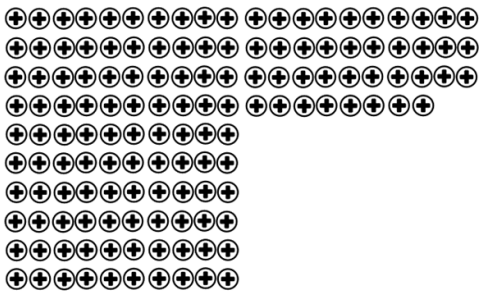
Q19. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
10 €	**7 €**
28 minutes 	**52 minutes** 
15 fatally injured car drivers / year * 	**1** fatally injured car drivers / year * 
3 seriously injured car driver / year * 	**138** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

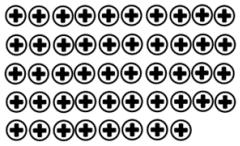
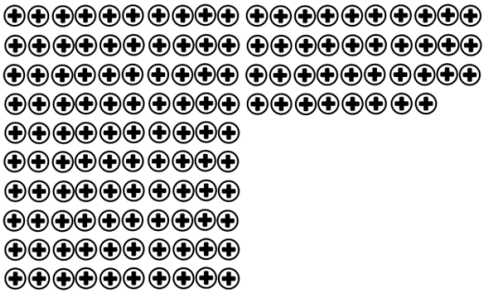
Q20. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes 	**28 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

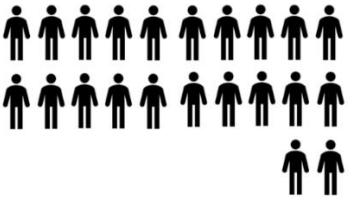
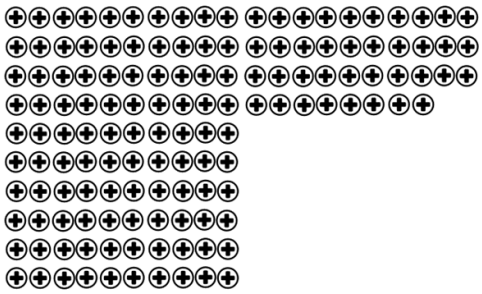
Q21. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
10 €	**5.5 €**
52 minutes 	**28 minutes** 
1 fatally injured car drivers / year * 	**15** fatally injured car drivers / year * 
48 seriously injured car driver / year * 	**138** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

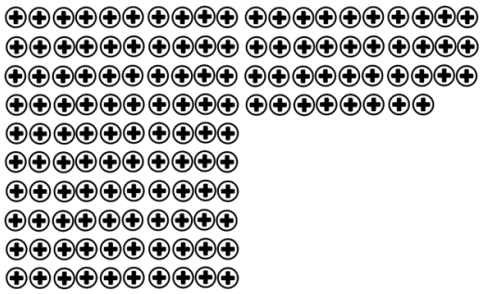
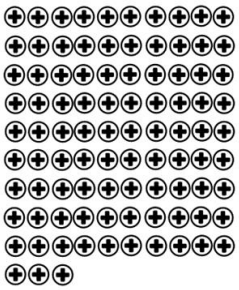
Q22. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
10 €	**5.5 €**
44 minutes 	**52 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

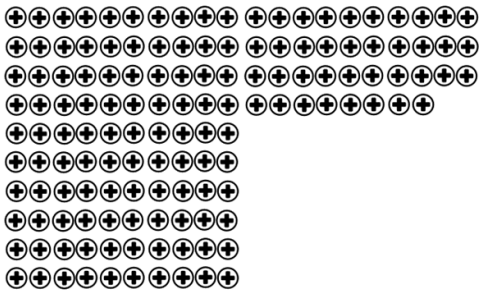
Q23. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
52 minutes 	**28 minutes** 
1 fatally injured car drivers / year * 	**22** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**93** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

Q24. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

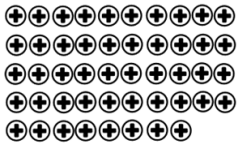
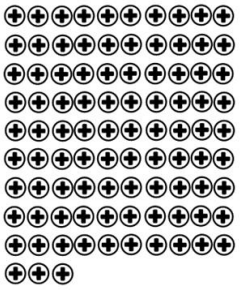
Which route do you choose?

○	○
Route A	**Route B**
5.5 €	**10 €**
44 minutes 	**52 minutes** 
22 fatally injured car drivers / year * 	**8** fatally injured car drivers / year * 
138 seriously injured car driver / year * 	**3** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

FIXED **Erreur ! Source du renvoi introuvable.**: always last (dominant scenario)

Q25. Imagine that you have to make a trip under the **circumstances described** (50 km, by car, for a leisure activity, alone, over a motorway). You have to choose between two routes that differ according to the costs, the travel time and the risk. All other characteristics of the routes are similar, both routes have 20 million cars per year.

Which route do you choose?

○	○
Route A	**Route B**
7 €	**7 €**
36 minutes	**44 minutes**
1 fatally injured car drivers / year * 	**1** fatally injured car drivers / year * 
48 seriously injured car driver / year * 	**93** seriously injured car driver / year * 
*20 million cars per year	*20 million cars per year

Q26. How sure were you of having chosen the best routes for you personally?

- Very unsure
- rather unsure
- rather sure
- very sure

Q27. How important were the characteristics of the routes to you for your selection?

	Unimportant	Rather unimportant	Rather important	Important
Number of fatalities per year				
Number of serious injuries per year				
Travel cost				

Travel time				

Respondents that answered lexicographically towards risk (fatalities or serious injuries)

Q28. From your choices it appears that you have always chosen the route with the smallest number of fatalities or serious injuries. What was the reason?

- The choice was too complex so I focused only on fatalities and/or serious injuries.
- I did consider costs and travel time when taking my decision, but the differences in the number of fatalities and/or serious injuries were too big to choose a cheaper or faster route.
- I did consider costs and travel time when taking my decision, but the differences in the costs or the travel time were too small to choose a less safe route.
- I would always take the safest route, even if the cost or travel time would be (very) high.
- I don't know
- Other: ___

Respondents that answered lexicographically towards costs

Q29. From your choices it appears that you have always chosen the route with the lowest cost. What was the reason?

- The choice was too complex so I focused only on costs.
- I did consider risk and travel time when taking my decision, but the differences in the costs were too big to choose a safer or faster route.
- I did consider risk and travel time when taking my decision, but the differences in the risk or the travel time were too small to choose a more expensive route.
- I would always take the cheapest route, even if the risk or travel time would be (very) high.
- I don't know
- Other: ___

Respondents that answered lexicographically towards travel time

Q30. From your choices it appears that you have always chosen the route with the lowest travel time. What was the reason?

- The choice was too complex so I focused only on travel time.
- I did consider risk and costs when taking my decision, but the differences in the travel time were too big to choose a safer or cheaper route.
- I did consider risk and costs when taking my decision, but the differences in the risk or the costs were too small to choose a route with longer travel time.
- I would always take the fastest route, even if the risk or costs would be (very) high.
- I don't know
- Other: ___

Q31. Are there parts of the choice situations that you think were not realistic?

- Yes
- No

  Please explain: _____

Q32. What is the maximum amount you would be willing to pay extra each time to take a route that has 1 fatality instead of 8 fatalities per year? (there are 20 million cars per year)

[Dropdown list]

- 0€
- Less than 0€
- 1€
- 2€
- 3€
- 4€
- 5€
- 6€

- 7€
- 8€
- 9€
- 10€
- More than 10€

Q33. What is the maximum amount you would be willing to pay extra each time to take a route that takes 28 minutes instead of 36 minutes?

[Dropdown list]

- 0€
- Less than 0€
- 1€
- 2€
- 3€
- 4€
- 5€
- 6€
- 7€
- 8€
- 9€
- 10€
- More than 10€

INTRO

The following questions are about your safety feeling in traffic and your personal experience with road accidents.

Q34. How safe or unsafe do you feel when travelling by car on a motorway in [country]? You can indicate your answer on a scale from 0 to 10, where 0 is "very unsafe" and 10 is "very safe". The numbers in between can be used to refine your response.

- 0 : very unsafe
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 : very safe

Q35. Do you have the feeling that road safety in [country] has decreased, increased or has remained the same in comparison with the period before the outbreak of COVID-19?

- Decreased
- Increased
- Remained the same
- I don't know

Q36. Has road safety become more, less or equally important to you personally since the outbreak of COVID-19?

- More important

- Less important
- Equally important
- I don't know

Q37. Have you ever been involved in a road accident in which …

	Yes	No
There was only material damage		
You were slightly injured		
Someone else was slightly injured		
You were severely injured		
Someone else was severely injured		
Someone else died		

Q38. Has anyone close to you (a relative or friend) ever been involved in a road accident and …

	Yes	No
Got slightly injured		
Got severely injured		
Died		

INTRO

In the next part of the questionnaire we will ask you some questions about your general attitudes. There are no right or wrong answers. Please indicate in the table to what extent you agree or disagree with the statements.

Q39. For each of the following statements, please indicate the extent to which you agree or disagree with the statement.

	Stronly eisagree	Disagree	Rather disagree	Neither agree or	Rather agree	Agree	Strongly agree
When I do my shopping, I am on the lookout for potential promotions.							
To me it is important to save as much as possible.							
I hesitate to spend money, even on necessities.							
I am careful with my money.							
I find it difficult to limit my spending.							
I can easily postpone a purchase so that I can save.							

Q40. For each of the following statements, please indicate the extent to which you agree or disagree with the statement.

	Stronly eisagree	Disagree	Rather disagree	Neither agree or disagree	Rather agree	Agree	Strongly agree
I am often in a hurry.							
I always seem to be doing things at the last moment.							

I often try to do more than one thing at a time.							
I regularly check what time it is.							
The days are too short to carry out all daily tasks.							
I often feel time pressure in my daily life.							

Q41. For each of the following statements, please indicate the likelihood that you would engage in the described activity or behaviour if you were to find yourself in that situation

	Extremely unlikely	Moderately unlikely	Somewhat unlikely	Not sure	Somewhat likely	Moderately likely	Extremely likely
Try out a new extreme sport.							
Driving as a passenger with someone who may have had too much to drink.							
Visiting someone who has the flu.							
Driving on a moped as a passenger without a helmet.							
Sunbathing without sunscreen.							
Walking home alone at night in an unsafe area of town.							

INTRO

The survey is almost finished. The following questions have nothing to do with your travel behaviour or general attitudes, but they are important background information. There are no good or bad answers.

Q42. What is the highest qualification or educational certificate that you have obtained?
- None
- Primary education
- Secondary education
- Bachelor's degree or similar
- Master's degree or higher

Q43. Which of the following terms best describes your current professional occupation?
- white collar or office worker (excluding executive)/ employee (public or private sector) ➔ **Erreur ! Source du renvoi introuvable.**a
- blue collar or manual worker/worker ➔ **Erreur ! Source du renvoi introuvable.**a
- executive ➔ **Erreur ! Source du renvoi introuvable.**a
- self-employed/independent professional ➔ **Erreur ! Source du renvoi introuvable.**
- currently no professional occupation ➔ **Erreur ! Source du renvoi introuvable.**

Q44. Is your professional occupation to transport freight or persons? (taxi, bus, truck driver, courier, mailman, food delivery,…)
- yes
- no

Q45. You stated that you currently have no professional occupation. Which of the following terms best describes your current situation? I am …
- a student
- unemployed, looking for a job
- retired
- not fit to work
- a stay-at-home spouse or parent

- other

Q46. Do you have children?
- Yes
- No

Q47. How many other people live in your household (**except yourself**)? A household means all persons, family members or not, who live on the same address and share household expenses.
- Persons of 14 year and older (partner, older children, other family members) : ___
- Children (persons younger than 14): ___

Q48. What is your household's net monthly income?

To determine this income you add up the net salaries of all your household's members (i.e. what each person receives each month), plus other income such as family allowance, social benefits, pensions, allowances, income from real estate or movable property or a trade, unemployment benefits, etc. When you add them all up, to which category does your entire household's net income for last month belong?

Remember that this question relates to **all the members** of your household.

- Less than EUR 1,000
- EUR 1,000 – 2,000
- EUR 2,000 – 3,000
- EUR 3,000 – 4,000
- EUR 4,000 – 5,000
- More than EUR 5,000
- I don't know
- I prefer not to answer

Q49. Would you like to comment on this survey or add something for a better understanding of your answers? Did you notice anything negative during your participation in this survey? Were the questions not clear at one point or were you uncomfortable with the answers?
- Yes: _____
- No

e. Experimental design final survey

BLOCK 1		Cost	Time	Fatalities	Serious injuries
Q11	A	10.0	52	1	3
	B	5.5	28	22	93
Q12	A	7.0	28	22	138
	B	10.0	52	1	3
Q13	A	5.5	52	22	3
	B	10.0	28	1	138
Q14	A	8.5	28	1	138
	B	7.0	44	22	3
Q15	A	5.5	52	1	138
	B	10.0	28	22	48
Q16	A	10.0	52	15	3
	B	5.5	44	22	138
Q17	A	10.0	28	8	138
	B	5.5	52	15	3

BLOCK 2		Cost	Time	Fatalities	Serious injuries
Q17.1	A	5.5	52	22	93
	B	10.0	36	1	138
Q17.2	A	10.0	28	15	3
	B	7.0	52	1	138
Q17.3	A	5.5	52	1	138
	B	10.0	28	22	3
Q17.4	A	10.0	52	1	48
	B	5.5	28	15	138
Q17.5	A	10.0	44	1	138
	B	5.5	52	22	3
Q17.6	A	5.5	52	1	138
	B	10.0	28	22	93
Q17.7	A	5.5	44	22	138
	B	10.0	52	8	3

FIXED		Cost	Time	Fatalities	Serious injuries
Q17.8	A	7	36	1	48
	B	7	44	1	93

f. Lexicographic sequences in the two blocs of scenarios

Since two blocks of seven different scenarios have been created, the sequences of lexicographic responses are not the same depending on the block. For the respondents who were confronted with the first block, the lexicographical sequences for each attribute are the following:

- In relation to travel time: 2121221
- In relation to travel cost: 2112122
- In relation to risk of death: 1221111
- In relation to risk of injury: 1212212

In the block 2, the lexicographical sequences are:

- In relation to travel time: 2122121
- In relation to travel cost: 1212211
- In relation to risk of death: 2211112
- In relation to risk of injury: 1121222

In each block, there are four lexicographical sequences among 128 possible sequences or 3.1 %.

In block 1, there were 1,375 (36.5 %) lexicographic respondents out of 3,769:

- 648 respondents (17.2 %) answered lexicographically in relation to travel time.
- 232 respondents (6.2 %) answered lexicographically in relation to travel cost.
- 297 respondents out of (7.9 %) answered lexicographically in relation to the risk of being killed.
- 198 respondents out of (5.3 %) answered lexicographically in relation to the risk of being injured.

In Block 2, there were 1138 (30 %) lexicographical respondents out of 3,789:

- 343 out of (9.1 %) respondents answered lexicographically in relation to travel time.
- 317 respondents out of (8.3 %) answered lexicographically in relation to travel cost.
- 408 out of (10.8 %) respondents answered lexicographically in relation to the risk of being killed.
- 71 out of (1.9 %) respondents answered lexicographically in relation to the risk of being injured.

g. Results of the modelling on the sample with lexicographic respondents

Table 59: Results of the application of the MLMM and the Binomial Logit to the base sample.

Coefficients	Mixed Logit (7,557 respondents)	Binomial Logit (7,557 respondents)
Cost	-0.291***	-0.106***
Time	-0.085***	-0.035***
Risk of death	-0.092***	-0.037***
Risk of injury	-0.012***	-0.005***
VSL *[Min, Median, Max]* *St. deviation*	6.35 Mill EUR *[2.44, 6.39, 9.45]* *1.06 Mill EUR*	6.91 Mill EUR
VSSI *[Min, Median, Max]* *St. deviation*	0.81 Mill EUR *[0.38, 0.80, 1.22]* *0.17 Mill EUR*	0.86 Mill EUR
VoT *[Min, Median, Max]* *St. deviation*	16.9 EUR/h *[-12.5, 14.1, 42.0]* *12.9 EUR/h*	19.9 EUR/h
Adjusted AIC	46,880	52,286
Adjusted Log-likelihood	-23,436	-26,192

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

Table 60: Results of the application of the MLMM with panel dimension, with triangular distributions bounded at zero for risk attributes and a normal distribution for time, for every country, from the base sample of each country.

Coefficients	Analysis sample Belgium (1,911 respondents)	Analysis sample France (1,880 respondents)	Analysis sample Germany (1,887 respondents)	Analysis sample Netherlands (1,879 respondents)
Cost	-0.296***	-0.319***	-0.266***	-0.232***
Time	-0.094***	-0.073***	-0.089***	-0.064***
Risk of death	-0.092***	-0.091***	-0.099***	-0.073***
Risk of injury	-0.012***	-0.012***	-0.013***	-0.011***
VSL *[Min, Median, Max]* *St. deviation*	6.21 Mill EUR *[2.86, 6.22, 9.30]* *1.00 Mill EUR*	5.78 Mill EUR *[2.95, 5.83, 7.69]* *0.99 Mill EUR*	7.46 Mill EUR *[3.22, 7.51, 10.80]* *1.24 Mill EUR*	6.23 Mill EUR *[2.90, 6.26, 8.99]* *1.00M*
VSSI *[Min, Median, Max]* *St. deviation*	0.79 Mill EUR *[0.41, 0.78, 1.14]* *0.16 Mill EUR*	0.72 Mill EUR *[0.38, 0.70, 1.03]* *0.15 Mill EUR*	0.95 Mill EUR *[0.48, 0.96, 1.37]* *0.20 Mill EUR*	0.79 Mill EUR *[0.41, 0.79, 1.13]* *0.16 Mill EUR*
VoT *[Min, Median, Max]* *St. deviation*	18.8 EUR/h *[-11.5, 15.3, 42.1]* *14.6 EUR/h*	13.6 EUR/h *[-7.5, 12.0, 33.5]* *10.7 EUR/h*	19.8 EUR/h *[-12.7, 16.7, 45.3]* *15.4 EUR/h*	17.5 EUR/h *[-11.6, 14.3, 41.2]* *14.3 EUR/h*
Adjusted AIC	11,699	11,972	11,468	11,632

Signification codes: *** < 0.001, ** < 0.01, * < 0.05

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