



Comportements pro-environnementaux, incertitude et bien-être social

Maria José Montoya Villalobos

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Membre de l'université Paris Lumières

Maria José Montoya Villalobos

Comportements pro- environnementaux, incertitude et bien-être social

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sous la direction de Mme Meglena Jeleva (Université Paris Nanterre)
et de Mme Noémi Berlin (Université Paris Nanterre)

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À mon grand-père et à ma mère.

RÉSUMÉ

Les modes de production et de consommation actuels sont en grande partie responsables de la dégradation environnementale. L'étude des comportements pro-environnementaux est donc nécessaire dans l'objectif de réduire les externalités négatives, d'éviter la dégradation de la qualité environnementale, et d'inciter les individus à contribuer aux biens publics environnementaux. Les comportements pro-environnementaux sont considérés comme des comportements prosociaux car ceux-ci bénéficient à la société dans sa globalité. Dans cette thèse, nous cherchons à comprendre les déterminants de ce type de comportements et l'impact de l'incertitude et des attitudes face à l'incertitude sur ces comportements. Ainsi que les déterminants de l'acceptabilité des politiques publiques visant à corriger les externalités négatives. Cette thèse s'appuie sur deux méthodologies de recherche complémentaires : des modèles théoriques de la microéconomie comportementale et des expériences en laboratoire. Le premier chapitre étudie l'impact de l'incertitude, la confiance et le pessimisme sur la consommation de biens verts, grâce à un modèle de consommation de biens verts sous incertitude non-probabilisée. L'objectif est d'analyser l'impact des attitudes face à l'incertitude sur la demande de biens verts. Dans ce modèle, l'incertitude est caractérisée par la confiance dans l'information en provenance de sources officielles et par le pessimisme. Les résultats suggèrent que le pessimisme a un impact négatif sur la consommation de biens verts, tandis qu'une augmentation de la confiance peut avoir un impact positif ou négatif, selon le niveau du pessimisme de l'individu. Ce chapitre montre que dans le cadre d'un bien public en situation d'incertitude, la sur-provision de l'équilibre de Nash peut ne pas être garantie. Le deuxième chapitre s'intéresse à l'impact de l'incertitude et des attitudes envers l'incertitude sur les dons à des associations environnementales. L'étude de ces déterminants est indispensable car souvent les individus ne connaissent pas exactement l'impact de leurs dons puisqu'il peut y

avoir des risques de mauvaise gestion ou de détournement de fonds. L'incertitude conduit à une mauvaise perception de l'impact des dons et à l'incapacité d'estimer correctement leur impact. Nous cherchons à mieux comprendre le lien entre le risque, l'ambiguïté et les dons. Ce chapitre utilise un jeu du dictateur modifié afin de varier le niveau d'incertitude sur les dons reçus par les associations. Nous trouvons qu'un « haut » niveau d'ambiguïté a un effet négatif sur les dons par rapport à un niveau d'ambiguïté plus faible, ou un environnement risqué. L'effet du pessimisme dépend du niveau d'ambiguïté. Ces résultats suggèrent qu'il existe un seuil pour lequel l'aversion à l'ambiguïté et le pessimisme ont un impact sur les dons. Le troisième chapitre examine l'acceptabilité de différentes politiques publiques visant à limiter les externalités négatives. Pour ce faire, des instruments de marché, tels que les taxes ou les interdictions, sont nécessaires. Cependant, les politiques publiques peuvent échouer en raison d'une mise en œuvre inadéquate, de conséquences imprévisibles ou d'un manque de soutien de la part de la population dû à un manque de compréhension de la politique ou aux perceptions de la politique. Nous nous focalisons sur les différents déterminants de l'acceptabilité des politiques publiques. Dans cette thèse, nous utilisons une expérience en laboratoire dans laquelle les participants sont confrontés à un jeu d'externalités négatives. Dans le jeu, des politiques publiques sous la forme de taxes et de politiques de régulation avec des alternatives disponibles sont introduites. Nous trouvons que l'acceptabilité des politiques varie selon l'instrument utilisé, et que l'introduction d'un essai de politique publique augmente l'acceptabilité des taxes, mais pas l'acceptabilité d'une politique de régulation. Ce chapitre démontre aussi que les individus ayant une vision moins égalitaire du monde acceptent moins les taxes.

Mots-clés : Comportements pro-environnementaux ; comportements prosociaux ; incertitude ; attitudes face à l'incertitude ; politiques publiques.

ABSTRACT

Current modes of production and consumption are largely responsible for environmental degradation. The study of pro-environmental behaviors is, therefore, necessary to reduce negative externalities, avoid degradation of environmental quality, and encourage individuals to contribute to environmental public goods in order to ensure their provision. Pro-environmental behaviors are considered as pro-social behaviors because they benefit others or society as a whole. In this thesis, we seek to understand the determinants of pro-social behaviors, the impact of uncertainty, and attitudes towards uncertainty on these behaviors, as well as the determinants of the acceptability of public policies aimed at encouraging pro-environmental behaviors. This thesis is based on two complementary research methodologies: theoretical models of behavioral microeconomics and laboratory experiments.

The first chapter studies the impact of uncertainty, trust, and pessimism on the consumption of green goods using a model of green consumption under non-probabilistic uncertainty. The objective is to analyze the influence of attitudes towards uncertainty on green consumption. Measuring the environmental impact of consumption is difficult since its impact is distant in time, and scientific research does not always provide a clear understanding of the environmental impact of a green good. In this model, uncertainty is characterized by trust in information from official sources and by pessimism. The results of the comparative static analysis indicate that pessimism has a negative impact on the consumption of green goods, while an increase in trust does not always translate into an increase in demand for green goods, as the impact depends on the level of pessimism. In addition, this chapter shows that in the case of a public good in a situation of uncertainty, the over-provision of the Nash equilibrium may not be guaranteed.

The second chapter aims to study the impact of uncertainty and attitudes towards uncer-

tainty on donations to NGOs. The study of these determinants is essential because individuals often do not know exactly the impact of their donations and to what extent due to risks of mismanagement or diversion of funds. Uncertainty leads to a poor perception of the impact of donations and an inability to estimate their impact accurately. We seek to understand better the link between risk, ambiguity, and donations. This chapter uses a modified dictator game to modulate the level of uncertainty regarding donations received by NGOs. We find that a “high” level of ambiguity has a negative effect on donations compared to a lower level of ambiguity or a risky environment. The effect of pessimism depends on the level of ambiguity. These results suggest that there is a threshold for which ambiguity and pessimism have an impact on donations.

The third chapter examines the acceptability of different public policies to limit negative externalities. Market-based instruments are necessary, such as carbon taxes, eliminating subsidies for polluting agents, and prohibitions. However, public policies may fail due to inadequate implementation, unpredictable consequences, or a lack of support from the population. We focus on the different determinants of the acceptability of public policies. We use a laboratory experiment in which participants are confronted with a game of negative externalities, and we introduce public policies through taxes and bans with available alternatives. The acceptability of public policies varies depending on the instrument used. Introducing a public policy trial increases the acceptability of taxes but not the acceptability of a prohibition policy. This chapter also demonstrates that individuals with a less egalitarian view of the world are less likely to accept taxes.

Keywords: Pro-environmental behaviors; prosocial behaviors; uncertainty; attitudes toward uncertainty; public policies.

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INTRODUCTION

0.1 Contexte

Nos modes de production et de consommation actuels sont en grande partie responsables de la dégradation environnementale. Les risques environnementaux touchent de plus en plus de personnes. Par exemple, les effets combinés de la pollution de l'air ambiant et de la pollution de l'air domestique sont associés à 6,7 millions de décès prématurés par an¹. Le réchauffement climatique a aussi d'autres impacts négatifs sur de nombreux domaines tels que la biodiversité, l'eau ou la sécurité alimentaire. C'est dans ce contexte de dégradation environnementale que s'inscrit cette thèse, qui cherche à apporter des réponses aux défis environnementaux grâce à l'adoption de comportements "verts". Dans l'objectif de promouvoir efficacement l'adoption de ces comportements, cette thèse étudie les déterminants de ces derniers. Plus particulièrement, nous nous intéressons à la consommation de biens verts, aux dons aux associations environnementales et aux politiques publiques environnementales. Cette thèse prend en compte certains biais cognitifs dans les comportements pro-environnementaux des individus en donnant une place centrale aux biens publics et aux externalités négatives. Elle se focalise sur la prise en compte des facteurs psychologiques dans les comportements écologiques, notamment en contexte incertain, tels que l'aversion au risque et à l'ambiguïté et de façon plus générale les perceptions des individus. Mobilisant différentes méthodologies de l'économie publique comportementale, telles que les modèles théoriques de la microéconomie comportementale et les expériences en laboratoire, cette thèse contribue à la compréhension des motivations des individus à adopter des comportements "verts".

1. <https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health> - Lien disponible le 09/07/2023

0.1.1 L'économie publique comportementale

L'économie publique a pour objet d'apporter des perspectives sur l'analyse économique ainsi que d'éclairer le développement et la mise en place des politiques publiques. Son étude apporte des connaissances sur les conséquences des politiques publiques afin de donner aux décideurs publics des moyens efficaces dans la réalisation de leurs objectifs ([Teraji, 2021](#)). D'un point de vue de l'économie néoclassique, l'intervention du gouvernement dans l'économie ne se justifie qu'en présence de défaillances de marché. Ces dernières se produisent lorsque le marché n'arrive pas à produire par lui-même la quantité socialement optimale du bien en question, et donc lorsque l'optimalité de Pareto n'est pas réalisée. Les principaux phénomènes produisant des défaillances de marché sont les biens publics, les externalités, les asymétries d'information et le pouvoir de marché. Comme expliqué par [Madrian \(2014\)](#) l'analyse traditionnelle des défaillances de marché et de l'impact des politiques publiques sur le marché suppose que les acteurs (consommateurs et firmes) considèrent soigneusement les coûts et les bénéfices. Cette analyse se base sur l'hypothèse que les biais cognitifs n'existent pas : les individus maximisent leur utilité et agissent toujours selon leur propre intérêt. Cette modélisation de la prise de décision des individus a été questionnée par la littérature en économie comportementale ([Teraji, 2021](#)), puisqu'il semblerait nécessaire de prendre en compte l'existence de biais cognitifs dans la compréhension des comportements pouvant avoir un impact sur les politiques publiques. L'économie comportementale se démarque en intégrant dans l'analyse économique la possibilité qu'il existe des biais cognitifs qui vont remettre en cause les principes de rationalité des individus tels que la maximisation de l'utilité personnelle sous contrainte budgétaire ou la capacité de l'individu à classer parfaitement ses préférences. Ces biais peuvent entraver la réalisation de la maximisation du bien-être collectif (ou d'atteindre l'optimum social). La présence de biais cognitifs, étant considérée comme une forme particulière de défaillance de marché, va générer des divergences entre l'optimalité et les décisions individuelles permettant de maximiser l'utilité de l'agent. Ces facteurs psychologiques devraient être pris en compte dans la conception et mise en place des politiques publiques ([Chetty, 2015](#)).

D'après [Chetty \(2015\)](#), il existe trois domaines pour lesquels l'économie comportementale a des implications pour les politiques publiques. Ce champ de recherche permet de concevoir de nouveaux instruments de politiques publiques. Il permet aussi d'apporter des meilleures prédictions sur les effets des politiques publiques existantes en incorporant les caractéristiques comportementales. L'économie comportementale engendre des nouvelles implications de bien-être social, en remettant en cause la mesure utilitariste du bien-être social. L'économie publique comportementale distingue l'approche positive de l'approche normative. L'approche positive se concentre sur la description et l'explication du comportement économique ainsi que sur les conséquences de ces comportements. L'objectif principal est de comprendre comment les individus prennent des décisions économiques (dans le cadre de l'économie publique) en tenant compte de leurs motivations, biais cognitifs et perceptions de divers phénomènes. L'approche positive est essentielle pour comprendre au mieux les comportements individuels afin de concevoir des politiques publiques efficaces et d'éviter l'échec de leur mise en place. L'approche normative cherche à combiner les connaissances provenant de l'économie comportementale à des aspects normatifs, dans l'objectif d'évaluer des politiques existantes ou de proposer des nouvelles politiques. Au cours de cette thèse, grâce à une approche positive, nous étudions comment la présence de ces biais peuvent impacter les défaillances de marché déjà présentes (dans le cadre des biens publics et des externalités négatives). Grâce à une approche normative nous étudions l'acceptabilité des politiques publiques qui peuvent dépendre de différents biais de perception. Les implications de cette thèse pourront, par la suite, aboutir à des recommandations de politiques publiques.

0.1.2 Les biens publics et les externalités négatives

Cette thèse traite deux concepts principaux que nous cherchons à définir : les biens publics et les externalités négatives. Comme expliqué dans la section précédente, les biens publics et les externalités négatives sont problématiques dans la mesure où leur présence empêche l'allocation optimale des ressources.

Le premier concept étudié dans cette thèse est celui des externalités négatives. Une externalité négative apparaît lorsque l'activité économique d'un agent a des effets négatifs sur un

autre agent sans contrepartie financière. Cela crée une divergence entre les coûts privés et sociaux. L'intervention du gouvernement est donc nécessaire afin de permettre d'avoir une allocation efficace des ressources. Dans le cadre de la correction des externalités négatives, différents instruments sont mis en place, tels que les taxes, les subventions et les régulations. Chaque instrument a ses avantages tout comme ses inconvénients. Par exemple, les subventions ont le bénéfice d'être bien acceptées par la population, mais sont assez coûteuses à mettre en place. Les taxes sont les politiques les moins coûteuses et rapportent des revenus au gouvernement. Cependant, celles-ci sont perçues comme génératrices d'inégalités au sein de la population. Les régulations de quantités représentent une contrainte au libre échange et sont vues comme des politiques fortes et restrictives. En ce sens, l'économie comportementale apporte des explications différentes à celles de l'économie publique standard, comme les différences culturelles ou les perceptions, à l'acceptabilité des différentes politiques publiques qui théoriquement sont équivalentes car permettent la maximisation du bien-être social.

Le deuxième concept étudié dans cette thèse est celui des biens publics. Un bien public est un bien non-exclusif et non-rival. Ces deux caractéristiques impliquent que le bien en question peut être utilisé par plus d'un individu simultanément sans avoir à payer pour utiliser le bien (non-rival) et qu'il est impossible d'exclure un individu de la consommation du bien public (non-exclusif). La présence de ces deux caractéristiques pose problème car la stratégie optimale d'un individu en présence d'un bien public est de ne pas contribuer à la fourniture de ce bien. En faisant cela, l'individu pourra retirer une utilité provenant de la consommation du bien à moindre coût, c'est le phénomène du passager clandestin. La problématique qui émerge est celle de la fourniture du bien public, si personne ne contribue, le bien public ne sera pas fourni faute de moyens. La question de la contribution au bien public se pose alors. D'après [Bernheim and Rangel \(2005\)](#), les économistes se demandent : est-ce que l'Etat devrait s'assurer de la fourniture d'un bien public grâce à un système de taxation ? Ou est-ce qu'il est possible de fournir des biens publics grâce à des contributions privées ? Serait-il possible d'avoir un système hybride comprenant des sources publiques et privées ? Des biens fournis par le gouvernement peuvent être complétés par une fourniture privée du bien public. C'est le cas, par exemple, de la qualité

environnementale qui peut être complétée par l'action des associations environnementales. Dans les deux premiers chapitres de cette thèse nous nous concentrons sur les biens publics impurs, qui sont des biens possédant les caractéristiques d'un bien privé mais dont leur consommation contribue à un bien public pur. Ceci est effectué à travers une optique environnementale, dans laquelle il est toujours question d'une fourniture privée du bien public.

La compréhension des déterminants à la contribution volontaire privée au bien public, et du comportement des individus face à des situations différentes est incontournable dans l'objectif de proposer des politiques publiques efficaces afin de contrer les défaillances de marché que ce soit de façon privée ou grâce à des politiques publiques.

0.1.3 Les comportements pro-environnementaux

L'économie comportementale a apporté différents outils permettant de lutter contre le réchauffement climatique, par exemple, grâce à la mise en place de labels d'efficacité énergétique des logements ou l'envoi de relevés de consommation énergétique personnalisés en comparant les ménages à la moyenne des foyers similaires. D'après [Bhargava and Loewenstein \(2015\)](#), l'économie publique standard offre des pistes sur les causes de l'échec de la lutte contre le changement climatique et des solutions aux problématiques environnementales. Cependant, la prise en compte des facteurs psychologiques semble indispensable. Nous pouvons notamment penser aux comportements liés à la présence d'incertitude, le réchauffement climatique possédant des caractéristiques incertaines.

D'une part, l'impact négatif de notre consommation sur l'environnement est considéré comme une externalité négative. La consommation peut imposer un fardeau supplémentaire à la société, sans que ces coûts ne soient intégrés dans les prix des produits concernés, ne reflétant ainsi pas leur véritable coût environnemental. Ceci a pour effet d'encourager la surconsommation, produisant une quantité à l'équilibre supérieure à celle à l'optimum social. D'autre part, la qualité environnementale est considérée comme un bien public du fait de ses caractéristiques de non-rivalité et de non-exclusion. Non-exclusif car l'accès à la qualité environnementale ne peut pas être exclue pour certains individus, tel que respirer de l'air pur. Non-rival car la consommation de

la qualité environnementale par une personne n'empêche pas d'autres personnes de la consommer également.

Que ce soit considéré comme un bien public, ou comme une externalité négative, l'intervention de l'Etat est justifiée. Dans cette perspective, certains états ont pris différentes mesures. Nous pouvons penser notamment au Pacte vert pour l'Europe, qui a pour objectif la fin des émissions nettes de gaz à effet de serre d'ici à 2050. Par exemple, la France propose par exemple une subvention de 5000 € aux ménages très modestes pour l'achat d'un véhicule électrique ou hybride. Diminuer l'impact anthropique sur l'environnement passe par différents canaux. La diminution de la pollution produite par les firmes et par les consommateurs. Mais surtout l'action gouvernementale est indispensable afin de s'assurer que les firmes et les consommateurs diminuent leur impact environnemental bien que ces actions aillent à l'encontre de la maximisation de leur profit ou utilité. L'étude du comportement des individus vis-à-vis des contributions volontaires au bien public est nécessaire afin d'assurer au mieux une transition écologique durable et soutenable de la part des individus. Comprendre les mécanismes, ainsi que le comportement des individus semble indispensable pour mettre en place des politiques publiques environnementales tout en minimisant leur taux d'échec.

Les deux derniers chapitres de cette thèse ne portent pas principalement sur des thématiques environnementales. Pour autant, ils s'intéressent aux dons à des associations environnementales et à la correction d'externalités négatives. Les dons étant une contribution volontaire à la fourniture d'un bien public qu'est la qualité environnementale, et les externalités négatives représentant une multitude de concepts environnementaux, comme la pollution. Ces deux chapitres sont donc étroitement liés aux questions environnementales. C'est ainsi que cette thèse se focalise principalement sur l'action des consommateurs et des pouvoirs publics. Elle apporte une perspective sur les différents leviers des comportements pro-environnementaux afin de proposer des politiques publiques souhaitables d'un point de vue social tout en réduisant le risque climatique. Nous apportons aussi une compréhension des déterminants de l'acceptabilité des politiques publiques environnementales.

0.1.4 La prise en compte de l'incertitude dans la compréhension des comportements individuels

Une multitude de prises de décision s'effectuent dans l'incertitude, que ce soit pour des décisions d'investissement immobilier ou la souscription à une assurance santé. Celles-ci se rapportent aussi à un cadre d'actions qui font partie de la vie de tous les jours telles que faire ses courses au supermarché ou faire un don à une association. La prise en compte de l'incertitude dans les comportements individuels est une opération que les individus sont habitués à réaliser. La présence de l'incertitude n'est pas sans effet sur le comportement. Elle va le plus généralement modifier la façon de prendre des décisions comparées à une situation certaine, les différentes attitudes face à l'incertitude ayant le plus souvent un rôle à jouer.

Nous distinguons deux types d'incertitude. L'incertitude probabilisée (le risque) : situation dans laquelle les probabilités associées à chaque événement possible sont parfaitement connues. L'incertitude non-probabilisée, ou l'ambiguïté, qui représente une situation dans laquelle les probabilités d'occurrence d'un événement sont inconnues, il n'existe pas suffisamment d'informations permettant d'estimer les probabilités.

La présence d'ambiguïté n'a pas nécessairement un impact négatif sur la prise de décisions économiques. Son existence joue un rôle essentiel dans la présence de biais comportementaux tels que le pessimisme, qui a un impact sur les différentes décisions. En effet, ces biais comportementaux ont pour effet de créer un écart entre l'équilibre en situation incertaine et celui en situation certaine, ou de celui d'un individu complètement rationnel en situation incertaine. Ceci crée donc une déviation de l'équilibre, qu'il est nécessaire de corriger par une intervention étatique. Dans d'autres cas, notamment lorsque la déviation est déjà existante, comme en présence de biens publics et d'externalités, la présence de biais comportementaux liés à l'incertitude permet de réduire ou d'augmenter la déviation en question. La conception des politiques publiques, lorsque les décisions des individus s'effectuent dans l'incertain, doit prendre en compte les effets de la présence d'incertitude afin de s'assurer que la mise en place des politiques publiques s'avère efficace et n'échoue pas. La compréhension des interactions entre les attitudes face à l'incertitude

et les comportements semble pertinente dans la conception des politiques publiques, et peut même s'avérer être un levier utile dans la correction des défaillances de marché. C'est dans cette optique que les deux premiers chapitres de cette thèse traitent de l'incertitude et des attitudes face à l'incertitude.

La présence d'incertitude soulève aussi d'autres questions en économie publique comme la mesure du bien-être social, ou la détermination d'une fonction de bien-être social. Faut-il considérer des fonctions de bien-être social utilitaristes, dans lesquelles le planificateur social connaît exactement toutes les préférences individuelles et les attitudes face à l'incertitude ? Cette possibilité amènerait à considérer que le planificateur social possède des pouvoirs extraordinaires. Même dans ce cas improbable, est-il pertinent de considérer une telle fonction d'utilité sachant que les attitudes face à l'ambiguïté représentent des biais comportementaux et devraient être corrigés ? Ou ne serait-il peut-être pas plus pertinent de considérer une fonction de bien-être social dans laquelle les biais comportementaux n'existent pas et dont le rôle du planificateur social est de corriger ces biais et non pas la nécessité de connaître tous les paramètres individuels en incertitude ? Ou peut-être, considérer le planificateur social comme un individu ayant été élu. Dans ce cadre, ce sont ces propres biais comportementaux qui seront reflétés dans la fonction de bien-être social, car celui-ci ayant été élu possède les mêmes préférences et caractéristiques que l'électeur médian, étant cette dernière possibilité la plus réaliste.

Pour conclure cette sous-partie, il semble pertinent de mettre en lumière, dans le cadre de cette thèse, l'importance de la prise en compte de l'incertitude dans un contexte environnemental. Malgré les efforts effectués par les recherches environnementales, il existe encore une incertitude majeure sur la qualité environnementale future. La recherche scientifique avance et nous disposons de plus en plus d'informations sur l'impact de la consommation sur l'environnement. Cependant, il est très difficile à ce stade de quantifier cet impact sur l'environnement car celui-ci est difficilement mesurable et distant dans le temps.

0.2 Présentation de la thèse

Dans ce contexte, afin d'assurer la maximisation du bien-être social dans le cadre de biens publics ou d'externalités négatives, la mise en place de politiques publiques semblent nécessaire. La compréhension des déterminants des comportements des individus est indispensable afin de concevoir des politiques publiques réalisables et efficaces. Dans cette thèse nous cherchons à comprendre les différents déterminants de contribution volontaire à un bien public, et d'acceptabilité des politiques publiques visant à corriger une externalité négative.

Cette thèse se focalise sur l'économie publique comportementale en utilisant une approche autant positive que normative, ainsi que des méthodologies complémentaires : les modèles théoriques de la microéconomie comportementale et les expériences en laboratoire.

Les deux premiers chapitres proposent une approche positive de l'économie comportementale publique. Dans ces chapitres, nous nous focalisons principalement sur les biens publics (impurs) et sur les caractéristiques individuelles en tant que déterminants des défaillances de marché. Nous nous focalisons sur le rôle de l'incertitude et des attitudes vis à vis à l'incertitude sur la contribution volontaire à un bien public. Le dernier chapitre propose une approche plus normative des politiques publiques où nous étudions l'acceptabilité de la mise en place des politiques publiques dans le cadre d'externalités négatives.

0.2.1 Chapitre 1 - La consommation de biens verts : le rôle de la confiance et du pessimisme

Afin de concevoir des politiques publiques efficaces et acceptables par la population, ayant pour objectif d'augmenter la consommation verte si c'est socialement désirable, il est indispensable de comprendre les facteurs pouvant jouer un rôle dans la consommation de biens verts.

Les déterminants de la consommation de biens verts ont largement été étudiés en économie. [Joshi and Rahman \(2015, 2019\)](#) présentent une revue de littérature détaillant les différents déterminants ayant un impact sur la consommation de biens verts. Même si beaucoup de déterminants ont été étudiés, certains restent à ce jour inexplorés. C'est le cas de l'incertitude. Pourtant, pren-

dre en compte l'aspect incertain dans un contexte environnemental est indispensable puisque la qualité environnementale future est incertaine, ou du moins elle est prise comme telle par les individus. Ce chapitre se focalise sur l'étude de l'incertitude ainsi que des attitudes en présence d'incertitude et leur lien avec la consommation de biens verts. Les bénéfices environnementaux des biens verts ne sont pas directement visibles et peuvent, dans certains cas, ne pas exister. Ces bénéfices sont distants dans le temps et difficilement mesurables.

Dans ce premier chapitre nous cherchons à comprendre comment l'incertitude, à travers les attitudes face à l'incertitude, joue un rôle dans les décisions de consommer vert. Nous proposons un modèle de biens publics impurs basé sur le modèle de [Kotchen \(2005\)](#). L'originalité de ce modèle est l'intégration d'un modèle d'incertitude à un modèle de bien public impur. Nous intégrons l'incertitude grâce à un modèle à capacités néo-additives ([Chateauneuf et al., 2007](#)), face à une incertitude non probabilisée entourant les bénéfices environnementaux des biens verts. Nous étudions les implications théoriques de l'introduction de l'incertitude non probabilisée (ambiguïté) et des attitudes face à l'incertitude : la confiance dans l'information disponible, la croyance sur la véracité des informations disponibles et le pessimisme (surestimation de la probabilité de réalisation du pire résultat possible).

Nous analysons leur impact respectif sur la consommation écologique et nous considérons des individus aux croyances hétérogènes. Nos résultats montrent que le pessimisme a un impact négatif sur la demande de biens verts. Quant à l'augmentation de la confiance, elle n'entraîne pas toujours une augmentation de la demande écologique, cela dépend du niveau de pessimisme. Nous déterminons l'impact de l'incertitude et des croyances sur l'équilibre et le niveau socialement optimal de la fourniture volontaire privée. Nous constatons qu'en cas d'incertitude, le niveau individuel de consommation écologique à l'équilibre de Nash peut être supérieur au niveau individuel à l'optimum social.

0.2.2 Chapitre 2 - Niveaux d'incertitude et dons

Après avoir étudié théoriquement dans le premier chapitre de cette thèse l'impact de l'incertitude et du pessimisme dans la contribution volontaire à un bien public, à travers la consommation

d'un bien public impur, nous nous intéressons dans ce deuxième chapitre à la contribution volontaire à un bien public grâce aux dons, en utilisant une méthodologie expérimentale.

La fourniture des biens publics est essentielle pour le bon fonctionnement de la société. Les biens publics peuvent être financés par l'Etat, mais ils peuvent aussi être fournis par des entités privées telles que des associations à but non lucratif dont le fonctionnement se base sur les dons de la part de la population. Ces dons représentent des contributions volontaires à un bien public. Afin d'assurer la fourniture privée des biens publics, il est indispensable d'étudier les comportements de don.

Les dons aux associations sont sujets à la présence d'incertitude. Il est possible que le don effectué à une association ne soit pas reçu par les destinataires. L'utilisation des dons peut être inefficace ce qui peut empêcher la réalisation des objectifs souhaités ou la fourniture du bien public. Ce risque existe car les associations peuvent avoir des coûts de fonctionnement élevés ou une de mauvaise gestion des fonds. Il existe aussi les risques de détournement de fonds au sein d'une association, ou des escroqueries caritatives de la part d'individus se faisant passer pour des représentants d'une association. Un manque de transparence dans l'utilisation des fonds peut créer une méfiance de la part des donateurs vis-à-vis des associations. A l'inverse, il est possible que les donateurs sous-estiment l'impact des dons, sans prendre en compte l'effet multiplicateur que peut avoir la mise en commun des dons. L'objectif de ce chapitre est de prendre en compte cette perception erronée de l'impact des dons, et d'étudier l'impact de l'incertitude et des attitudes vis-à-vis de l'incertitude sur les comportements caritatifs.

Afin de répondre à la question de la prise en compte de l'incertitude dans les dons, nous réalisons une expérience en laboratoire dans laquelle nous utilisons un jeu du dictateur modifié. Les hypothèses découlent d'un modèle théorique de bien publics impurs développé dans ce chapitre dans lequel nous introduisons de l'incertitude grâce au modèle à capacités néo-additives. Dans le jeu du dictateur modifié, les participants représentent les donateurs et ils doivent choisir un montant de don compris entre 0 et 100 ECU (Experimental Currency Units) pour une association environnementale de leur choix (parmi une liste de trois options). Selon le traitement, les dons sont exposés à différents niveaux d'incertitude. Ainsi, nous étudions le montant que les

individus donnent à des associations environnementales en faisant varier le niveau d'incertitude reposant sur les dons. Nous incluons un traitement risque, un traitement "faible" ambiguïté et un traitement ambiguïté "élevée".

Nous élicitons des paramètres individuels propres à une situation en incertitude tels que l'aversion au risque en utilisant la méthode proposée par [Holt and Laury \(2002\)](#) (préférence pour les situations faiblement risquées par rapport aux situations plus risquées); l'aversion à l'ambiguïté (préférence pour les risques connus par rapport aux risques inconnus), l'insensibilité à la vraisemblance (pouvoir discriminatoire insuffisant pour différencier le degré de probabilité d'événements ambigus) et le pessimisme (surestimation de la probabilité de réalisation du pire événement possible) grâce à la méthode proposée par [Baillon et al. \(2018, 2021\)](#). L'originalité de ce chapitre réside dans l'étude de l'impact des attitudes face à l'ambiguïté sur les dons.

Nous ne constatons aucune différence entre les niveaux d'incertitude par rapport à l'absence d'incertitude. Le modèle théorique propose qu'une augmentation du niveau d'incertitude, que ce soit entre un niveau de risque et l'ambiguïté, ou entre deux niveaux d'ambiguïté, diminue les niveaux de dons si l'individu est suffisamment pessimiste. Les résultats de l'expérience indiquent bien une diminution du niveau de dons en présence d'ambiguïté "élevée" comparé à un environnement risqué ou en présence de "faible" ambiguïté, sachant que 78,38% de l'échantillon possède un niveau de pessimisme suffisamment élevé.

Nous constatons également que l'effet de l'aversion à l'ambiguïté et du pessimisme dépendent du niveau d'ambiguïté. Nous ne trouvons aucun effet de l'aversion à l'ambiguïté, de l'insensibilité à la probabilité et du pessimisme en cas d'ambiguïté "faible" sur le comportement altruiste. Au contraire, en cas d'ambiguïté "élevée", nous constatons un effet négatif de l'aversion à l'ambiguïté et du pessimisme. Ces résultats suggèrent qu'il existe un seuil au-delà duquel l'ambiguïté et les attitudes face à l'ambiguïté ont un impact sur les dons. Ceci sous-entend que le niveau d'ambiguïté a un effet amplificateur sur les attitudes face à l'ambiguïté, qui jouent un rôle central dans les décisions en ambiguïté.

0.2.3 Chapitre 3 - Corriger des externalités négatives : une expérience sur l'acceptabilité des taxes et des politiques de régulation des quantités

Les deux premiers chapitres de cette thèse se focalisent sur la provision privée des biens publics, en adoptant une approche positive. Dans ce troisième chapitre, nous employons une approche plus normative pour étudier une autre source de défaillance de marché en économie publique : les externalités négatives.

La présence d'externalités négatives génère une défaillance de marché et empêche d'atteindre l'optimum social. Afin de corriger ces externalités négatives, des politiques publiques peuvent être mises en place : des taxes, des subventions ou encore des politiques de régulation des quantités. Cependant, les politiques publiques peuvent échouer à cause d'un manque de support de la part de la population. Cela peut être dû à un manque de compréhension de la politique, à un manque de communication de la part du décideur public, ou à des opinions culturelles et politiques divergentes. L'échec de la mise en place de politiques publiques peut s'avérer coûteux pour le gouvernement dans la mesure où l'optimum social n'est pas atteint. De plus l'abandon de la politique entraîne des coûts financiers, mais aussi des coûts en termes de cohésion sociale qui peut se voir atteint si le rejet de la politique est représenté par des mouvements sociaux. Il est donc indispensable de comprendre les déterminants de l'acceptabilité des politiques publiques et d'étudier si des mécanismes tels que la mise en place d'un essai de politique publique augmentent l'acceptabilité de celle-ci grâce à une meilleure compréhension des bénéfices.

C'est dans cet objectif que ce troisième chapitre propose une expérience en laboratoire. Nous examinons l'acceptabilité des politiques publiques visant à atténuer les externalités négatives par le biais d'un vote à la majorité, comme étudié par [Cherry et al. \(2017\)](#). Notre expérience en laboratoire offre différents biens imparfaitement substituables comme choix, contrairement à ce qui a été fait dans la littérature.

Nous proposons deux traitements différents : un traitement taxe et un traitement politique de régulation. Dans le cadre de l'expérience, les participants sont amenés à voter trois fois pour ou contre la mise en place de la politique publique proposée, qui dépend du traitement.

Après chaque vote les participants sont confrontés à un jeu d'externalités négatives dans lequel ils doivent choisir entre trois options, parmi lesquelles le choix d'une des options génère une externalité négative, et donc entraîne un coût supplémentaire pour les participants. Nous mettons en place un essai de politique publique avant le troisième vote afin d'étudier l'impact d'un essai de politique publique sur l'acceptabilité de la politique publique. Afin de prendre en compte les différentes divergences culturelles, nous construisons un index de visions du monde culturelles grâce au questionnaire proposé par [Kahan et al. \(2011\)](#), dans lequel nous pouvons classifier les individus dans différentes dimensions : individualistes, hiérarchiques, communautaires et égalitaire.

Nous constatons dans nos résultats que l'acceptabilité des politiques de régulation est plus élevée que celle des taxes. De plus, la mise en place d'un essai de politique publique augmente l'acceptabilité d'une politique de régulation de quantités, mais pas celle des taxes. Finalement, nous trouvons que les visions du monde culturelles hiérarchiques diminuent uniquement le soutien aux politiques de taxation. Ces résultats suggèrent que malgré des efforts pédagogiques, s'il y a une forte aversion à un instrument spécifique, il est difficile de changer les opinions des individus vis-à-vis de cette politique.

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GREEN CONSUMPTION: THE ROLE OF CONFIDENCE AND PESSIMISM¹

Abstract

This paper proposes a green consumption model under non-probabilized uncertainty surrounding the environmental benefits of green goods. We study the theoretical implications of the introduction of non-probabilized uncertainty (ambiguity) and attitudes towards uncertainty: confidence (belief about the veracity of the available information) and pessimism (consumer's probability estimation of the realization of the worst possible outcome when consuming green goods). We analyze their respective impact on green consumption and consider individuals with heterogeneous beliefs. Pessimism has a negative impact on green demand; meanwhile, an increase in confidence does not always imply an increase in green demand, it depends on the level of pessimism. We determine the impact of uncertainty and beliefs on the equilibrium and the socially optimal level of private voluntary provision. We find that under uncertainty, the individual level of green consumption at the Nash equilibrium may be greater than the individual level at the social optimum.

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1.1 Introduction

For the last few years, there has been an increase in environmental awareness. More than half of French people (55%) believe that the economy must be reoriented in depth by supporting exclusively activities that preserve the environment, health, and social cohesion.² These concerns are partly due to the harmful effects of the consumption of some conventional goods on the environment. For example, some cosmetics contain microplastics that can end up in the ocean, impacting marine wildlife. These concerns led to the emergence and growth of a green goods market. In 2020 in France, more than 6.5% of household food consumption was devoted to organic products. France's organic sector has doubled in 5 years. It is one of the leading producers and markets in Europe.³ A green good is a product (tangible or intangible) that minimizes its environmental impact (direct and indirect) during its whole life-cycle, subject to the present technological and scientific status (Sdrolia and Zarotiadis, 2019). For example, these goods can be more recyclable, consume fewer resources, or have reduced packaging, such as green energy or green fashion. Their consumption is seen as having a lesser impact on environmental quality than a conventional good.

There is extensive literature on the different determinants of green consumption; it aims to understand which variables impact environmentally-friendly consumption. Identifying these determinants of green consumption is important to implement public policies to attain socially optimal green consumption. The literature has identified three types of determinants of green consumption: market variables, as high price or availability (Joshi and Rahman, 2015, Brouhle and Khanna, 2012); sociodemographic and socioeconomic characteristics of the consumers, as age, income or education (Brouhle and Khanna, 2012, Brécard et al., 2009); individual and social preferences, as environmental and health concerns (Young et al., 2010, Tsakiridou et al., 2008, Joshi and Rahman, 2019), social norms (Nyborg et al., 2006, Thøgersen, 2011, Farrow et al., 2017, Welsch and Kühling, 2009) or knowledge about the environment (Joshi and Rahman,

2. ADEME, Boy Daniel, RCB Conseil, 2020, Rapport. Les représentations sociales de l'effet de serre et du changement climatique, 40p

3. Agence Bio, July 2021, Dossier de presse, Le bio, acteur incontournable de la souveraineté alimentaire

2015, Young et al., 2010, Pieniak et al., 2010). Lack of consumer trust has also been identified as a brake for green consumption (Joshi and Rahman, 2015).

Despite the extensive literature about green goods, the literature has not sufficiently explored the importance of uncertainty surrounding the benefits of green goods. However, uncertainty appears to be a significant barrier to green consumption. For instance, the study by OECD (2014) shows that many individuals do not believe there are environmental benefits to consuming green. Indeed, 60% of Australian respondents do not think that organic fruits and vegetables have environmental and health benefits, and the proportion increases to 85% for Korean respondents.

There are multiple reasons why uncertainty surrounds the benefits of green goods. If some of the benefits of green consumption are easily identifiable, such as the taste of organic products; nevertheless, environmental benefits are more complex to identify and measure because some of them are only visible in the long term. There is also a lack of information concerning the effect that conventional and green goods have on the environment, it has been shown that lack of confidence is also a barrier to green consumption (Tsakiridou et al., 2008, Young et al., 2010). The existing research about the effects on the environment is not precise enough to allow a thorough comparison of the consequences of the different available products; consequently, it becomes more difficult for the consumer to choose among goods. For instance, there could be a subjective trade-off between consuming an organic fruit that has traveled long distances and a conventional non-organic, grown with pesticides, local fruit. Considering every aspect of consumption and its unexpected consequences is difficult for the consumer because of the complexity of verifying their efficiency. The presence of (non-probabilized) uncertainty leads to a lack of confidence in the available information in society since individuals cannot tell with confidence to which extent green consumption results in environmental benefits.

This lack of confidence can result from industries themselves that deceive consumers and market their products as « green » while they are not environmentally friendly. Also, it can come from the multiplicity of different eco-labels present in the market, these labels are not always certified by the government, and their labeling standards are usually different. It is difficult to tell which products are environmentally friendly and which are not.

Moreover, individuals do not always have confidence in the existing research and the government about consumption and environmental quality. For instance, the study by the [OECD \(2014\)](#) shows that there is globally a low level of confidence in the information given by the government about the environmental effect of goods. Indeed, only 30% of the respondents in France trust the government concerning the environment, meanwhile, they are 75% trusted researchers, scientists, and experts.

We can distinguish two levels of uncertainty. Probabilized uncertainty (risk), where the decision-maker possesses enough information about the likelihood of the events and can be represented by probabilities; and non-probabilized uncertainty (ambiguity), where the information is too imprecise to associate a probability to each event. In this paper, we study the impact of non-probabilized uncertainty (ambiguity) and attitudes towards uncertainty on individual and socially optimal consumption of green goods.

To model green goods consumption, we extend the framework of [Kotchen \(2005\)](#), which is built on the characteristics approach to consumer behavior ([Lancaster, 1966](#)) and characterizes green goods as impure public goods. The impure public goods model was first introduced by [Cornes and Sandler \(1984, 1994\)](#), where the authors developed the standard model: consumers acquire utility from the characteristics of the goods. An impure public good is a good that generates utility to the consumer through the joint production of a private characteristic and a public characteristic. The modeling of green goods as impure public goods has been done multiple times in the literature ([Kotchen, 2005, 2006](#), [Kim, 2009](#), [Wichman, 2016](#), [Chan and Kotchen, 2014](#), [Chan, 2015](#), [Chan and Dinelli, 2020](#)). To introduce non-probabilized uncertainty (ambiguity) and attitudes towards uncertainty, we use the neo-additive capacity model ([Chateauneuf et al., 2007](#)) that we apply to an impure public goods model.

In this model, uncertainty and attitudes towards uncertainty are introduced by a parameter of lack of confidence in a probability distribution (estimated on the basis of the available information) and a pessimism parameter. Moreover, it allows individuals to have different beliefs about the efficiency of green goods. We will study the theoretical implications of the introduction of uncertainty and attitudes towards uncertainty on green consumption. To our knowledge, this

is the first paper to integrate and study how non-probabilized uncertainty (ambiguity) and attitudes towards uncertainty (lack of confidence and pessimism) interact with green consumption, although some papers that study the impact of ambiguity and ambiguity attitudes in games (Eichberger et al., 2008, Eichberger and Kelsey, 2014); in environmental quality (Etner et al., 2007); in contributions to a public good (Tamai, 2018, Kelsey and Le Roux, 2017). Kim (2009) also studies the effect of social uncertainty in impure public goods surrounding the contributions of others and the response of others to an individual's own contribution, while in this paper, we study uncertainty surrounding the benefits of impure public goods.

The main results of this paper are the following. An increase in confidence does not necessarily lead to increased green consumption. We find that the lack of confidence's effect will depend on the individual's level of pessimism. We also show that pessimism has a negative impact on green consumption. Furthermore, assuming that individuals possess heterogeneous preferences and beliefs, under uncertainty, the social planner can behave differently according to their beliefs: the social planner can maximize the sum of utilities, can use objective information, and finally, can use her own beliefs, highlighting the importance of heterogeneous beliefs in the measuring of social welfare. Finally, we prove that under uncertainty, the individual level of green consumption at the equilibrium might be greater than that at the social optimum.

The closest work to our paper is Chan (2015), where the author considers green goods as impure public goods and studies how misinformation affects equilibrium public good provision. The author finds that misinformation about green products can help or harm the environmental quality; they model misinformation through the difference between perceived and actual greenness. In this paper, we also study misinformation, however, the modeling is different since we introduce uncertainty and attitudes toward uncertainty. We also find that misinformation, through lack of confidence in information, may harm the environment by diminishing green consumption.

This paper is structured as follows. In section 2.4, we present the impure public goods model. In section 1.3, we introduce uncertainty in the model, and we study the effect of confidence and pessimism in environmentally friendly consumption. Finally, section 1.4 concludes.

1.2 Green good demand under certainty: the basic determinants

1.2.1 The individual consumption of a green good

Following the literature about green consumption, we model green goods as impure public goods. Coupling the public good with private benefits has the advantage that it mitigates under-provision of the public good (Cornes and Sandler, 1984). Impure public goods, therefore, act as an incentive for increasing the private provision of the public good.

In our framework, following Kotchen (2005), consumers derive utility from the characteristics of the goods rather than from the goods themselves. Individuals derive utility from two characteristics, X and Y . The characteristic X gives private utility to the consumer, it represents the shared characteristic (for instance, nutrition if we consider a fruit), and Y satisfies the properties of a pure public good. It represents the common environmental characteristic or environmental quality. We assume that there are two market goods in the economy. A conventional good (c) that only generates the characteristic X , and there is a green good (g), which is an impure public good, that generates characteristics X and Y . In this setting, the green good and the conventional good will generate the same amount of characteristic X . For instance, if we consider electricity, the conventional good would be electricity generated from fossil fuels. Then, the green good would be electricity generated from renewable energies; in this case, X represents energy, and Y represents environmental quality. If the individual has no environmental preferences, she will be indifferent between purchasing either one, assuming the goods have the same price. The model in Kotchen (2005) is in line with the model developed by Cornes and Sandler (1994) of impure public goods, with the particularity that it allows substitute goods for the impure public good.

In our model, the preferences of a representative consumer are represented by a utility function $U(X, Y)$. We assume that the utility function is additively separable: $u(X) + v(Y)$ with $u(X)$ and $v(Y)$ increasing and concave. The separability assumption allows us to have independent preferences over the characteristics: the marginal utility of the private characteristic does not depend on the public characteristic and *vice-versa*. We can make this assumption since private preferences are independent of public preferences. The demand for private characteristics

does not impact the demand for public characteristics in our framework. The function $u(X)$ represents the agent's preferences over the primary functionality of the good itself, and $v(Y)$ represents the agent's preferences towards the environmental characteristic. The consumer has an income of m , she will devote her income to consuming conventional and green goods. Each unit of the conventional good (c) generates a unit of X . Each unit of the green good (g) will generate one unit of X and $\varepsilon_0 > 0$ units of Y . ε_0 represents the exogenous impact that the consumption of the green good has on the environmental quality. The relationship between the private characteristic X , the conventional good c , and the green good g is given by $X = c + g$. The relationship between Y and g is given by $Y = \varepsilon_0 g + Y_0$. P_g represents the exogenous green good's price, and P_c is the conventional good's price, which we normalize to 1. In accordance with the markets, the green good's price is higher than the conventional good's price $P_g > P_c$.⁴ Individual consumption is solution to the following problem:

$$\begin{aligned}
 \max_{X,Y} \quad & U(X,Y) = u(X) + v(Y) \\
 \text{s.t.} \quad & m = P_g g + c \\
 & X = c + g \\
 & Y = \varepsilon_0 g + Y_0 \\
 & c \geq 0, g \geq 0
 \end{aligned} \tag{1.1}$$

Note that in this framework, the public characteristic Y will depend on the impact of the green good ε_0 , on the individual's green consumption g , and on the environment's quality Y_0 . It will not depend on the other individuals' green consumption in the economy. The individual is myopic and only considers her own consumption. Other's green consumption is given by Y_0 .

We rewrite the program as a function of the quantity of the green good by substituting the characteristics by their expression and by substituting the budget constraint into the consumer's

4. If this inequality is not verified ($P_g \leq 1$) the consumer's problem becomes trivial, and the consumer will only consume green goods.

utility function, such as we obtain a maximization program that depends directly on goods and not on characteristics:

$$\max_{g \geq 0} U(g) = u(m - g(P_g - 1)) + v(\varepsilon_0 g + Y_0) \quad (1.2)$$

Since we assume the concavity of the utility functions u and v , the second-order condition is satisfied:

$$U''_{gg}(g) = (-P_g + 1)^2 u''(m - g(P_g - 1)) + \varepsilon_0^2 v''(\varepsilon_0 g + Y_0) < 0 \quad (1.3)$$

The condition for an interior solution $g \in]0; \frac{m}{P_g}[$ is $U'_g(g) = 0$:⁵

$$U'_g(g) = (-P_g + 1)u'(m - g(P_g - 1)) + \varepsilon_0 v'(\varepsilon_0 g + Y_0) \quad (1.4)$$

The demand for the green good g is thus implicitly given by equation 1.4. The interpretation of this equation is straightforward, g equalizes the marginal cost to the marginal benefit, as it appears in the following equation.

$$u'(m - g(P_g - 1)) + \varepsilon_0 v'(\varepsilon_0 g + Y_0) = P_g u'(m - g(P_g - 1)) \quad (1.5)$$

The first part of the marginal benefit comes from the consumption of the good itself and its functionality. Meanwhile, the second part of the marginal benefit comes from the environmental preferences of the consumer: the marginal public benefit (relative to the public utility).

If all the income is spent on the conventional good c , we obtain the following allocation: $U(m, Y_0)$. On the contrary, if all the income is spent on the green good g , the resulting allocation is $U(\frac{m}{P_g}, \varepsilon_0 \frac{m}{P_g} + Y_0)$.

5. From now on we will note $\frac{\partial f(x, y)}{\partial x} = f'_x(x, y)$ and $\frac{\partial f(x, y)}{\partial x \partial y} = f''_{xy}(x, y)$.

1.2.2 Comparative statics

In this section, we analyze the impact of the changes in exogenous parameters on green consumption. The sign of the impact of a given parameter $\theta \in \{P_g, m, \varepsilon_0, Y_0\}$ on green good consumption is given by:

$$\frac{dg^*}{d\theta} = \frac{-U''_{g\theta}(g^*, \theta)}{U''_{gg}(g^*)}$$

From equation (2.10), $U''_{gg}(g)$ is negative. Consequently, the effect of a variation in any of the parameters will depend on the sign of $U''_{g\theta}(g, \theta)$.

The results from the comparative statics are standard in the literature, the following proposition summarizes them and confirms in our framework some of the results in [Kotchen \(2005\)](#).

Proposition 1 *The exogenous market and the individual characteristics have the following impact on green goods consumption for interior solutions:*

- *If the income of the consumer increases, she will increase her green consumption.*
- *An increase in green goods' price will decrease green consumption.*
- *An increase in green good's quality increases green consumption if $\frac{1}{\varepsilon_0 g} > \frac{-v''(\varepsilon_0 g + Y_0)}{v'(\varepsilon_0 g + Y_0)}$.*
- *An increase in the initial environmental quality will decrease green consumption.*

Proof. See Appendix 1.A.

Proposition 1 finds that if the income of the consumer increases, she will increase her green consumption. Therefore, a wealthier individual will consume more green goods, which is a normal good.

We find conventional results: the green good is an ordinary good. An increase in the price of green goods will diminish green consumption, and the substitution and the income effect go in the same direction. On the contrary, an increase in the conventional good's price has an unknown effect on green consumption, this ambiguous result comes from the substitution effect and the income effect.⁶ Both of the previous results are in line with the empirical literature: [Joshi and](#)

6. This result has already been identified by [Kotchen \(2005\)](#).

Rahman (2015) find that a higher price outweighed ethical considerations. They also find that lack of income act as a barrier to purchasing green goods since it magnifies the effect of price.

An increase in quality will not necessarily imply an increase in green consumption. We recognize a saturation threshold that depends on a concavity index (right side of the inequality). When the utility function is strongly concave, increasing the green good's quality will decrease green goods consumption. This threshold depends directly on the concavity of the individual's utility function. The more the utility function is concave, the more the marginal utility will rapidly decrease, and the more the individual will rapidly attain the saturation threshold. The consumer will value less an additional unit of the green good, it will not be enough to induce the individual to increase her consumption after an efficiency increase.

An increase in Y_0 will induce a diminution in green consumption. The more the environmental quality is high, the less the individual will want to improve the environmental quality by increasing green consumption. From this result, we can infer a crowding-out effect. If there is an exogenous variation in environmental quality through an increase in public spending relative to environmental protection, individuals will contribute less to the public good.

1.3 Uncertainty, confidence and the consumption of green goods

1.3.1 Introducing confidence in the consumer's decisions: a neo-additive capacity model

In this section, we seek to introduce ambiguity on the impact of green goods on environmental quality. Considering ambiguity through beliefs (pessimism and confidence) brings the previous model closer to reality, especially since we usually are not aware of the real impact of a green good on the environment compared to a conventional good. Thanks to the following model, we can formulate some recommendations in order to increase green consumption in the case when it is socially desirable. As explained in the introduction, we introduce non-probabilized uncertainty on the environmental benefits of green goods. The state of knowledge nowadays does not allow us to estimate the green goods' efficiency with certainty. Despite this lack of information, there is

still available information that all the agents possess, although it is partial. Thanks to this partial knowledge, the agents can determine some estimates about the efficiency and communicate them to the consumers. However, consumers do not always have confidence in these estimates. We now assume that the impact of green goods consumption on environmental quality is uncertain. Authorities provide probabilistic information on this impact, but consumers do not consider this information perfectly reliable. These authorities can be either the government or scientific experts. For some goods, this assumption can be made because the state of knowledge about the efficiency of these goods is not sufficient; there is only partial scientific knowledge (data is limited in quantity). For others, this assumption may come from a more general lack of confidence in official sources such as scientific experts or the government.

This uncertainty will not be lifted until extensive research about the subject allows the individuals to compare the real impact of the goods between them.

More precisely, from now on, ε_0 that measures the impact of a unit of green good on environmental quality is not perfectly known and will be noted $\tilde{\varepsilon}$; it can take all the values in the interval $[\underline{\varepsilon}, \bar{\varepsilon}]$ with $\underline{\varepsilon} < \bar{\varepsilon}$. $\bar{\varepsilon} \geq 0$ is the best possible outcome (the best impact that green goods can have on environmental quality). On the contrary, $\underline{\varepsilon} \leq 0$ represents the worst possible outcome,⁷ the worst impact that green goods can have on environmental quality. We allow $\tilde{\varepsilon}$ to take negative values to take into account situations in which green goods can have a negative impact on the environment compared to the conventional good. For example, biofuels are considered a green substitute for petrol: they may reduce greenhouse gas emissions, and it is renewable energy. However, agricultural production has unintended negative impacts on water, land, or biodiversity. Depending on the methods and the crops used to produce the biofuels, they can cause more greenhouse gas emissions than fossil fuels, for example, by using nitrogen fertilizers.⁸ In this section, we will also consider the goods perceived as green by the consumer as green goods, even if they are not actually green.

We assume that public authorities provide consumers with a probability distribution of the

7. Note that the model does not yield the same results without this assumption.

8. Food and Agriculture Organization of the United Nations (FAO). 2008. Biofuels: prospects, risks, and opportunities. In *The State of Food and Agriculture 2008*. FAO. Rome.

random variable $\tilde{\varepsilon}$ with a density function $f(\cdot)$, and we assume that $\mathbb{E}(\tilde{\varepsilon}) > 0$. To consider the potential lack of confidence in this probabilistic information, as well as consumers' ambiguity attitudes and risk attitudes, we assume that their preferences are represented by the model of [Chateauneuf et al. \(2007\)](#). This model generalizes a subjective expected utility model and allows the separation between risk attitude and non-probabilized uncertainty attitudes.

With this preferences representation model, the consumers' problem in (1.2) writes:

$$\max_g U(g) \tag{1.6}$$

with

$$\begin{aligned} U(g) = & u(m - g(P_g - 1)) + (1 - \delta) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v(\varepsilon g + Y_0) f(\varepsilon) d\varepsilon \\ & + \delta [\alpha v(\underline{\varepsilon} g + Y_0) + (1 - \alpha) v(\bar{\varepsilon} g + Y_0)] \end{aligned}$$

where

$\delta \in [0, 1]$ measures the level of lack of confidence in the distribution P ;

$\alpha \in [0, 1]$ measures the level of pessimism;

$U(\cdot)$ is a Von Neumann–Morgenstern utility function.

These parameters allow us to model psychological phenomena. The first represents the degree of confidence $(1 - \delta)$ in the probabilistic assessment from official sources of the uncertain event (the efficiency of green consumption in environmental quality). This confidence parameter may differ between the consumers because it may depend on past experience and other people's beliefs. Moreover, a mistrustful individual will react differently to new information. She will over-weight the best (worst) outcome, considering the extreme outcomes without differentiating the different degrees of likelihood. The second parameter (α) represents the degree of pessimism where the individual gives a subjective weight to the probability of realization of the worst possible outcome given by official sources. It can be interpreted as her belief about the probability of realization of $\underline{\varepsilon}$. Suppose she assigns a value (α) to the probability of realization of $\underline{\varepsilon}$ higher

than the one given by the available information (or official sources). In that case, she will be over-weighting this probability and we can consider that the decision-maker is a pessimist. When $\delta = 1$ and $\alpha = 0$, she completely believes that the green good will have a high positive impact on the environment, considering that the probability of realization of the worst possible outcome is 0, she believes that the probability of realization of the best possible outcome is equal to 1, she is a pure optimistic; if $\alpha = 1$ the individual strongly believes that consuming green is more damaging than consuming a conventional good, believing that the probability of realization of the worst possible outcome is 1.

In this model, we assume that when a decision-maker lacks confidence in the probability distribution of reference, she is in total uncertainty (complete ignorance) and applies the Hurwicz Max-Min criterion:⁹ the individual evaluates her decision by a weighted sum of the best and the worst outcomes. On the contrary, when her confidence is total on the probability distribution of reference, she takes her decisions under risk using expected utility.

The condition for an interior solution $g \in]0, \frac{m}{P_g}[$ is $U'_g(g) = 0$. We only consider individuals consuming green goods.

$$\begin{aligned} (-P_g + 1)u'(m - g(P_g - 1)) + (1 - \delta) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon v'(\varepsilon g + Y_0)] f(\varepsilon) d\varepsilon \\ + \delta [\alpha \underline{\varepsilon} v'(\underline{\varepsilon} g + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} g + Y_0)] = 0 \end{aligned} \quad (1.7)$$

The second-order condition is satisfied due to the assumption of concavity of the function $U(g)$:

$$\begin{aligned} (-P_g + 1)^2 u''(m - g(P_g - 1)) + (1 - \delta) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon^2 v''(\varepsilon g + Y_0)] f(\varepsilon) d\varepsilon \\ + \delta [\alpha \underline{\varepsilon}^2 v''(\underline{\varepsilon} g + Y_0) + (1 - \alpha) \bar{\varepsilon}^2 v''(\bar{\varepsilon} g + Y_0)] < 0 \end{aligned} \quad (1.8)$$

When we compare the first-order condition of the model without uncertainty (equation 1.4)

9. Note that in the Hurwicz Max-Min criterion, the coefficient α is also interpreted as a measure of pessimism.

to the model's first-order condition with uncertainty (equation 1.7), the marginal costs stay the same for the same quantity of green goods g in both models, with and without uncertainty. This comes from the assumption that the introduction of uncertainty only lies in the public benefits of green consumption and not in the costs nor the private benefits of consuming green. The prices of a conventional good and a green good remain the same in both configurations, and the individual also retrieves the same private utility from consuming green.

The marginal benefit (MB) takes the following different form and depends on δ , α , and the reference distribution $f(\varepsilon)$:

$$MB = u'(m - g(P_g - 1)) + (1 - \delta) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon v'(\varepsilon g + Y_0)] f(\varepsilon) d\varepsilon + \delta [\alpha \underline{\varepsilon} v'(\underline{\varepsilon} g + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} g + Y_0)]$$

The model without uncertainty is a particular case of the model with uncertainty: if $\delta = 0$, the individual has complete confidence in the available information and makes decisions based on this information. On the contrary, if $\delta = 1$, the individual lacks confidence in the available information, and α will be the only parameter impacting green consumption. If $\alpha = 1$, the only outcome that is taken into account is the worst possible. On the contrary, if $\alpha = 0$, the best possible outcome is the only one considered.

It is necessary to notice that the function is not differentiable in zero. Therefore, when $g = 0$, we seek a corner solution. The following propositions are only valid for interior solutions. If $g = 0$, then $c = m = X$ and $Y = Y_0$, meaning that the individual will spend all her income on conventional goods. Implying that the individual retrieves private utility from the conventional good and public utility from the exogenous level of environmental quality. Her utility function will take the following form :

$$U(0) = u(m) + v(Y_0)$$

This case is possible when the individual is overly pessimistic and has a sufficiently high lack of confidence in the information. In this case, the marginal utility of green consumption, when $g = 0$, is lower than the marginal utility that could be obtained from equivalent spending on the

conventional good. Also, if the individual has no environmental preferences, we have $v(Y) = 0$; consuming green will not generate any public utility for the individual. This happens since the green good's price is higher than the conventional good, therefore, it is in her interest to only consume conventional goods. Another possible scenario is that the individual has environmental preferences; however, they are sufficiently low, and the exogenous environmental quality is sufficiently high, so the individual is satisfied with the current environmental quality level.

In the following sections, we are going to study the impact of confidence and pessimism on green consumption.

1.3.2 The impact of pessimism

In this section, we seek to study how an increase in the level of pessimism has an impact on the individual level of green consumption. We can formulate the following proposition:

Proposition 2 *Pessimism has a negative impact on green consumption.*

Proof.

Changes in an individual's pessimism over the impact of green goods on the environment is given by: $\frac{dg^*}{d\alpha} = -\frac{U''_{g\alpha}(g^*, \alpha)}{U''_{gg}(g^*)}$ (equation (1.8) shows that $U''_{gg}(g) < 0$). The sign of this expression is hence determined by:

$$U''_{g\alpha}(g^*, \alpha) = \delta \underline{\varepsilon} v'(\underline{\varepsilon} g^* + Y_0) - \delta \bar{\varepsilon} v'(\bar{\varepsilon} g^* + Y_0) < 0 \quad (1.9)$$

Since the utility function $v(Y)$ is increasing and concave, we know that $v'(Y) > 0$ and $v''(Y) < 0$, we also assume that $\underline{\varepsilon} < 0$, therefore, we can conclude that $U''_{g\alpha}$ is negative.

Notice that if we assume that $\underline{\varepsilon}$ is positive (however still inferior to $\bar{\varepsilon}$) the result above will hold if and only if $\frac{v'(\underline{\varepsilon} g^* + Y_0)}{v'(\bar{\varepsilon} g^* + Y_0)} < \frac{\bar{\varepsilon}}{\underline{\varepsilon}}$.

□

Consequently, $\frac{dg^*}{d\alpha}$ is also negative: a higher level of pessimism induces a decrease in green goods consumption. The more pessimistic the individual is, the less she will consume green

goods. If an individual thinks that her green consumption will have a negative or no impact on environmental quality, she will consume less of these goods since the consumer will not want to pay the premium price of consuming a green good. Optimistic consumers have a higher marginal public benefit from consuming the green good: they value an additional unit of the public good more than pessimists. If the individual has complete confidence in the available information (when $\delta = 0$), the decision will not depend on pessimism. On the contrary, if $\delta \neq 0$, regardless of the level of confidence, if pessimism (α) increases, the decision-maker will consume less green goods. This result is in line with the empirical literature, [Joshi and Rahman \(2015\)](#) found that a lack of beliefs about the environmental performance of green products acts as a barrier toward green purchase behavior. Moreover, [Bang et al. \(2000\)](#) found in their study that consumers who have stronger beliefs about the positive consequences of using renewable energy are willing to pay a premium price for renewable energy. If it is socially desirable to increase green consumption, we suggest focusing on changing pessimistic beliefs among the individuals in the economy, for example, through awareness policies or campaigns aiming to highlight the importance and the positive environmental effect of green goods.

1.3.3 The impact of confidence

In this section, we focus on the second belief of this model: we seek to study the impact of an increase in the level of lack of confidence (δ) in available information on green goods consumption. We can formulate the following proposition:

Proposition 3 *The impact of confidence on green consumption will depend on the level of pessimism. There is a threshold $\hat{\alpha}$ such as:*

- *If $\alpha > \hat{\alpha}$, green consumption decreases with an increase in lack of confidence (δ).*
- *If $\alpha < \hat{\alpha}$, green consumption will increase.*

Proof. See Appendix 1.B.

If α is greater than $\hat{\alpha}$, then an increase in lack of confidence will induce a decrease in green consumption. There is a threshold $\hat{\alpha}$ specific to each individual for which if its level of

pessimism is higher than this threshold, an increase in lack of confidence will decrease green consumption. Consequently, the more an individual lacks confidence in information, the less she will consume green goods, if and only if the individual is sufficiently pessimistic such that we have $\alpha > \hat{\alpha}$. An individual who lacks confidence in information will consume more green goods if the individual is not pessimistic enough: $\alpha < \hat{\alpha}$. This result is counter-intuitive since we could expect that an increase in confidence will increase the consumption of green goods. However, in this framework, we have an increase in confidence in the information that will mitigate the impact of any optimistic or pessimistic beliefs.

Since we are studying the effect of a variation in the level of the individual's lack of confidence (δ), and the level of confidence corresponds to $(1 - \delta)$, we can say that in order to increase green goods consumption of pessimists, one way is to increase its confidence in the available information.

This result implies that if it is socially desirable to increase green goods consumption, it is necessary to target different types of individuals. An individual who lacks confidence in information and is optimistic will consume more green goods than a consumer who has more confidence in the information. The decision of the individual who possesses more confidence will only depend on the available information and not on pessimism or optimism. The effects of confidence and pessimism show that social opinion and ambiguity attitudes can have an impact on green consumption. Increasing optimism among consumers is a way to increase green consumption. However, the level of optimism is difficult to increase for public authorities. It is easier to modify the levels of confidence among the individuals by reassuring pessimistic individuals about the true probability of the different events and therefore transforming their beliefs. Information is an important parameter that can significantly impact environmental quality. However, increasing confidence in information may generate the opposite effect than the one desired if it is not implemented carefully and focuses only on pessimistic individuals.

The result is in line with those found in the literature: proposition 3 is close to one of the results of [Chan \(2015\)](#), where the author finds that misinformation can help or harm the environment. We can consider that lack of trust in the information relates to a lack of informa-

tion (misinformation), this lack of confidence may have a positive or negative impact on green consumption. Thus, it has a positive or a negative impact on environmental quality.

One way of obtaining reliable information about the green characteristics of a green good is through eco-labels. Joshi and Rahman (2015) found that eco-labeling might not have any impact on consumer green purchase behavior if they do not trust the information provided: this result in the empirical literature might be explained by the present model and its results. The different studies do not find any clear (positive or negative) impact of eco-labeling on green consumption because the impact of skepticism related to the official information can either have a negative or a positive effect on green consumption, depending on the beliefs of the consumer. Implementing information campaigns about the information vehiculated by eco-labels is suggested to increase trust in them. We also suggest information campaigns that focus on giving information about green goods and their impact on the environment, it can also be done by reassuring individuals about this positive impact.

1.3.4 Equilibrium

In this section, we seek to determine the Nash equilibrium. Consider a population of N individuals where each individual chooses her public contribution, \hat{g}_i , considering the green consumption of the other individuals in the economy. This section considers that the individual is no longer myopic and will consider others' green consumption as having an impact on Y , the public characteristic. From now on, the public characteristic Y will also depend on the green consumption of all the N individuals in the economy $Y = \tilde{\varepsilon}G + Y_0$, where $G = \sum_{i=1}^N g_i$. We introduce strategic interaction where each individual will consider how others behave to make her decision and choose her level of green consumption.

The following maximization program gives the consumers problem with strategic interaction at the Nash equilibrium.

$$\begin{aligned}
 \max_{X,Y} U_i(X,Y) &= u_i(X) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i(Y(\varepsilon)) f(\varepsilon) d\varepsilon + \delta_i [\alpha_i v_i(Y(\underline{\varepsilon})) + (1 - \alpha_i) v_i(Y(\bar{\varepsilon}))] \\
 s.t. \quad m_i &= c_i + P_g g_i \\
 X &= c_i + g_i \\
 Y &= \bar{\varepsilon} G + Y_0 \\
 G &= \sum_{i=1}^N g_i
 \end{aligned} \tag{1.10}$$

We can rewrite the program in function of the quantity of green goods by substituting the constraints into the program and in the function of the green good's quantity:

$$\begin{aligned}
 \max_{g_i} U_i(g_i) &= u_i(m_i - g_i(P_g - 1)) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i\left(\varepsilon \sum_{i=1}^N g_i + Y_0\right) f(\varepsilon) d\varepsilon \\
 &\quad + \delta_i \left[\alpha_i v_i\left(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0\right) + (1 - \alpha_i) v_i\left(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0\right) \right]
 \end{aligned}$$

The program above differs from the program (1.6) since we introduce strategic interaction. Therefore the public characteristic and the individual's utility level will depend on the green consumption of others. At the Nash equilibrium, for all $i = 1, \dots, N$, for an interior solution \hat{g}_i verifies the following first-order condition:

$$\begin{aligned}
 (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i\left(\varepsilon \sum_{i=1}^N g_i + Y_0\right) \right] f(\varepsilon) d\varepsilon &+ \delta_i \left[\alpha_i \underline{\varepsilon} v'_i\left(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0\right) + (1 - \alpha_i) \bar{\varepsilon} v'_i\left(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0\right) \right] \\
 &= (P_g - 1) u'_i(m_i - g_i(P_g - 1))
 \end{aligned} \tag{1.11}$$

The equation above determines the individual level of green consumption at the equilibrium.

This level depends on the levels of confidence and pessimism. To determine the Nash equilibrium, solving the equation system composed of N equations is necessary. Each equation is the first-order condition of each individual in the economy. We have $\hat{G} = \sum_{i=1}^N \hat{g}_i$, which is the level of private voluntary contributions to the public good at the Nash equilibrium.

Strategic interaction

In this section, we seek to study how a change in the individual j 's level of consumption influences an individual i 's consumption. We assume strategic interaction, where the individual i considers the others' green consumption. However, we assume that we are not at the Nash equilibrium.

Proposition 4 *If the level of green consumption increases for an individual j , the level of green consumption for the individual i will decrease.*

The following equation defines, for an individual i , her best-response function for an interior solution.

$$\begin{aligned} (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i + Y_0) \right] f(\varepsilon) d\varepsilon + \delta_i \left[\alpha_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0) + (1 - \alpha_i) \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0) \right] \\ = (P_g - 1) u'_i(m_i - g_i(P_g - 1)) \end{aligned} \quad (1.12)$$

The following equation shows how the individual i 's marginal utility changes when there is an increase in the individual j 's green consumption:

$$U''_{g_i g_j}(g_i, g_j) = (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon^2 v''_i(\varepsilon \sum_{i=1}^N g_i + Y_0)] f(\varepsilon) d\varepsilon + \delta_i [\alpha_i \underline{\varepsilon}^2 v''_i(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0) + (1 - \alpha_i) \bar{\varepsilon}^2 v''_i(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0)] < 0 \quad (1.13)$$

Since $v''(g_i)$ is negative, the equation above is also negative. This means that an increase in individual j 's green consumption will decrease the public marginal utility of individual i . For

any increase in the individual j 's green consumption, the left part of the equation (1.12) will decrease, as shown by the equation (1.13). We now have an inequality where the left side of the equation (1.12) is smaller than the right side. To obtain the equalization of the terms of the equation, it is necessary to increase i 's public marginal utility (left side of the equation) through the decrease of g_i (since $v'' < 0$). This decrease in g_i also has an impact in the right side of the equation: a decrease in g_i will decrease the private marginal utility of individual i (since $u'' < 0$).

□

This result shows us that if another individual in the economy increases her green consumption, increasing the global contribution to environmental quality, it is in the interest of the individual i to decrease her green consumption. Therefore, there is crowding out between agents. If an individual j contributes to the provision of the public good (environmental quality Y), the individual i will contribute less to the public good: each individual will benefit from the consumption of green goods by another individual through the private contribution to the public good and thus to the improvement of the environmental quality. Therefore, the consumer is interested in reducing her green consumption and prefers that other individuals contribute to the public good. This means that g_i and g_j are strategic substitutes.

Heterogeneous beliefs

At the Nash equilibrium, we assume that the individuals are symmetric, therefore all \hat{g}_i are equal. In this section, in the following corollaries, we consider heterogeneous behaviors characterized by different levels of pessimism or different levels of confidence among the individuals. We seek to compare the individual level of green consumption between consumers that possess heterogeneous beliefs; first, we consider heterogeneous levels of pessimism with an equivalent level of confidence, and second, we consider heterogeneous levels of confidence among the individuals with an equivalent level of pessimism.

First, we consider heterogeneous levels of pessimism: two types of individuals, pessimists,

and optimists, as pessimists possess a higher value of α : $\alpha_{pe} > \alpha_{op}$.¹⁰ They are identical in all other characteristics: in their utility functions, such as we have, $u_{pe} = u_{op}$, $v_{pe} = v_{op}$, in their level of lack of confidence $\delta_{pe} = \delta_{op} = \delta$, and in income $m_{pe} = m_{op}$.

Taking the previous result of proposition 2, where we prove that an increase in pessimism decreases green consumption, allows us to formulate the following corollary.

Corollary 1 *Pessimistic individuals will consume less green goods than optimistic individuals, at the Nash equilibrium, with an equivalent level of confidence.*

The proof of the corollary 1 is immediate and comes directly from the proof of proposition 2. Note that the results from comparative statics at the individual level (section 1.3.2) remain true in equilibrium. This corollary finds that different attitudes toward ambiguity induce a modification in green consumption and therefore modify voluntary contributions to the public good. Pessimistic individuals will contribute less to the environmental quality than optimistic individuals: $\hat{g}_{op} > \hat{g}_{pe}$. The reason is that optimists believe that consuming a green good will have a greater positive impact on environmental quality than pessimists. Optimists value more consuming an additional unit of green goods than pessimists. We may say that optimists think their green consumption will positively impact environmental quality. Meanwhile, pessimists give more weight to the worst possible outcome, overestimating the likelihood of the worst possible outcome. Greenwashing, for example, may be one of the reasons why individuals possess heterogeneous beliefs. It can have a negative effect on beliefs, even for individuals possessing environmental preferences. Greenwashing can lead to deception: selling products as green meanwhile they do not possess any green characteristics. Once the individual realizes this deception, she might not trust the green claims of the products, increasing pessimism.

On the other side, greenwashing might also increase optimism: individuals can trust the deceitful information from green marketing. Greenwashing can also spill over to other green products, meaning that the individual will take all the products marketed as green as positive and good for the environment, incentivizing their purchase. We could also think about individuals

10. Pessimism and optimism are defined relatively.

that are climate skeptics. This type of individual does not believe that climate change is due to human activities, they might tend not to trust that consumption has an impact on the environment, and therefore they will strongly believe that the efficiency of green products is equal to the conventional goods. Another case may arrive when the individual possesses extreme environmental preferences and therefore thinks that any type of consumption is bad for the environment, taking all the different goods as equal in their environmental efficiency, without differentiating in efficiency green products from conventional products, being this individual extremely pessimistic.

Let us now assume that individuals possess heterogeneous levels of confidence in the information and an equivalent level of pessimism. Individuals can be divided into two groups: consumers that have confidence in the information $\delta_c < 0.5$, and those who lack confidence in information $\delta_l > 0.5$, such as $\delta_c < \delta_l$. They possess the same private and public utility functions.

Taking the previous result of proposition 3, where we prove that an increase in confidence will depend on the level of pessimism, allows us to formulate the following corollary.

Corollary 2 *With an equivalent level of pessimism, at the Nash equilibrium, an individual that possesses more confidence in information, δ_c , may consume more or less green goods than an individual who possesses less confidence in information, δ_l . It will depend on their level of pessimism.*

The proof of this corollary is immediate and comes directly from proposition 3. The corollary tells us that it is not straightforward that a higher lack of confidence in information will necessarily imply a lower consumption level at Nash equilibrium, $\hat{g}_l < \hat{g}_c$. The level of consumption will directly result from the pessimistic or optimistic beliefs of the consumers. As seen in proposition 3, there is a threshold $\hat{\alpha}$. If $\alpha > \hat{\alpha}$, then the individual that lacks more confidence in information will consume less green goods than the individual that has more confidence in the information, at the Nash equilibrium: $\hat{g}_c > \hat{g}_l$. On the contrary, if $\alpha < \hat{\alpha}$ then the individual lacking more confidence in the information will consume more green goods than the individual possessing more confidence in information: $\hat{g}_c < \hat{g}_l$.

1.3.5 Social optimality

In this section, we seek to determine the individual social optimal level of green consumption and, thus, the private voluntary contribution to environmental quality. We consider strategic interaction, however, in this section, we no longer seek to obtain the level of green consumption at the equilibrium, we seek to maximize social welfare. We will study three different definitions of the social optimum, since we are not able to define only one definition of social optimality in this framework due to the presence of beliefs. We will see that some cases are closer to reality than others. The central planner criterion will differ in the three different cases. First, we will assume that the social planner is utilitarian; second, we will study the case when the social planner uses objective information on green good efficiency to determine the social optimum; and finally, we will consider a social planner using her own beliefs.

A utilitarian social planner

We study the individual level of green consumption at the utilitarian social optimum. The utilitarian central planner maximizes the social welfare function, which is the sum of the individuals' utilities $W^u = \sum_{i=1}^N U_i(X_i, Y)$, which is a perfect representation of agents' preferences. We assume that the individuals have heterogeneous preferences over private and public characteristics (heterogeneous utility functions), environmental quality, heterogeneous income, and beliefs. The social planner knows perfectly individual preferences and uses them to determine social welfare. The utilitarian social planner has no judgment about individual preferences and will not seek to change them.

We assume a utilitarian central planner that maximizes a social welfare function represented by the sum of utilities:

$$\begin{aligned}
 \max_{X_i, \dots, X_N, Y} W^u &= \sum_{i=1}^N u_i(X_i) + \sum_{i=1}^N (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i(Y(\varepsilon)) f(\varepsilon) d\varepsilon \\
 &\quad + \sum_{i=1}^N \delta_i [\alpha_i v_i(Y(\underline{\varepsilon})) + (1 - \alpha_i) v_i(Y(\bar{\varepsilon}))] \\
 s.t. \quad m_i &= c_i + P_g g_i, \quad i = 1, \dots, N \\
 X_i &= c_i + g_i, \quad i = 1, \dots, N \\
 Y &= \bar{\varepsilon} \sum_{i=1}^N g_i + Y_0
 \end{aligned} \tag{1.14}$$

$$\begin{aligned}
 \max_{g_i} W^u &= \sum_{i=1}^N u_i(m_i - g_i(P_g - 1)) + \sum_{i=1}^N (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i(\varepsilon \sum_{i=1}^N g_i + Y_0) \\
 &\quad + \delta_i [\alpha_i v_i(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0) + (1 - \alpha_i) v_i(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0)]
 \end{aligned} \tag{1.15}$$

To determine the utilitarian social optimum, it is necessary to solve the equation system composed of N equations. The utilitarian social optimum is given by the sum of the individual optimal levels of green consumption $G^u = \sum_{i=1}^N g_i^u$. The solution to the equation 1.15 gives the optimal individual level of green consumption. At the optimum, an interior solution g_i^u represents the quantity consumed of green goods and verifies the following first-order conditions:

$$\begin{aligned}
 \sum_{i=1}^N (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i + Y_0) \right] f(\varepsilon) d\varepsilon &+ \sum_{i=1}^N \delta_i \left[\alpha_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0) + (1 - \alpha_i) \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0) \right] \\
 &= (P_g - 1) u'_i(m_i - g_i(P_g - 1))
 \end{aligned} \tag{1.16}$$

The individual optimal level of green consumption for individual i is given by equation 1.16, it is obtained by equalizing the individual marginal cost (right side of equation 1.16) of consuming green goods to the marginal social benefit (left side of equation 1.16). The marginal

social benefit represents the sum of all the individuals' marginal benefits, including individual i 's.

If the individuals are heterogeneous in private utility and in income, then the individual levels of green consumption will also be heterogeneous. The difference in optimal levels of green consumption will depend on the marginal utility relative to the private characteristic X and on income m_i . Since the left side of the equation 1.16 is a sum of the social marginal benefit of green consumption from all the individuals in the economy, this value stays the same for the individuals even with heterogeneous beliefs (pessimism and confidence) and heterogeneous preferences over the public characteristic. The social planner will internalize the externalities of consuming green, they can be either positive or negative, depending on individual beliefs. Since we assume that individuals have heterogeneous beliefs, there might be some individuals in the economy that are overly pessimistic and lack confidence in information for whom the external benefits from consuming green become external costs, consuming an extra unit of green goods will have a negative effect on their utility. The right side of the equation 1.16 represents the marginal cost of consuming green, which is specific to each individual. This setting is the most unrealistic among the three settings presented since we assume that the social planner knows perfectly all individuals' beliefs.

A paternalistic social planner

In this section, we study the individual level of green consumption when we assume a paternalistic social planner. The social planner will only consider the available information as completely true, there are no optimistic or pessimistic beliefs. In this setting, the social planner considers available information as accurate and will not have any subjective beliefs. The social planner in this scenario possesses a value of $\delta = 0$ (complete confidence), meaning that it will not take into account any pessimistic or optimistic beliefs.

We assume a paternalistic social planner that maximizes a social welfare function that takes the following form:

$$\begin{aligned}
 \max_{X_i, \dots, X_N, Y} W^p &= \sum_{i=1}^N u_i(X_i) + \sum_{i=1}^N \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i(Y(\varepsilon)) f(\varepsilon) d\varepsilon \\
 \text{s.t. } m_i &= c_i + P_g g_i, \quad i = 1, \dots, N \\
 X_i &= c_i + g_i, \quad i = 1, \dots, N \\
 Y &= \bar{\varepsilon} \sum_{i=1}^N g_i + Y_0
 \end{aligned} \tag{1.17}$$

To determine the social optimum in this setting, it is necessary to solve the equation system composed of N equations. At the optimum, an interior solution g_i^p , represents the individual quantity of green goods consumed by an individual i and verifies the following first-order condition:

$$\sum_{i=1}^N \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i + Y_0)] f(\varepsilon) d\varepsilon = (P_g - 1) u'_i(m_i - g_i(P_g - 1)) \tag{1.18}$$

The left term of equation 1.18 corresponds to the sum of the private marginal public benefit and the external marginal benefit, which gives the social marginal benefit. The right term of the equation 1.18 represents the marginal cost of consuming the green good for an individual i , as seen in the previous section.

If the individuals are heterogeneous in private utility and in income, then the individual levels of green consumption will also be heterogeneous: in this scenario, the differences in the optimal level of green consumption will depend on the value of the left side of the equation 1.18: the marginal utility from the private characteristic and the income. Heterogeneity in beliefs will not have an impact on the green consumption level since the social planner does not take them into account.

If all of the available information comes from the government itself, the social planner will use its information as if it was entirely accurate. Therefore it will consider that the heterogeneous

beliefs of the individuals in the economy come from cognitive biases corresponding to a failure of reasoning. The social planner is entirely objective and maximizes welfare, assuming that the available information is true. This setting can also be considered as a special case of the utilitarian social planner setting, assuming that all the individuals have full confidence in information such as $\delta_i = \delta_j = \dots = \delta_N = 0$. The setting is possible since the government possesses the economic resources to obtain all necessary information relative to green goods.

A social planner with its own beliefs

In this section, we study the individual level of green consumption when the social planner possesses her own beliefs. In this setting, we assume that the social planner uses her own beliefs δ_A and α_A , and will not consider any of the beliefs coming from the individuals in the economy. Moreover, we assume that any information comes from scientific experts and not from the government (social planner) itself.

We assume a social planner that takes its own beliefs (pessimism and confidence) as the true levels of the parameters. The maximization program of the social planner takes the following form:

$$\begin{aligned}
 \max_{X_i, \dots, X_N, Y} W^A &= \sum_{i=1}^N u_i(X_i) + (1 - \delta_A) \sum_{i=1}^N \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} v_i(Y(\varepsilon)) f(\varepsilon) d\varepsilon \\
 &\quad + \delta_A \sum_{i=1}^N [\alpha_A v_i(Y(\underline{\varepsilon})) + (1 - \alpha_A) v_i(Y(\bar{\varepsilon}))] \\
 s.t. \quad m_i &= c_i + P_g g_i, \quad i = 1, \dots, N \\
 X_i &= c_i + g_i, \quad i = 1, \dots, N \\
 Y &= \bar{\varepsilon} \sum_{i=1}^N g_i + Y_0
 \end{aligned} \tag{1.19}$$

To determine the optimum, it is necessary to solve the equation system composed of N equations. At the optimum, an interior solution g_i^A represents the individual quantity consumed of green goods at the social optimum in this setting and verifies the following first-order condition:

$$\begin{aligned}
 & (1 - \delta_A) \sum_{i=1}^N \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i + Y_0) \right] f(\varepsilon) d\varepsilon + \delta_A \alpha_A \sum_{i=1}^N \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i + Y_0) \\
 & + \delta_A (1 - \alpha_A) \sum_{i=1}^N \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i + Y_0) = (P_g - 1) u'_i(m_i - g_i(P_g - 1))
 \end{aligned} \tag{1.20}$$

If the individuals are heterogeneous in private utility and income, the individual levels of green consumption will also be heterogeneous, as seen in previous sections. We assume two different reasons why the social planner will only consider her own beliefs. First, we could assume a case where the social planner's beliefs are completely independent of individual beliefs; the social planner possesses her own beliefs and can choose any level of beliefs. For example, the social planner may completely lack confidence in information and be completely pessimistic. In this case, the government will not implement any environmentally friendly policy related to green consumption; on the contrary, it will try to mitigate this behavior since it is seen as damaging to the environment and socially undesirable. Another extreme case happens when the social planner completely lacks confidence in the available information but is extremely optimistic. Then, the government will try to implement environmentally friendly public policies since it is seen as extremely positive and a way to achieve the social optimum. In both cases, the beliefs are completely independent of individual beliefs and might not be appropriate for the majority of individuals, and the individual optimal level of green consumption can move away from the individual level of green consumption at the Nash equilibrium. It can explain the implementation or not of environmental public policies despite the presence of information.

The second will arrive if the social planner represents the majority's beliefs. We assume that the social planner has been elected and represents the government. For instance, applying the median voter theorem, the social planner will follow the median voter's beliefs, where we will have $\alpha_A = \alpha_m$ and $\delta_A = \delta_m$, m denoting the median voter's beliefs. This last scenario is the closest to reality since the social planner does not possess the information related to the impact of green goods, however, it possesses information from scientific experts. The social planner

will follow her own beliefs about confidence and pessimism on this available information to implement environmental public policies. These policies will generally be well accepted by the population since the government possesses the same beliefs as the median voter; however, these beliefs will not necessarily be similar to the beliefs and characteristics of all the individuals in the population.

Note that in the three different settings, the level of green consumption will differ for each individual (excluding the case where individuals are equal in every characteristic except in beliefs). However, if we add the supplementary assumption of equal marginal utility regarding the private characteristic and equal income, the individuals in the economy will consume the same level of green goods: such as $g_i^k = g_j^k = \dots = g_N^k$ with $k = p, u, A$, denoting each different setting. This result will hold even if the individuals possess heterogeneous preferences over the public characteristic and heterogeneous beliefs since the marginal social benefit will stay the same for all the individuals, as explained in previous sections. This result does not imply that the level at the optimum will be the same in the different settings. However, within each set, all the individuals will consume the same level of green goods at the optimum.

The over-provision of the Nash equilibrium

In this section, we seek to prove that there exists a threshold for which the individual level of green consumption at the Nash equilibrium will over-provide. To do this, we compare the individual level of green consumption at the Nash equilibrium to the individual social optimal level of green consumption in different settings. It is a known result in public economics that when in the presence of a public good, the Nash equilibrium leads to an under-provision. At the equilibrium, the individual only considers her marginal benefit, meanwhile, at the optimum, the social marginal benefit is taken into account. Since we assume that green consumption may have a negative impact on the environment ($\varepsilon < 0$), it is possible that the marginal benefit of an individual is negative under particular scenarios and therefore represent a marginal cost. Therefore, the internalization of these externalities may lead to the over-provision of the Nash equilibrium at an individual level, such as $\hat{g}_i > g_i^k$, with $k = u, p, A$, where g_i^u denotes the

individual level of green consumption at the utilitarian social optimum; g_i^p denotes the individual level of green consumption at the paternalistic social optimum; and finally, g_i^A denotes the individual level of green consumption at the authoritarian social optimum.

Proposition 5 *Under uncertainty, there is a threshold $\bar{\alpha}$, for which if $\bar{\alpha} > \alpha_i$, the individual optimal level of green consumption is smaller than the individual level at the Nash equilibrium, such as $\hat{g}_i > g_i^k$, with $k = u, p, A$.*

Proof. See Appendix 1.C.

The sign of the threshold $\bar{\alpha}$ is ambiguous. In order to determine the sign of $\bar{\alpha}$, we study another threshold $\bar{\delta}$. By comparing $\bar{\delta}$ to δ_i we ensure that the first threshold $\bar{\alpha}$ will be positive or negative. We have two different cases depending on the comparison between $\bar{\delta}$ and δ_i :

- **Case 1:** If $\delta_i \leq \bar{\delta}$, then $\bar{\alpha}$ is negative or equal to 0, $\bar{\alpha} \leq \alpha_i$ and $\hat{g}_i \leq g_i^k$.
- **Case 2:** If $\delta_i > \bar{\delta}$, then $\bar{\alpha}$ is positive. When this condition is true, there are two possibilities:
 - **Case 2.1:** If $\bar{\alpha} > 1$, then $\bar{\alpha} > \alpha_i$, and $\hat{g}_i > g_i^k$.
 - **Case 2.2:** If $\bar{\alpha} \in [0, 1]$, then the comparison between $\bar{\alpha}$ and α_i is not straightforward.

Case 1: In this case, the individual i possesses a low level of lack of confidence in information δ_i (high level of confidence). The individual level of green consumption at the Nash equilibrium is lower than or equal to the one at the social optimum. This result tells us that the individual will not give important weight to her beliefs. We thus approach the expected utility model: obtaining the standard result of under-provision of the Nash equilibrium.

Case 2: In this case, the individual i possesses a high level of lack of confidence in information (low level of confidence). The individual will give important weight to her beliefs. We can divide this possibility into two sub-cases.

In case 2.1, if $\bar{\alpha} > \alpha_i$, then $\hat{g}_i > g_i^k$. This result is independent of the level of pessimism, the individual may be extremely pessimistic or optimistic; in both cases, we find the over-provision of the Nash equilibrium at the individual level. This result will depend on the level of $\bar{\alpha}$ which depends on the individual's public and private preferences. We could obtain this result when

the individual has strong public preferences and weak private preferences.

In case 2.2, if $\bar{\alpha} \in [0, 1]$, then the comparison between the individual levels of green consumption is not straightforward. In order to determine if the individual level at Nash equilibrium will over-provide, it is necessary to compare $\bar{\alpha}$ to the level of pessimism of individual i . If the individual is extremely optimistic ($\alpha_i = 0$), then $\bar{\alpha} \geq \alpha_i$. Therefore, the level of green consumption at the Nash equilibrium will be greater or equal to the level at the social optimum ($\hat{g}_i > g_i^k$). Since the individual is extremely optimistic and gives a large weight to her beliefs, at the Nash equilibrium, the individual will consume a large number of green goods. Since the individual level of green consumption at the social optimum takes into account the social marginal benefit (or cost) of all individuals in the economy, and the individuals possess heterogeneous preferences, the Nash equilibrium may over-provide. This result agrees with propositions 2 and 3 since in these propositions we see that an overly optimistic individual will consume more green goods than a less optimistic individual; besides, in these propositions, we can also see that an individual that lacks confidence in information will consume more green goods if she is optimistic. On the contrary, if the individual is extremely pessimistic ($\alpha_i = 1$), then $\bar{\alpha} \leq \alpha_i$. Therefore, the individual level of green consumption at the Nash equilibrium will be equal to or lower than the one at the social optimum ($\hat{g}_i < g_i^k$). We find the usual result of the under-provision of the Nash equilibrium. It is an interesting result since, under ambiguity, there might be a questioning of the result of the under-provision of public goods at the Nash equilibrium.

1.4 Conclusion

This paper contributes to the literature about impure public goods with the particularity that we introduce ambiguity through beliefs. This paper proposes a green consumption model that considers green goods as impure public goods and introduces uncertainty surrounding the benefits of green goods, it aims to study the different determinants of private voluntary contributions to environmental quality and their impact. Furthermore, we consider that green goods' environmental efficiency is partially unknown. In order to introduce uncertainty, we base

our model on [Chateauneuf et al. \(2007\)](#) model as a way to represent consumers' preferences. We introduce non-probabilized uncertainty into an impure public good model to analyze the impact of ambiguity and ambiguity attitudes on green consumption. The presence of uncertainty is modeled through consumers' beliefs: confidence and pessimism/optimism. We show that a lack of confidence in information may be a major barrier to green consumption. An increase in confidence does not necessarily lead to an increase in green consumption, the impact will depend on the individual's level of pessimism. We also find that pessimism has a negative impact on green consumption. These findings tell us that the presence of ambiguity might have a positive or negative effect on green consumption because of individual beliefs. These results are helpful in order to introduce non-monetary incentives by reassuring individuals about the probability of the possible efficiency of green goods since the increase of optimism in the economy and modifying confidence levels allow them to attain the socially optimal level of green consumption. Indeed, public policies may consider the possibility of influencing consumers' beliefs, such as confidence or pessimism. If it is socially optimal to increase green demand, increasing optimism represents a way to attain this objective. However, it might be easier for the government to influence confidence in information than optimism. The results show that increasing confidence might be counter-productive since it will diminish green consumption for optimistic individuals. Thus, it is necessary to target different types of individuals before implementing public policies looking for an increase in confidence: it is helpful to increase confidence only for pessimistic individuals if the aim is to increase green consumption.

Moreover, we study the case where individuals have heterogeneous preferences and beliefs, either pessimism or confidence, and allow strategic interaction. When comparing the individual level of green consumption at the Nash equilibrium to the individual level at the social optimum, we find a counter-intuitive result: at the individual level, the Nash equilibrium may be greater than the level at the social optimum, contrary to the usual result of under-provision of the Nash equilibrium for public goods. One of the model's limitations is that we assume that the government, or the experts, possess and communicate their probability estimation over the green good's efficiency. However, official sources do not always possess (and communicate)

these probabilities or information. Future research should consider experimentally testing the impact of the different determinants of green consumption, including confidence and pessimism. Furthermore, it might also consider introducing direct donations into the model.

1.A Proof of proposition 1

- An increase in income:

We know that $P_g > 1$, therefore $(-P_g + 1) < 0$, and from the concavity assumption of the utility function $u(X)$, we know that $u''(m - g(P_g - 1)) < 0$. Consequently, the sign of the following cross partial derivative is positive.

$$U''_{gm}(g, m) = (-P_g + 1)u''(m - g(P_g - 1)) > 0 \quad (\text{A.1})$$

- An increase in price:

Since we assume that $u(X)$ is increasing and concave, then $u'(m - g(P_g - 1)) > 0$ and $u''(m - g(P_g - 1)) < 0$. We also know that $P_g > 1$, therefore, the first part of the sum is negative, and the second part of the sum is also negative.

$$U''_{gP_g}(g, P_g) = -u'(m - g(P_g - 1)) + (1 - P_g)(-g)u''(m - g(P_g - 1)) < 0 \quad (\text{A.2})$$

- An increase in ε_0 :

Since we assume that $v(Y)$ is increasing and concave, then $v'(\varepsilon_0 g + Y_0) > 0$ and $v''(\varepsilon_0 g + Y_0) < 0$. Therefore, we can't conclude on the sign of the following equation.

$$U''_{g\varepsilon_0}(g, \varepsilon_0) = v'(\varepsilon_0 g + Y_0) + \varepsilon_0 g v''(\varepsilon_0 g + Y_0) \quad (\text{A.3})$$

An increase in ε_0 will have a positive impact in green goods consumption if and only if:

$$\frac{1}{\varepsilon_0 g} > \frac{-v''(\varepsilon_0 g + Y_0)}{v'(\varepsilon_0 g + Y_0)}$$

- An increase in the exogenous level of environmental quality:

Since we assume that $v(Y)$ is increasing and concave, we know that $v''(\varepsilon_0 g + Y_0)$ is negative. Therefore we can conclude that the sign of the following equation is negative.

$$U''_{gY_0}(g, Y_0) = \varepsilon_0 v''(\varepsilon_0 g + Y_0) < 0 \quad (\text{A.4})$$

□

1.B Proof of proposition 3

We want to determine the effect of a variation in the individual's confidence over green consumption, it can be determined by: $\frac{dg^*}{d\delta} = -\frac{U''_{g\delta}(g^*, \delta)}{U''_{gg}(g^*)}$.

Thanks to the concavity assumption of the function (equation (1.8): $U''_{gg}(g^*) < 0$), we only need to determine the sign of $U''_{g\delta}(g^*, \delta)$:

$$U''_{g\delta}(g^*, \delta) = -\int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon v'(\varepsilon g^* + Y_0)] f(\varepsilon) d\varepsilon + [\alpha \underline{\varepsilon} v'(\underline{\varepsilon} g^* + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} g^* + Y_0)] \quad (\text{B.1})$$

The sign of this expression is ambiguous. If $U''_{g^*\delta}$ is negative, $\frac{dg^*}{d\delta}$ will be negative as well. It will be the case if:

$$\alpha > \frac{\bar{\varepsilon} v'(\bar{\varepsilon} g^* + Y_0) - \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} [\varepsilon v'(\varepsilon g^* + Y_0)] f(\varepsilon) d\varepsilon}{\bar{\varepsilon} v'(\bar{\varepsilon} g^* + Y_0) - \underline{\varepsilon} v'(\underline{\varepsilon} g^* + Y_0)} \equiv \hat{\alpha}; \hat{\alpha} \in [0, 1] \quad (\text{B.2})$$

If α is greater than $\hat{\alpha}$, then lack of confidence will induce a negative impact on green goods consumption. Consequently, the more an individual lacks confidence in information, the less she will consume green goods, if and only if the individual is pessimistic enough such as we have $\alpha > \hat{\alpha}$. We need to verify that it is possible for α to be greater or smaller than $\hat{\alpha}$. To do this it is necessary that $0 \leq \hat{\alpha} \leq 1$. The inequality is verified if and only if:

$$\bar{\varepsilon} v'(\bar{\varepsilon} g^* + Y_0) > \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \varepsilon v'(\varepsilon g^* + Y_0) f(\varepsilon) d\varepsilon > \underline{\varepsilon} v'(\underline{\varepsilon} g^* + Y_0)$$

This inequality is verified since the expected value of a random variable is comprised between

its extreme values. On the contrary, if $U''_{g\delta}$ is positive, $\frac{dg^*}{d\delta}$ will be positive.

An individual that lacks confidence in information will consume more green goods if the individual is sufficiently optimistic:

$$\alpha < \hat{\alpha}$$

□

1.C Proof of proposition 5

We want to determine when the individual level of green consumption at the Nash equilibrium is greater than the one at the social optimum, in any of the different settings: $\hat{g}_i > g_i^k$ with $k = u, p, A$, denoting the individual optimal level of green consumption in each setting (utilitarian, g_i^u ; paternalistic, g_i^p ; and authoritarian, g_i^A). In order to do this, first we need to compare equation 1.11 to equation 1.16, with $g_i = g_i^u$, for both equations; second, we compare equation 1.11 to equation 1.18, with $g_i = g_i^p$, for both equations; and finally, we compare equation 1.11 to equation 1.20, with $g_i = g_i^A$, for both equations.

In the following we compare equation 1.11 to equation 1.16, with $g_i = g_i^u$:

$$\begin{aligned} & (-P_g + 1)u'_i(m_i - g_i^u(P_g - 1)) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^u + Y_0) \right] f(\varepsilon) d\varepsilon \\ & + \delta_i \left[\alpha_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i^u + Y_0) + (1 - \alpha_i) \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^u + Y_0) \right] > (-P_g + 1)u'_i(m_i - g_i^u(P_g - 1)) \\ & + \sum_{i=1}^N (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^u + Y_0) \right] f(\varepsilon) d\varepsilon + \sum_{i=1}^N \delta_i \left[\alpha_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i^u + Y_0) + (1 - \alpha_i) \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^u + Y_0) \right] \end{aligned}$$

We can see that the right side of the inequality above corresponds to the first order condition of the utilitarian social planner's maximization program, therefore it is equal to 0. It is also the case for every comparison in each different setting. The left side of the inequality stays the same in any of the settings, however, the comparison is made at a different level of green consumption.

Therefore, in each comparison the individual level of green consumption g_i will change, such as we have g_i^k , with $k = u, p, A$. In order to simplify the different comparisons we obtain the following inequality which is valid for any of the three comparisons:

$$(-P_g + 1)u'_i(m_i - g_i^k(P_g - 1)) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^k + Y_0) \right] f(\varepsilon) d\varepsilon + \delta_i \left[\alpha_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i^k + Y_0) + (1 - \alpha_i) \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^k + Y_0) \right] > 0$$

Thanks to the equation above we obtain the following threshold $\bar{\alpha}$ by isolating the parameter α_i :

$$\bar{\alpha} \equiv \frac{(-P_g + 1)u'_i(m_i - g_i^k(P_g - 1)) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^k + Y_0) \right] f(\varepsilon) d\varepsilon + \delta_i \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^k + Y_0)}{\delta_i \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^k + Y_0) - \delta_i \underline{\varepsilon} v'_i(\underline{\varepsilon} \sum_{i=1}^N g_i^k + Y_0)} > \alpha_i$$

$$\bar{\alpha} > \alpha_i$$

If $\bar{\alpha} > \alpha_i$, then $\hat{g}_i > g_i^k$. The denominator of $\bar{\alpha}$ is strictly positive, since $\underline{\varepsilon}$ is negative and $\bar{\varepsilon}$ is positive. However, the sign of the numerator is ambiguous. If the sign of the numerator is negative, then $\bar{\alpha} < \alpha_i$ and $\hat{g}_i < g_i^k$. If the sign of the numerator is positive, the comparison between $\bar{\alpha}$ and α_i is not straightforward. However, if the numerator is greater than 1 (since $\alpha_i \in [0, 1]$), then $\bar{\alpha} > \alpha_i$ and $\hat{g}_i > g_i^k$.

We seek to determine a second threshold $\bar{\delta}$ that assures us that the numerator will be positive.

$$(-P_g + 1)u'_i(m_i - g_i^k(P_g - 1)) + (1 - \delta_i) \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^k + Y_0) \right] f(\varepsilon) d\varepsilon + \delta_i \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^k + Y_0) > 0$$

$$\Leftrightarrow \delta_i > \frac{(P_g - 1)u'_i(m_i - g_i^k(P_g - 1)) - \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^k + Y_0) \right] f(\varepsilon) d\varepsilon}{- \int_{\underline{\varepsilon}}^{\bar{\varepsilon}} \left[\varepsilon v'_i(\varepsilon \sum_{i=1}^N g_i^k + Y_0) \right] f(\varepsilon) d\varepsilon + \bar{\varepsilon} v'_i(\bar{\varepsilon} \sum_{i=1}^N g_i^k + Y_0)} \equiv \bar{\delta}$$

If $\delta_i > \bar{\delta}$, the numerator of the expression of $\bar{\alpha}$ will be positive, in this case, the comparison between \hat{g}_i and g_i^k is not straightforward. On the contrary, if $\delta_i < \bar{\delta}$, the numerator of the expression of $\bar{\alpha}$ will be negative, therefore, $\bar{\alpha} < \alpha_i$, in this case $\hat{g}_i < g_i^k$.

□

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LEVELS OF UNCERTAINTY AND CHARITABLE GIVING¹

Abstract

This experiment seeks to study the impact of uncertainty and attitudes towards uncertainty on charity donations. We use a modified dictator game, where the beneficiaries (environmental NGOs) received donations that were exposed to different levels of uncertainty. We study the level of donations and elicit risk aversion, ambiguity aversion, likelihood insensitivity, and pessimism. We aim to test if different levels of uncertainty at the receiver level (risk and ambiguity) impact donations. We do not find any differences between levels of uncertainty compared to no uncertainty. We find that a “high” level of ambiguity has a significant and negative effect on altruistic behavior compared to a risk or a “low” ambiguity environment. We also find that pessimism and ambiguity aversion’s effect depends on the ambiguity level. We find no effect of ambiguity aversion, likelihood insensitivity and pessimism under “low” ambiguity on altruistic behavior. Meanwhile, under “high” ambiguity, we find a negative effect of pessimism and ambiguity aversion on charitable giving. These results suggest that there is a threshold for which ambiguity and ambiguity attitudes have a negative impact on donations.

1. This is a joint project with Noémi Berlin. A version of this chapter has been published in *EconomiX Working Papers*, 2023-8

2.1 Introduction

For the last few years, charitable giving has increased in most countries. For instance, world-wide in 2009, 44% of adults reported donating to charity, the share increased to 62% in 2021.² The importance of charities lies in their provision of public goods from private entities. A large literature has focused on determinants of charitable giving (see the review by [Bekkers and Wiepking, 2011](#)), but little attention has been devoted to the role of risk and ambiguity. It is somehow surprising because, in some cases, individuals are uncertain as to whether their contributions will produce the intended effect or to what degree. This is particularly true for environmental NGOs. In general, individuals are not always certain how their donations are used. While certain actions undertaken by NGOs and their outcomes are straightforwardly observable, such as cleaning a forest, other activities may be more ambiguous and difficult to measure. For instance, the impact of actions aiming to increase environmental quality or to decrease pollution is distant in time and difficult to quantify; they are also difficult to observe. Assessing whether the improvement of environmental quality is attributable to the actions undertaken by a specific NGO or not is not straightforward.

Furthermore, the presence of uncertainty leads to the misperception about the impact of donations and not being able to estimate its impact correctly through the over or underestimation of it, which could lead to non-efficient levels of donations. In the case of NGOs, uncertainty can have different sources; NGOs possess different levels of cost-effectiveness, and individuals generally do not know the level of cost-effectiveness of NGOs because of a lack of transparency. Some NGOs have high operating costs or collection fees. Charities are not equally cost-effective, and individuals are not always able to know about the impact of their donations.

Another source of uncertainty can come from a risk of misappropriation of donations; for example, in 2019, the Red Cross revealed that 5 million euros that were supposed to fight against the Ebola virus in West Africa were embezzled between 2014 and 2016. Depending on the NGO, these risks are more or less important.

2. World Giving Index 2022, Charities Aid Foundation. <https://good2give.ngo/wp-content/uploads/2022/09/2022-CAF-World-Giving-Index.pdf> - Link available on April 18, 2023.

Hence, individuals may have biased beliefs about the consequences of their donations and that their benefits and positive impact will effectively occur, affecting their perception of uncertainty. An individual might underestimate the impact of her donations, believing, for instance, that donations will not have the expected impact (for instance, thinking that all of her donations will be embezzled). Individuals may fail to assess the impact of their donations correctly. For example, not fully considering the multiplier effect that can arise from pooling contributions. The combination of individual donations can generate a larger pool of funds, magnifying each contribution's impact. By pooling resources, NGOs can undertake projects that may have been unfeasible otherwise and can carry out outcomes that go beyond what individual contributions could achieve on their own. Another example arises when an organization opts to allocate resources toward fundraising activities, it can be regarded as a form of capital investment that can generate future donations. Consequently, there exists a possibility of a multiplier effect resulting from the current expenditure on fundraising efforts.³ Individuals can also fail to assess the impact of their donations when a specific amount of money is targeted to enable the completion of a particular project, and a funding threshold is necessary to reach the desired outcome. Individuals may not be aware that it is necessary to reach a threshold in order for the donations to have an effect. Moreover, individuals do not equally behave in terms of donations, whether they are the beneficiaries of donations or only the giver, especially when risks are at stake.

The presence of uncertainty may or may not be probabilized. It is common not to know the exact amount of a donation that will be used for the intended cause. Therefore, studying different levels of risk and ambiguity is relevant. We can distinguish two levels of uncertainty: probabilized uncertainty (risk), individuals know about the probability distribution of the possible events. And non-probabilized uncertainty (ambiguity), where the available information is too imprecise to associate a probability to each event: the individuals do not know the probability distribution of the possible events. Studies have focused on the impact of risk on donations ([Haisley and Weber, 2010](#), [Krawczyk and Le Lec, 2010](#), [Brock et al., 2013](#), [Exley, 2016](#), [Freundt and Lange,](#)

3. Tinkelman, D., & Donabedian, B. (2009). Decomposing the elements of nonprofit organizational performance. *Research in Governmental and Nonprofit Accounting*, 12(1), 75-98.

2017, Cettolin et al., 2017) and found that altruistic behaviors are reduced under risk. Other studies focus on studying ambiguity and donations (Haisley and Weber, 2010, Cettolin et al., 2017, Garcia et al., 2020); however, found contradictory results, leading to a lack of consensus on the effect of ambiguity in donations.

In this perspective, in this paper, we study the impact of different levels of uncertainty (risk and ambiguity) and attitudes towards risk and ambiguity on donations to charity and attempt to clarify this lack of consensus. We also seek to study the impact of risk and ambiguity attitudes. Some papers have studied the role of risk aversion on altruistic behavior (Freundt and Lange, 2017, Cettolin et al., 2017, Fahle and Sautua, 2021), finding mixed effects on altruistic behaviors. Two cognitive components characterize ambiguity attitudes. Ambiguity aversion can be defined as how much a person dislikes ambiguity, and (ambiguity generated) likelihood insensitivity is defined as the insensitivity to changes in likelihood that is, how much individuals perceive ambiguity in a given decision situation (Li et al., 2019). Finally, besides ambiguity attitudes, we also study the impact of pessimistic beliefs, which is the over-weighting of the probability of realization of the worst possible event. To our knowledge, only Cettolin et al. (2017) studied the impact of ambiguity aversion on donations, however, to our knowledge, there are no other papers that have studied the impact of likelihood insensitivity or pessimism on donations.

In this paper, we aim to answer the following questions: How does introducing different levels of uncertainty impact donations? What is the impact of ambiguity attitudes on charitable giving? To that aim, we conduct a laboratory experiment where participants can donate to a charity when the amount received by the charity is unknown. We introduce different levels of uncertainty to each treatment: risk, lower ambiguity, and higher ambiguity. We also introduce a theoretical model of donations under risk and under ambiguity, assuming that donations are impure public goods since they give private utility (warm glow) and public utility (contributing to a public good).

We find that introducing risk and ambiguity does not impact mean donations. However, we find that a “high” level of ambiguity decreases mean donations compared to a lower level of ambiguity and risk. We also find that ambiguity aversion and pessimism only play a role in

donations when in the presence of a “high” level of ambiguity. However, we do not find any effect of ambiguity attitudes in lower levels of ambiguity.

The paper is organized as follows: section 2.2 summarizes the related literature, section 2.3 presents the experimental design, section 2.4 details the model and the hypotheses of the experiment, and section 2.5 presents the results. Finally, section 2.6 discusses the results and concludes.

2.2 Related literature

The dictator game is widely used in experimental economics allowing to study the different determinants of altruism, and finding consistent effects: for example, the older the recipient, the more she gives, or if the dictator is identified, she also gives more. [Engel \(2011\)](#) presents a meta-analysis of experiments using dictator games, the author studies 131 papers. Furthermore, [Cochard et al. \(2021\)](#) provides meta-analyses on the ultimatum and the dictator game focusing on fairness between individuals. However, they do not include studies in which dictators are asked to give their money to a charity association, as opposed to this experiment. It is important to note that, as shown by [Engel \(2011\)](#), when the recipients are needy (charities, for example), the proportion of participants that do not give decreases significantly.

This paper is related to studies on giving in the presence of uncertainty. We split the literature into two levels of uncertainty: risk and ambiguity.

2.2.1 Risk

[Krawczyk and Le Lec \(2010\)](#), [Brock et al. \(2013\)](#) and [Freundt and Lange \(2017\)](#) elicit altruistic behavior with a dictator game and show that altruistic behavior is reduced under risk. Furthermore, the literature focuses on proving and isolating one of the reasons there is a decrease in charitable giving under risk: the presence of a moral wiggle room, where individuals use risk to justify unfair behavior. In the context of donations, [Cettolin et al. \(2017\)](#), and [Exley \(2016\)](#) find that the negative impact of riskiness comes from “the adoption of a favorable view of ambiguous

risk” leading to a justification for unfair behavior (Haisley and Weber, 2010). Finally, in Beaud et al. (2023), risk is also on the recipients’ side, they do not find any statistically significant impact of the recipient’s risk exposure on dictators’ giving decisions. Engel and Goerg (2018) find that dictators tend to spend more if recipients’ endowments are risky because dictators are concerned about participants leaving the lab with no payoff.

Few studies have focused on risk attitudes regarding charitable giving. Furthermore, the literature is inconclusive about the effect of risk preferences on donations: Freundt and Lange (2017) find no effect of risk aversion on donations, Cettolin et al. (2017) showed that risk aversion decreases donations when risk is on the giver’s side. However, they find that risk aversion positively affects donations when risk is on the recipient’s side. Fable and Sautua (2021) found this positive effect exists for large-scale risk, and they also study the impact of loss aversion on donations. In this paper, we focus on the impact of risk aversion when risk is on the recipient’s side, bringing more evidence to the literature. We are also going to study the impact of risk aversion under ambiguity.

2.2.2 Ambiguity

Few papers have been studying ambiguity and charitable giving. There is no consensus in the literature about the impact of ambiguity. Haisley and Weber (2010) find a decrease in donations when introducing ambiguity, compared to risk. Cettolin et al. (2017) reveal mixed results; for some conditions, they find that individuals adopt a similar behavior regarding donations under risk and ambiguity, and for other conditions, they find a negative effect of ambiguity compared to risk. Garcia et al. (2020) do not find any behavioral differences between donations under partial and full ambiguity, and they find that individuals do not use an increase of ambiguity to donate less. They also find that excuse-driven behavior is comparable under ambiguity and risk. However, they do find that introducing ambiguity decreases altruistic behaviors.

The lack of consensus might be due to the mixed effect of ambiguity in donations. Ambiguity-driven excuse behavior partially explains the decline in contributions when uncertainty is introduced. However, as seen in the literature, the impact of excuse-driven behavior is the same for

any level of uncertainty. Hence, other factors may also explain this decrease. This paper aims to study what these other variables are and from what level of uncertainty they start/stop to matter in charitable giving and why.

As for ambiguity attitudes, only [Cettolin et al. \(2017\)](#) have studied the effect of ambiguity aversion on donations by using matching probabilities. We are unaware of other papers that study attitudes towards ambiguity, such as likelihood insensitivity, or beliefs, such as pessimism and charitable giving. Our experiment aims to enrich this literature by studying the effect of likelihood insensitivity and pessimism.

2.3 Experimental design

The experiment consists of different tasks: the main task, a dictator game to measure altruistic behavior, and different elicitation tasks of risk and ambiguity attitudes, which differ according to the different treatments. We will hereafter describe the main task (subsection 2.3.1), the different treatments (subsection 2.3.2), and how we elicit risk and ambiguity attitudes (subsection 2.3.3).

2.3.1 The main task: a modified dictator game

The main task of the experiment consists of a modified dictator game, where the senders are the experimental subjects, and environmental NGOs represent the receivers. At the beginning of the experiment, participants are told they will have to decide whether or not they would like to donate to an NGO. They are then asked to choose between three environmental-related NGOs: i) WWF (World Wide Fund for Nature), ii) Greenpeace, and iii) Zero Waste France. Participants are also provided with a description of each NGO.⁴

After choosing the NGO, each participant is endowed with 100 ECUs (Experimental Currency Units). Participants are then asked whether they want to donate to the chosen NGO.

4. WWF focuses on wildness preservation and the reduction of human impact on the environment; Greenpeace seeks to ensure the ability of the earth to nurture life in all its diversity, and Zero Waste France promotes the zero waste approach in Paris and Ile-de-France

They can choose an amount x between 0 and 100 ECUs. The participants keep the amount they decide not to donate, which is $100 - x$ ECUs. Note that each participant can decide not to donate ($x = 0$);

2.3.2 The treatments

The experiment includes one control group and three treatment groups, which modulate the level of risk and ambiguity applied to the donations. We used a between-subject design where the participants were randomly assigned to one of the four groups. In the following subsections, we present the *Control* group, the *Risk* Treatment (RT), the *Low Ambiguity* Treatment (LAMBt), and the *High Ambiguity* Treatment (HAMBt).⁵

Control group

In the Control group, there is no uncertainty. It is based on a dictator game where the amount donated to the NGO is multiplied by 1.2. For example, if the participant donates 10 ECUs, the NGO receives 12 ECUs. Only in the control group, as opposed to the treatments, the NGO always receives 1.2 times the donation. The number 1.2 represents the lottery winning expectation in the risk treatment (see subsection 2.3.2), which ensures equivalence between the control group and the treatment.

In the following subsections, we describe the three treatment groups. In the risk and ambiguity treatments, we introduce known or unknown probabilities. The amount received by the NGO differs from the amount in the control group since we introduce three different possible events each determining the amount received by the NGOs. A draw determines the realization of one of the events. The participants always face an urn with three types of colored marbles (purple, blue, and orange). The three possible events are: i) A purple marble is drawn: the NGO does not receive anything from the participant (i.e., the donation is destroyed), ii) A blue marble is drawn: the NGO receives the exact amount given by the participant, iii) An orange marble is drawn: the NGO receives twice (x2) as much as the amount given by the participant.

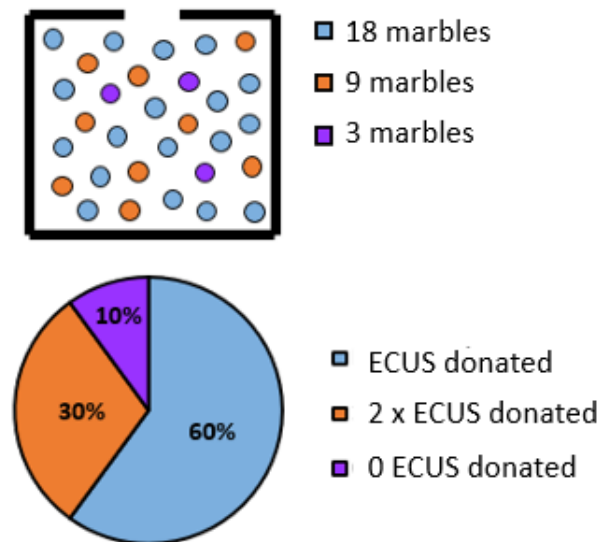
5. Instructions for the HAMBt can be found in the supplementary material

In the Risk Treatment, participants know the exact number of each colored marble in the urn. In ambiguity treatments, participants do not know about the whole distribution of the marbles.

Treatment 1: Risk Treatment (RT)

The Risk Treatment introduces risk in the donations received by the NGO: participants are told that with a 10% probability, the NGO will not receive the donation (purple marble); with a 60% probability, the NGO will receive the exact amount given by the participant (blue marble); and with a probability of 30%, the NGO will receive twice (x2) the amount given by the participant (orange marble). In this treatment, participants face an urn composed of 18 blue marbles, nine orange marbles, and three purple marbles. Figure 2.1 shows what the participant sees on their screen as instructions for the task before the decision to donate or not was made.

Figure 2.1 – Lottery under the risk treatment



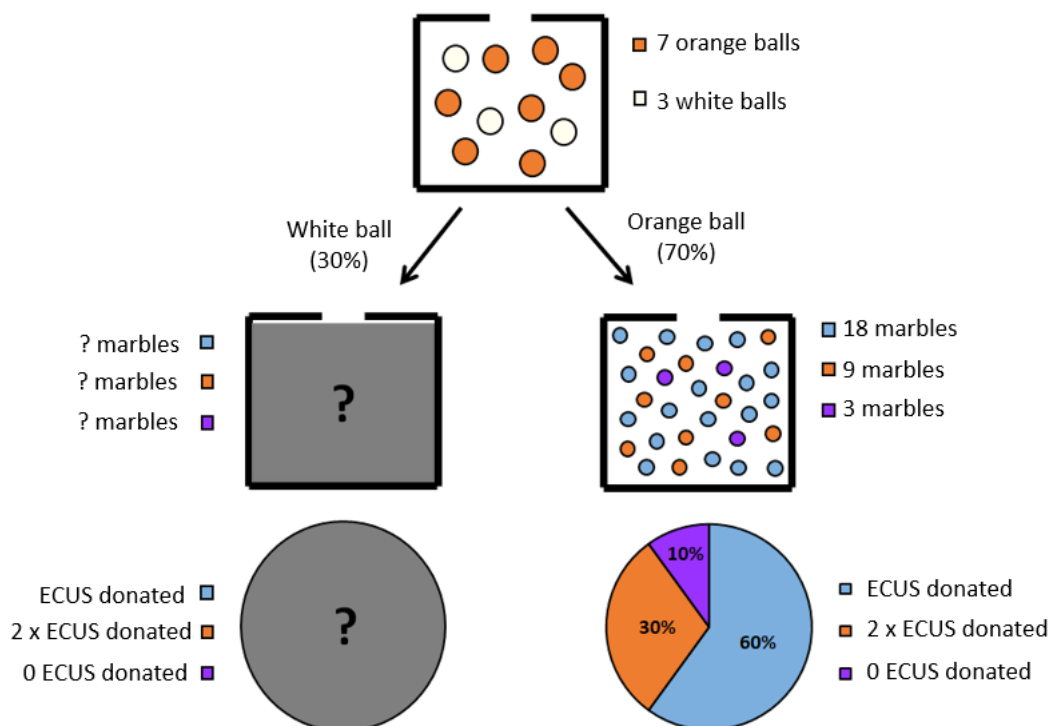
At the end of each RT session, a volunteer participant draws a marble in an opaque urn without looking. The drawn marble determines the event for each participant: if the purple

marble is drawn, the NGO will not receive anything at all; if the blue marble is drawn, the NGO receives exactly the amount donated by each participant of the session; and finally, if the orange marble is drawn, the NGO receives twice the amount donated by each participant.

Treatment 2: Low Ambiguity Treatment (LAmBT)

The Low Ambiguity Treatment introduces ambiguity in the donations received by the NGO. As opposed to the RT, participants do not know about the whole distribution of probabilities associated with each possible event. Participants are told that with a 70% probability, they know about the probability distribution to realize each possible event. The distribution is the same as in the RT. And they are told that with a 30% probability, they do not know about the distribution of probabilities associated with the realization of each possible event. In this case, participants are under complete uncertainty. Figure 2.2 shows the lottery participants face under LAmBT.

Figure 2.2 – Lottery under low ambiguity treatment



At the end of each LAMB T session, and to implement ambiguity, participants face two urns. The first urn comprises ten balls: seven orange balls and three white balls. A volunteer participant randomly draws a ball.

- If an orange ball is drawn, the experimenter composes an urn with known probabilities, as in the RT. And a second participant would draw a ball in this second opaque urn that would determine the event for the NGO.
- If a white ball is drawn, an urn with unknown probabilities is composed. First, the experimenter mixes an opaque urn with 30 blue marbles, 30 orange marbles, and 30 purple marbles. In this case, a second volunteer participant randomly draws, without looking, 30 marbles from the urn composed of 90 marbles to create the urn with unknown probabilities. Finally, a third volunteer participant randomly draws a marble from the urn, the color of which determines the NGO's payoff, with unknown probabilities.

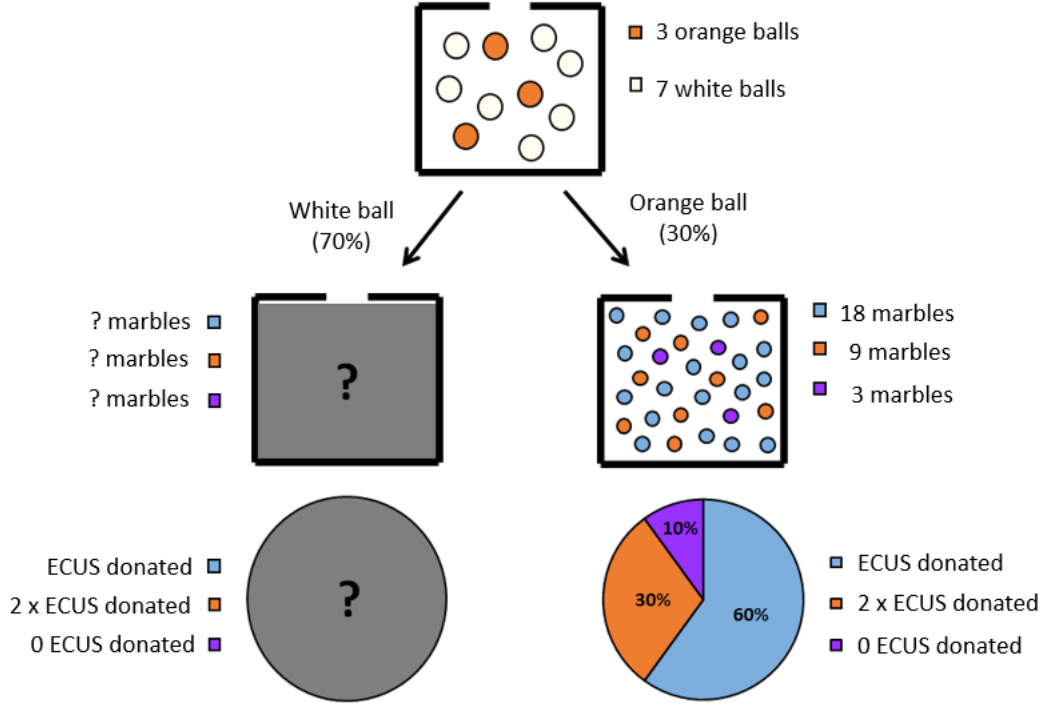
Treatment 3: High ambiguity treatment (HAMB T)

The third treatment is the High Ambiguity Treatment. We call this treatment “high” ambiguity in opposition to the LAMB T. However, participants in this treatment do not face full ambiguity, they still face partial ambiguity as in the LAMB T. Subjects know the exact distribution of the probabilities of each event with a 30% probability. And with a 70% probability, participants are in complete uncertainty.

Figure 2.3 shows the lottery faced by the participants in the HAMB T.

The proposed model suggests that individuals behave under uncertainty by relying on a probability distribution as a basis for their decision-making. In the experiment, we introduce different treatments to investigate the impact of uncertainty on individuals' choices. If participants behave consistently with this model, it suggests that, under ambiguity, they will use the known

Figure 2.3 – Lottery under high ambiguity treatment



probability distribution as a reference point. They will then assign probabilistic beliefs to each possible event accordingly. By employing the neo-additive capacities model, we can conclude that the treatments are equivalent and differ only in the level of uncertainty.

2.3.3 Elicitation of risk and ambiguity attitudes

As in the LAMBt, at the end of each HAMBt session, and to implement ambiguity, the same drawing procedure occurs except that the first urn comprises seven white balls and three orange balls. Hence, if an orange ball is randomly drawn, the urn with unknown probabilities is composed; if a white ball is randomly drawn, then the urn with known probability is composed.

We elicit levels of risk aversion and ambiguity aversion, likelihood insensitivity, and pessimism to study their effect on charitable giving. First, we elicit risk aversion and unframed ambiguity attitudes, the tasks appear randomly before the donations task. Then, we elicit framed ambiguity attitudes and excuse-driven behavior, the tasks appear randomly after the main task.

Elicitation of risk aversion

We elicit risk aversion in all treatment and control groups using the [Holt and Laury \(2002\)](#) method. Participants face ten pairs of lotteries (see Figure B1). They are asked to choose the lottery they prefer between lottery A, and lottery B. Lottery A represents a safer lottery choice (winning 20 ECUs vs. winning 16 ECUs). Meanwhile, lottery B is riskier (winning 38.5 ECUs vs. 10 ECUs). The probability of winning the favorable payoff increases for each pair of lottery (therefore, the probability of winning the unfavorable payoff also changes). The later the participant switches from lottery A to lottery B, the more the participant is risk averse, and its coefficient of relative risk aversion would increase. Participants could only switch once from lottery A to lottery B.

Elicitation of ambiguity attitudes

Using [Baillon et al. \(2018\)](#) method,⁶ we elicit ambiguity aversion and likelihood insensitivity. We elicit matching probabilities for each single and composite events such that a matching probability of an event is defined as the probability m when the individual is indifferent between receiving an amount X if the event occurs or receiving X with probability m .

In the control and RT groups, we elicit likelihood insensitivity and ambiguity aversion only once within an unframed setup (not contextualized). They are elicited twice in LAmbT and HAmbT groups: once within an unframed setup, as in the two other groups, and once within a framed one (contextualized). We elicit framed, unframed ambiguity attitudes since [Baillon et al. \(2018, 2021\)](#) claim that ambiguity attitudes are context dependent.

Unframed elicitation of ambiguity attitudes

We first determine the event of the donation. To do so, we randomly choose the urn using the probabilities associated with each treatment. We then create a second urn. This urn is also constituted of 30 colored marbles; blue, orange, and purple. However, participants do not know

6. Note that we use this method since it allows us to represent easily the parameters in our theoretical model.

the number of marbles for each color (unknown probabilities). To elicit ambiguity attitudes, we use the method of [Baillon et al. \(2018\)](#). First, we elicit six matching probabilities: one for every single event and one for every composite event. There are three events: randomly drawing a blue, orange, or purple marble. And three composite events: to randomly draw a blue or an orange marble, to randomly draw a blue or a purple marble, and to randomly draw an orange or a purple marble.

Subjects face six tables that appear randomly, each composed of 20 decisions. They have to choose the option they prefer between option A and option B. Option A is the same for every table: The participant can win 30 ECUs if the blue/orange/purple (depending on the presented table) are randomly drawn. If the subject chooses option B, she can win 30 ECUs with a probability of p (or win 0 ECUs with a probability of $1-p$). Figure B2 is a screenshot of one of the six tables for the composite event “to randomly draw an orange or purple marble”.

To elicit the matching probability of a specific event, we calculate the sum of the probabilities associated with the decision before and after the switching point (between option A and option B) and divide it by two to obtain a more precise estimation of the matching probability.

Participants face full ambiguity, as they have no information about the distribution of marbles by color in the urn. Consequently, (unframed) ambiguity attitudes are always elicited before the donation task (main task) before the participants are aware of the distribution of probabilities associated with donations. This ensures that individuals’ beliefs about the probability distribution remain uncontaminated.

Framed elicitation of ambiguity attitudes

We again use the method of [Baillon et al. \(2018\)](#) to elicit framed ambiguity attitudes. We replicate a second time the same task for subjects in the LAmbT and HAmbT after the donation task. In this task, we elicit ambiguity attitudes for the exact level of ambiguity that participants face in the main task. Since control and RT participants do not face ambiguity in the donation task, we could not elicit their framed ambiguity attitudes. In the framed setup, individuals do not face any more full ambiguity when choosing between options A and B, they face partial

ambiguity and the exact probability distribution as the one presented in the main task.

In order to elicit framed ambiguity attitudes, subjects faced six tables appearing in random order, one for each matching probability (three for single events and three for composite events). They have to choose the option they prefer between option A and option B. The three single events in this context are: the NGO receives 0 ECUs; the NGO receives the ECUs donated; the NGO receives double the amount donated. The three composite events are: the NGO receives either 0 ECUs or the amount donated; the NGO receives either 0 ECUs or double the amount donated; the NGO receives either the amount donated or double the amount. Depending on the treatment, each event possesses the exact probabilities as in the main task.

These matching probabilities allow us to elicit an ambiguity aversion index, a likelihood insensitivity index, and, thanks to the first two indexes, a pessimism index. The matching probability of an event will depend on the subjective belief of the decision maker in the event and on her ambiguity attitude. Figure B3 is a screenshot of one of the six task tables for eliciting the matching probability of the composite event “the NGO will receive 0 ECUs or the NGO will receive the amount donated”.

The ambiguity aversion index (b) is calculated from the following equation:

$$b = 1 - \bar{m}_c - \bar{m}_s$$

The insensitivity index (a) is:

$$a = 3 \times \left(\frac{1}{3} - (\bar{m}_c - \bar{m}_s) \right)$$

Where \bar{m}_c corresponds to the average composite-event matching probability of the composite events’ matching probabilities, and \bar{m}_s corresponds to the average single-event matching probability.

Under ambiguity neutrality $\bar{m}_s = \frac{1}{3}$ and $\bar{m}_c = \frac{2}{3}$, hence $a = 0$ and $b = 0$. The indexes are normalized so that the maximal value is 1. An ambiguity-averse individual will have a positive ambiguity aversion index; for an extreme ambiguity-averse individual, her ambiguity aversion

index will be equal to 1. Ambiguity lovers will have a negative aversion index. The likelihood insensitivity index is defined as the lack of discriminatory power of the decision maker regarding different levels of likelihood (Li et al., 2019) or perception of the level of ambiguity. The smaller the insensitivity index is if the subject discriminates between composite and single events. This index is usually positive. However, there are some subjects with $a < 0$ (sensitive individuals), which is desirable to include in our analysis (as explained in Baillon et al., 2018).

Thanks to the indexes above, we are able to obtain a pessimism index (α), following Baillon et al. (2021):

$$\alpha = \frac{b}{2a} + \frac{1}{2}$$

This index represents the individual’s belief about the probability of the event “the NGO will receive 0 ECUs”. A pessimistic individual will assign a high probability to the realization of this event; in this case, her pessimism parameter will be close to 1. On the contrary, if the individual is optimistic, she will assign a low probability to the worst possible event, “the NGO will receive 0 ECUs”; her parameter will be close to 0.

2.3.4 Eliciting excuse-driven behavior and additional questions

Introducing risk or ambiguity to donations creates situations that decrease the guilt of not being altruistic. This may lead to a “moral wiggle room” for individuals to behave less altruistically. It has been proven that introducing risk or ambiguity reduces donations because of this moral wiggle room, as shown in Exley (2016) and in Garcia et al. (2020). Proving that the individual is less altruistic when confronted with uncertainty. In this experiment, we use a modified method of elicitation to control for this effect (Garcia et al., 2020). We include two price lists to take into account any excuse-driven behavior.

In one table (charity table), participants face 20 decisions, and they have to choose the option they prefer between option A and option B. Option A is the same across the 20 decisions: a lottery for the NGO; this lottery gives the NGO an additional payoff of either 0, 30 ECUs, or 60 ECUs. Option B: a safe payoff for the NGO.

In the other table (self table), participants also face 20 decisions and also have to choose the option they prefer between option A and option B. Option A stays the same as in the charity table. However, option B is a safe payoff for the subject. In both tables, subjects can not switch back and forth and can not switch from option B to option A. The tables appear randomly. In the two tables, the safe payoff goes from 0 ECUs to 60 ECUs.

Since this behavior only appears when there is uncertainty, we did not include this task in the control group. This task was different for every treatment (RT, LAmbT, and HAmbT), the lottery for each treatment in this task possess the exact probabilities as in the main task for each treatment to measure a possible excuse-driven behavior in the same setup when the subjects make their giving decisions. However, the events are not the same. Figure B4 is a screenshot of the self table under HAmbT.

Charity-valuation corresponds to the safe payoff of the switching point from option A to option B in the charity table. Self-valuation corresponds to the safe payoff of the switching point from option A to option B in the self table. For an individual with excuse-driven preferences, the charity valuation is above the self-valuation ([Garcia et al., 2020](#)). Therefore, we only calculate the difference between charity-valuation and self-valuation to have a simplified measure of excuse-driven behavior.

Finally, participants must answer a survey including socio-demographic questions: age, sex, income, and level of education. They also have to answer a questionnaire that measures environmental attitudes, the NEP scale (New Environmental Paradigm scale) ([Dunlap et al., 2000](#)) to control any pro-environmental behavior since charities are environmental NGOs. We also control for previous donation behaviors: such as if the participant has previously donated, the amount they usually donate, and the frequency.

2.3.5 Experimental procedures

The experiment was conducted at the “Laboratoire d’Economie Expérimentale de la Défense” (Courbevoie, France). The experimental laboratory is located in the Paris business district (La Défense), not within the university. Its location means that participants have heterogeneous

characteristics and are not just students but also individuals working in the business district or living in the surrounding area. We obtained the approval of the ethics committee of the University of Paris Nanterre (CER-PN). It was preregistered in *aspredicted.org*. 218 individuals took part in the experiment and were randomly assigned to one of the four treatment groups: 53 participants were assigned to the control group, 53 were assigned to RT, 54 were assigned to LAmBT, and 58 to HAmBT. Sessions took place in April, June, and November 2022. 81 subjects were male (39.90%), and three participants did not inform about their gender (1.49%). Their average age was 37.75 years old, and 35.32% were students. The experiment was developed using z-Tree ([Fischbacher, 2007](#)).

The analysis is run on a total of 217 subjects since 1 participant made non-consistent decisions in the framed elicitation task of ambiguity attitudes, s/he had an insensitivity index equal to -2 since the index is normalized to 1.

The instructions were on the computer's screen, subjects also had paper instructions. Instructions were explained orally, and each part of the experiment was explained before its beginning. The experimenter explained each task using a visual presentation. Subjects could ask questions at any time during the explanation and the session. The participants knew that one volunteer participant was going to randomly draw the marble, and the urns were created in front of the participants.

The session lasted, on average, one hour and fifteen minutes. The average payoff was € 14.66 (including a show-up fee of € 7), and the average donations were € 2.83. All participants received their payoff privately in cash at the end of the experiment. Participants know that the NGOs will effectively receive their given amount a few days after the experimental session. Participants were asked to fill out a survey in order to receive a tax receipt for their donation. Each individual received proof of their donation and a tax receipt directly issued by the NGO in order to be sure that the participants trusted the experimenter that the donation was going to be made. The donations were sent by the experimenter. As found by [Di Falco et al. \(2016\)](#), introducing one intermediary between the giver and the receiver does not decrease the level of donations.

Individuals' payoff depended on the main task and on one of the elicitation tasks. The

participants received at the beginning of the experiment 100 ECU (100 ECUs = € 7.5), and they kept the money that they didn't decide to donate. Therefore, participants had 7.5 euros to donate to the chosen charity. This amount is lower than the usual in the literature (which is generally 10 euros), however, it is close to the endowment in [Cettolin et al. \(2017\)](#) (8 euros). Furthermore, the fact that the initial endowment was 100 ECUs (and not in euros) may have ruled out the effect of a small endowment. As explained above, besides the payoff of the main task, one of the decisions of the experiment in one of the elicitation tasks was randomly chosen to determine the additional payoff. The individual's payoff of the main task (kept amount) was certain, however, the amount received by the NGO was uncertain for risk and ambiguity treatments. The drawing of a marble would determine the amount received by the NGO. The participants received an additional payoff based on one decision of one of the supplementary tasks. The additional payoff was incentivized using the prior incentive system PRINCE ([Johnson et al., 2021](#)). This method is commonly used in [Baillon et al. \(2018\)](#) method to elicit ambiguity attitudes. It is implemented in order to avoid any strategic behavior from individuals conceiving the set of decisions as a meta-lottery and not considering each decision independently; that might happen in matching. The experiment contains a certain number of decisions y in total (by adding all decisions from all elicitation tables). 140 for the control group, 170 for the RT group, and 290 for the LAmbT and HambT groups. At the beginning of the experiment, each participant had to pick and enter a number between 1 and the corresponding y . This chosen number was previously randomly paired with one of the decisions of the experiment. The decision randomly associated with the chosen number was implemented to determine the additional payoff. At the end of the experiment, we gave the participants an envelope with a table inside where they could verify that the decision implemented corresponded to the number they chose at the beginning of the experiment. Even if there might be a dilution effect because one of the decisions among y was going to be implemented, it was necessary in order to implement PRINCE.

It is important to note that our incentive mechanism differs from the “pay all correlated” mechanism as labeled by [Cox et al. \(2015\)](#), which consists of paying all decisions at the end of the experiment with one realization of the state of the world determining all payoffs. This means that

there is a full payoff for all chosen lotteries according to one random draw, and this mechanism has low incentive compatibility with expected utility models. Our incentive mechanism differs since, on the one hand, we do not pay all lotteries. On the other hand, the realization of one state of the world does not imply the full payment of all lotteries. Under the certainty treatment, we constitute one ambiguous urn in order to pay the unframed ambiguity attitudes elicitation task, which is not correlated to the main task since the amount donated is certain. Under the risk and ambiguity treatments, we constitute two different urns, with two different draws (one for each urn): one for the main task and one for determining the payoff of the supplementary task. Moreover, the realization of the “good” state of the world in the main task (the NGO receives double the amount donated) does not imply the realization of the best possible event in the supplementary tasks.

Following our theoretical predictions, we do not expect any difference between the control group and the treatments. However, we do expect a difference between risk treatment and ambiguity treatments. Considering the literature, the mean donations in a dictator game is 28% of the endowment [Engel \(2011\)](#). Following the results from [Engel and Goerg \(2018\)](#), we expect an increase/decrease of 45% between the risk treatment and the high ambiguity treatment. Their left symmetry treatment is the closest to our risk treatment, and their ignorance treatment is close to our high ambiguity treatment. Between their treatments, there is a difference of around 45%. Assuming a mean donation of 28 in the risk treatment with a standard deviation of 25. If we are being conservative, we expect a difference between our risk treatment and low ambiguity treatment of 20%. We expect that the difference between the low and high ambiguity treatment can be either 20% or 40%, depending on the sign of the effect between the risk and the low ambiguity treatment, which can be either positive or negative (depending on the degree of pessimism of the participants). In order to ensure that we capture an effect of 40%, the power analysis gives $n=63$ in each treatment for a power of 0.8 and alpha of 0.1, and $n=80$ for a significance level of 95%. In order to capture an effect of 20% with a significance level of 90%, the power analysis gives $n=183$.

2.4 The model

In this section, we present a theoretical model of donations under different levels of uncertainty. Thanks to this model, we propose the experiment's hypothesis. Note that all the formulated hypotheses follow our experimental framework.

2.4.1 Donations without uncertainty

Following the literature on charitable giving, [Andreoni \(1989\)](#) proposes an explanation of why individuals donate to charities since it goes against the economic theory. The reason is impure altruism or warm glow, as written by [Andreoni \(1989\)](#) “people get some private goods benefits from their gift per se, like a warm glow”, the author shows that individuals may enjoy making gifts. We propose here another representation of impure altruism thanks to an impure public goods model, where donations to charity yield public utility through the contribution of public goods and private utility thanks to the warm glow of giving.

We use an impure public goods model following [Kotchen \(2005\)](#), where givers derive utility from the characteristics of the goods rather than from the goods themselves. They derive utility from two characteristics, X and Y . The characteristic X gives private utility to the consumer, it represents the utility given by the consumption of a private good x with a price P_x , and the warm glow from giving. Y represents a public good. The provision of the public good comes from the exogenous donations (Y_0) of other individuals to NGOs, finally, we assume that the impact of the donation is multiplied by ε_0 since there is a multiplier effect of the pooling of contributions. In the model, the preferences of givers are represented by a utility function $U(X, Y)$, assuming that the utility function is additively separable: $u(X) + v(Y)$ with both functions being increasing and concave. The giver has an income m , which she spends on private consumption and donations.

Givers solve the following maximization problem:

$$\begin{aligned}
 \max_{X,Y} U(X,Y) &= u(X) + v(Y) \\
 \text{s.t. } m &= P_x x + d \\
 X &= x + d \\
 Y &= \varepsilon_0 d + Y_0 \\
 x &\geq 0, d \geq 0
 \end{aligned} \tag{2.1}$$

We rewrite the program as a function of donations by substituting the characteristics by their expression and the budget constraint into the giver's utility function.

$$\max_{d \geq 0} U(d) = u\left(\frac{m-d}{P_x}\right) + v(\varepsilon_0 d + Y_0) \tag{2.2}$$

The condition for an interior solution $d \in]0; m[$ is $U'_d(d) = 0$:⁷

$$U'_d(d) = \frac{-1}{P_x} u'\left(\frac{m-d}{P_x}\right) + \varepsilon_0 v'(\varepsilon_0 d + Y_0) = 0 \tag{2.3}$$

We assume the concavity of the utility functions u and v , therefore, the second-order condition is satisfied:

$$U''_{dd} = \frac{1}{P_x^2} u''\left(\frac{m-d}{P_x}\right) + \varepsilon_0^2 v''(\varepsilon_0 d + Y_0) < 0 \tag{2.4}$$

2.4.2 Donations under risk

From now on, we assume that the NGO does not receive for certain the given donations because of risks of embezzlement, mismanagement, or thanks to the multiplier effect of pooling donations. Therefore the individual takes her giving decision under risk. Under risk, there are three possible events: $\underline{\varepsilon}$ which is the worst possible event, ε which is the “middle” event, and $\bar{\varepsilon}$

7. From now on we will note $\frac{\partial f(x,y)}{\partial x} = f'_x(x,y)$ and $\frac{\partial f(x,y)}{\partial x \partial y} = f''_{xy}$.

which is the best possible event. Each event is associated to a known probability: \underline{p} , p and \bar{p} , respectively. We introduce risk into the previous model under certainty given in equation (2.2). We assume that the giver's preferences are represented by the expected utility model and that risk only lies in the amount received by the NGO. The different events do not impact the giver's private utility.

$$\max_d U(d) = u\left(\frac{m-d}{P_x}\right) + \underline{p}v(\underline{\varepsilon}d + Y_0) + pv(\varepsilon d + Y_0) + \bar{p}v(\bar{\varepsilon}d + Y_0) \quad (2.5)$$

The condition for an interior solution $d \in]0; m[$ is $U'_d(d) = 0$:

$$U'_d(d) = \frac{-1}{P_x} u'\left(\frac{m-d}{P_x}\right) + \underline{p}\underline{\varepsilon}v'(\underline{\varepsilon}d + Y_0) + p\varepsilon v'(\varepsilon d + Y_0) + \bar{p}\bar{\varepsilon}v'(\bar{\varepsilon}d + Y_0) = 0 \quad (2.6)$$

The second-order condition is satisfied due to the assumption of concavity of the function $U(d)$:

$$U''_{dd} = \frac{1}{P_x^2} u''\left(\frac{m-d}{P_x}\right) + \underline{p}\underline{\varepsilon}^2 v''(\underline{\varepsilon}d + Y_0) + p\varepsilon^2 v''(\varepsilon d + Y_0) + \bar{p}\bar{\varepsilon}^2 v''(\bar{\varepsilon}d + Y_0) < 0 \quad (2.7)$$

2.4.3 Donations under ambiguity

Let's now assume that the existing information is partial, there is a lack of transparency, and individuals are not sure about the likelihood of the probability distribution.

Following the neo-additive capacities model ([Chateauneuf et al., 2007](#)), we assume that participants rely on available information in order to make decisions. In the presence of partial ambiguity, there is a probability that the participants do not know the probability distribution.

$$\begin{aligned} \max_d U(d) = & u\left(\frac{m-d}{P_x}\right) + (1-\delta) \left[\underline{p}v(\underline{\varepsilon}d + Y_0) + pv(\varepsilon d + Y_0) + \bar{p}v(\bar{\varepsilon}d + Y_0) \right] \\ & + \delta \left[\alpha v(\underline{\varepsilon}d + Y_0) + (1-\alpha)v(\bar{\varepsilon}d + Y_0) \right] \end{aligned} \quad (2.8)$$

The condition for an interior solution $d \in]0; m[$ is $U'_d(d) = 0$:

$$U'_d(d) = \frac{-1}{P_x} u'(\frac{m-d}{P_x}) + (1-\delta) [p\underline{\varepsilon}v'(\underline{\varepsilon}d + Y_0) + p\varepsilon v'(\varepsilon d + Y_0) + \overline{p}\overline{\varepsilon}v'(\overline{\varepsilon}d + Y_0)] \\ + \delta [\alpha\underline{\varepsilon}v'(\underline{\varepsilon}d + Y_0) + (1-\alpha)\overline{\varepsilon}v'(\overline{\varepsilon}d + Y_0)] = 0 \quad (2.9)$$

The second-order condition is satisfied due to the assumption of concavity of the function $U(d)$:

$$U''_{dd} = \frac{1}{P_x^2} u''(\frac{m-d}{P_x}) + (1-\delta) [p\underline{\varepsilon}^2 v''(\underline{\varepsilon}d + Y_0) + p\varepsilon^2 v''(\varepsilon d + Y_0) + \overline{p}\overline{\varepsilon}^2 v''(\overline{\varepsilon}d + Y_0)] \\ + \delta [\alpha\underline{\varepsilon}^2 v''(\underline{\varepsilon}d + Y_0) + (1-\alpha)\overline{\varepsilon}^2 v''(\overline{\varepsilon}d + Y_0)] < 0 \quad (2.10)$$

2.4.4 Comparisons of the level of donations

Comparison of the level of donations under certainty vs. risk

Hypothesis 1 *There is no difference between the mean donations under certainty compared to the mean donations under risk.*

We want to determine when the individual level of donations under certainty is greater than the one under risk. In order to do this, we need to compare equation (2.3) to equation (2.6), with $d = d^R$ for both equations. If $d^C > d^R$, then the following inequality is true:

$$\frac{-1}{P_x} u'(\frac{m-d^R}{P_x}) + \varepsilon_0 v'(\varepsilon_0 d^R + Y_0) > \frac{-1}{P_x} u'(\frac{m-d^R}{P_x}) + p\underline{\varepsilon}v'(\underline{\varepsilon}d^R + Y_0) + p\varepsilon v'(\varepsilon d^R + Y_0) + \overline{p}\overline{\varepsilon}v'(\overline{\varepsilon}d^R + Y_0) \\ \varepsilon_0 v'(\varepsilon_0 d^R + Y_0) > p\underline{\varepsilon}v'(\underline{\varepsilon}d^R + Y_0) + p\varepsilon v'(\varepsilon d^R + Y_0) + \overline{p}\overline{\varepsilon}v'(\overline{\varepsilon}d^R + Y_0) \quad (2.11)$$

The level of donations without uncertainty will be higher than under risk if and only if the inequality above is verified; in order to conclude, it is necessary to make further assumptions about the level of the parameters.

Following the experimental design, let's assume that $\underline{p} = 0.1$, $\underline{\varepsilon} = 0$, $p = 0.6$, $\varepsilon = 1$, $\varepsilon_0 = 1.2$,

$\bar{p} = 0.3$ and $\bar{\varepsilon} = 2$. The inequality (2.14) becomes:

$$1.2v'(1.2d + Y_0) > 0.6v'(d + Y_0) + 0.3 \times 2v'(2d + Y_0)$$

$$\Leftrightarrow 1.2v'(1.2d + Y_0) > 0.6[v'(d + Y_0) + v'(2d + Y_0)]$$

$$\Leftrightarrow 2 > \frac{v'(d + Y_0) + v'(2d + Y_0)}{v'(1.2d + Y_0)} \quad (2.12)$$

It appears that it is not possible to determine the sign of the inequality since the level of donations is directly related to the form of the utility function. Depending on the individual's utility function, the level of donations without uncertainty could be higher than the level of donations under risk and vice-versa. In Appendix 2.A, there is a numerical application that illustrates the different possibilities, where the preferences are represented by different utility functions.

Comparison of the level of donations under certainty vs. ambiguity

Hypothesis 2 *There is no difference between the mean donations under certainty compared to the mean donations under ambiguity.*

We want to determine when the individual level of donations under certainty is greater than the one under ambiguity: $d^A < d^C$. In order to do this, we need to compare equation (2.3) to equation (2.9), with $d = d^A$ for both equations.

$$\begin{aligned} \frac{-1}{P_x}u'(\frac{m - d^A}{P_x}) + \varepsilon_0 v'(\varepsilon_0 d^A + Y_0) &> \frac{-1}{P_x}u'(\frac{m - d^A}{P_x}) \\ &+ (1 - \delta) \left[\underline{p} \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + p \varepsilon v'(\varepsilon d^A + Y_0) + \bar{p} \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \right] \\ &+ \delta \left[\alpha \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \right] \end{aligned} \quad (2.13)$$

$$\begin{aligned}
 \leftrightarrow \varepsilon_0 v'(\varepsilon_0 d^A + Y_0) &> (1 - \delta) \left[\underline{p} \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + p \varepsilon v'(\varepsilon d^A + Y_0) + \bar{p} \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \right] \\
 &+ \delta \left[\alpha \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \right] \\
 \leftrightarrow \alpha &> \frac{(1 - \delta) [\underline{p} \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + p \varepsilon v'(\varepsilon d^A + Y_0)] + \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) ((1 - \delta) \bar{p} - \delta)}{\delta \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) - \delta \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0)} \quad (2.14)
 \end{aligned}$$

Inequality (2.14) shows a threshold α for which the level of donations under ambiguity will be lower than the one under certainty. This means that if the individual is sufficiently pessimistic, she will donate less under ambiguity than under certainty. However, we can't make further conclusions without giving a specific utility function. In Appendix 2.A, there is an illustration of the different possibilities related to the comparison between the level of donations under certainty and under ambiguity, thanks to a numerical application.

2.4.5 The impact of attitudes towards uncertainty

The impact of confidence

In this section, we seek to study how an increase in ambiguity (δ) has an impact on donations.

Hypothesis 3 *Following an increase in ambiguity, donations will increase or decrease depending on the level of pessimism.*

Changes in an individual's pessimism over the amount of the donation received by the NGO is given by: $\frac{dd^A}{d\delta} = -\frac{U''_{d\delta}(d^A, \delta)}{U''_{dd}(d^A)}$ (equation (2.10) shows that $U''_{dd}(d) < 0$). The sign of this expression is therefore determined by:

$$U''_{d\delta} = -\underline{p} \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) - p \varepsilon v'(\varepsilon d^A + Y_0) - \bar{p} \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) + \alpha \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) + (1 - \alpha) \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \quad (2.15)$$

$$U''_{d\delta} = (\alpha - \underline{p})\underline{\varepsilon}v'(\underline{\varepsilon}d^A + Y_0) + [(1 - \alpha) - \bar{p}]\bar{\varepsilon}v'(\bar{\varepsilon}d^A + Y_0) - p\varepsilon v'(\varepsilon d^A + Y_0) \quad (2.16)$$

The sign of equation (2.16) is ambiguous, however, by making further assumptions on the values of the parameters, following our experimental framework, we can find the sign. In order to see the impact of ambiguity under the framework of our experiment, it is necessary to substitute the known parameters into the equation. Assuming that an increase in ambiguity has a negative impact on donations, we have the following inequality:

$$[(1 - \alpha) - 0.3]2v'(2d^A + Y_0) - 0.6v'(d^A + Y_0) < 0$$

$$[1.4 - 2\alpha]v'(2d^A + Y_0) < 0.6v'(d^A + Y_0)$$

$$\frac{1.4 - 2\alpha}{0.6} < \frac{v'(d^A + Y_0)}{v'(2d^A + Y_0)} \quad (2.17)$$

We know that the right side of the equation is superior to 1, since $v'(2d^A + Y_0) > v'(d^A + Y_0)$. Therefore, we seek a threshold α for which the left side of the equation is inferior to 1, and hence an increase in ambiguity decreases the optimal level of donations.

$$\frac{1.4 - 2\alpha}{0.6} < 1$$

$$0.4 < \alpha$$

Note that it is possible that the left side of the inequality (2.17) is higher than 1, in that case, we are not able to know if the individual will increase or decrease her level of donations under ambiguity compared to under risk without making further assumptions about the utility function.

This result allows us to compare the levels of donations under risk to under ambiguity and between levels of ambiguity. The utility function under risk represented by the expected utility is a special case of the neo-additive capacities model where there is no ambiguity such that $\delta = 0$. When going from the risk framework to the ambiguity framework, the value of δ increases, which allows us to conclude the sign of the effect of a passage from risk to ambiguity. We show that an increase in ambiguity, under our experimental framework, decreases the level of donations if the individual is sufficiently pessimistic. It is important to highlight that an increase in ambiguity might yield an increase in donations if the individual is sufficiently optimistic.

The impact of pessimism

In this section, we seek to study how an increase in the level of pessimism has an impact on the individual level of donations.

Hypothesis 4 *Pessimism has a negative impact on donations.*

Changes in an individual's pessimism over the amount of the donation received by the NGO is given by: $\frac{dd^A}{d\alpha} = -\frac{U''_{d\alpha}(d^A, \alpha)}{U''_{dd}(d^A)}$ (equation (2.10) shows that $U''_{dd}(d) < 0$). The sign of this expression is therefore determined by:

$$U''_{d\alpha} = \delta \underline{\varepsilon} v'(\underline{\varepsilon} d^A + Y_0) - \delta \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) \quad (2.18)$$

The sign of the above equation is ambiguous, however, following the assumptions in our experimental framework $\underline{\varepsilon} = 0$. Replacing $\underline{\varepsilon}$ by its value, we find that equation (2.18) is negative:

$$U''_{d\alpha} = -\delta \bar{\varepsilon} v'(\bar{\varepsilon} d^A + Y_0) < 0 \quad (2.19)$$

Therefore, $\frac{dd^A}{d\alpha}$ is negative. Pessimism has a negative impact on donations, the more the individual is pessimistic, the less she will donate.

The impact of risk aversion

In this section, we seek to study how an increase in risk aversion decreases the level of donations.

Hypothesis 5 *An increase in risk aversion decreases the level of donations under risk and under ambiguity.*

Knowing that the utility function v is increasing and concave, an increase in risk aversion is translated by an increase in the concavity of the utility function. The concavity of the utility function implies that the marginal utility is decreasing, therefore, an additional unit of donation implies a decrease in the marginal utility. The more concave the function is, the more rapidly decreases the marginal utility, attaining 0 (the individual level of donations at the equilibrium). This means the more concave the utility function, the smaller the level of donations is necessary in order to attain the individual level of donations at the equilibrium. The more risk averse, the less donations the individual will give.

2.5 Results

2.5.1 Descriptive statistics

Table 2.1 presents summary statistics of the main control variables used in our analysis.

2.5.2 The effect of risk and ambiguity on the levels of donations

In Figure 2.4, we represent the average donation levels in the different treatment groups. The average donation in the control group is 26.25 ECUs (s.d. = 30.62); in the Risk treatment it is 24.66 ECUs (s.d. = 25.01); in the LAmbT, the average is 28.91 ECUs (s.d. = 27.72), and in the HAmbT it is 18.84 ECUs (s.d. = 25.45). In the experiment, 57 participants (26.27%) did not give anything to charity. In the control treatment, 19 participants did not donate anything, in the risk treatment, they were 9, in the LAmbT they were 10, and finally, in the LAmbT, 19 participants donated 0 ECUs. There are no significant differences between levels of donations

Table 2.1 – Summary statistics

Variables	All	Control	Treatments		
			RT	LAmbT	HAmbT
Age	38.81	36.21	36.91	41.54	40.40
Gender					
- Female (%)	59.45	52.83	50.94	68.52	64.91
- N/A (%)	1.84	0.00	0.00	3.70	3.51
Previous donation to an NGO (%)	70.05	73.58	71.70	64.81	70.18
NEP score	44.00	43.71	45.7	42.59	45.18
Student (%)	33.64	35.85	39.62	29.63	29.82
Monthly income					
- Less than 800 € (%)	29.03	28.30	32.09	25.93	29.82
- From 800 to 1200 € (%)	15.21	9.43	20.75	14.81	15.79
- From 1200 to 1800 € (%)	21.20	30.19	15.09	22.22	17.54
- From 1800 to 2500 € (%)	12.44	3.77	15.09	11.11	19.39
- Above 2500 € (%)	9.22	7.55	7.55	14.81	7.02
- N/A (%)	12.90	20.75	9.43	11.11	10.53
# of observations	217	53	53	54	57

Notes: NEP score is comprised between 0 and 60, the score measures pro-environmental attitudes. Previous donations to an NGO is a dummy variable = 1 if the participant has already donated to a NGO, and = 0 if not.

in the control compared to RT, LAmbT, and HAmbT (Wilcoxon sign rank test yields p-values respectively of 0.55, 0.25, and 0.37). Hypothesis 1 is verified, we do not find any significant difference between the control group and RT.

Result 1: There is no difference in donations between certainty and risk.

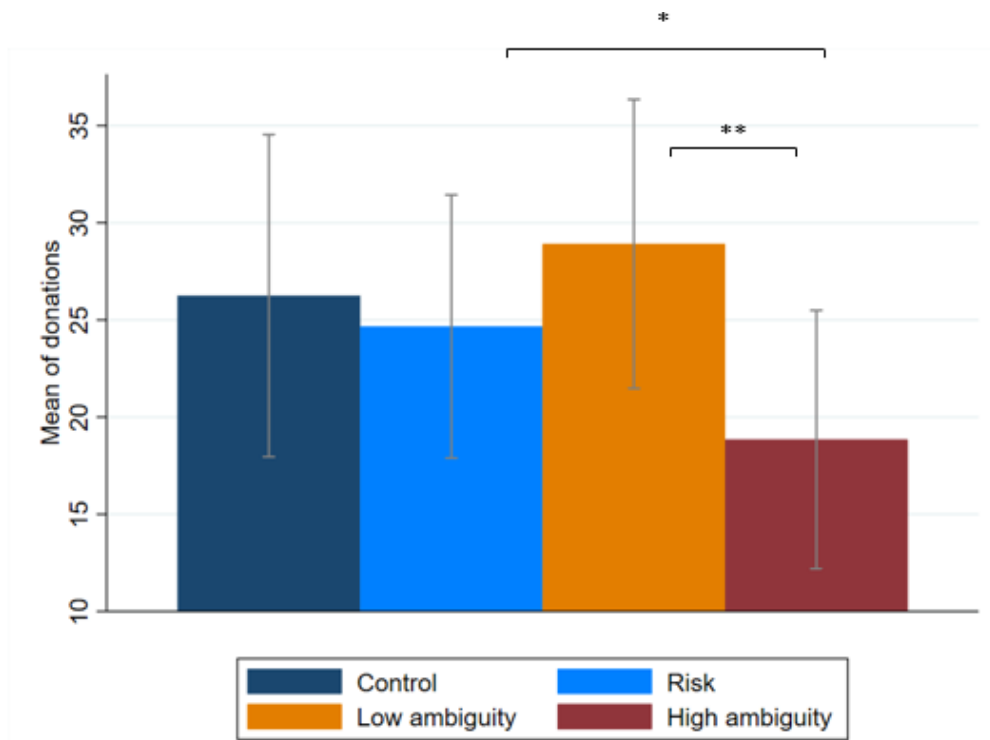
Hypothesis 2 is verified, we do not find any significant difference between the control group and any of the ambiguity treatments.

Result 2: There is no difference in donations between certainty and ambiguity.

In Figure 2.4, we observe an increase in the level of donations in LAmbT, compared to risk, however, the difference is not significant (Wilcoxon test, p-value= 0.50). On the contrary, we observe a marginally significantly lower level of donations between HAmbT and RT (a Wilcoxon test yields a p-value= 0.06). We can also observe in Figure 2.4 a decrease of donations in HAmbT compared to LAmbT (a Wilcoxon test yields a p= 0.02). This figure hence shows that donations are lower in the context of higher levels of ambiguity, confirming hypothesis 3.

Result 3 : The introduction of a “low” level of ambiguity does not decrease nor increase donations compared to risk. A “high” level of ambiguity decreases donations compared to risk.

Figure 2.4 – Mean donations per treatment



Notes: Stars represent the level of significance for Mann Whitney U Test.
 *** $p < 0.01$, ** $p < 0.05$, $p^* < 0.1$. Grey lines correspond to 95% confidence intervals.

A “high” level of ambiguity decreases donations compared to a lower level of ambiguity.

We run a Tobit regression clustered at the session level on the amount of donations to NGOs as shown in Table 2.2, since we consider the data to be left-censored because 57 participants (26.27%) donated 0 ECU. As justified by Engel (2011), the tobit model assumes that there are dictators who could have given a negative amount if possible, such as seen in experiments having a take option. We clustered at the session level since the sessions were spaced out over the year, and in some sessions, there was a large number of participants (20), and in others, there were few participants (2). We think that temperature can have an impact on altruism.⁸ We also think that it may be possible that fewer participants in a session may feel more observed (therefore increasing altruism because they feel compelled to donate) or understand the instructions better since they might feel free to ask more questions to the experimenter (making the elicited

8. Van de Vliert et al. Do colder and hotter climates make richer societies more, but poorer societies less, happy and altruistic? *Journal of Environmental Psychology* 24 (2004) 17–30

Figure 2.5 – Kernel density estimation of donations per treatment

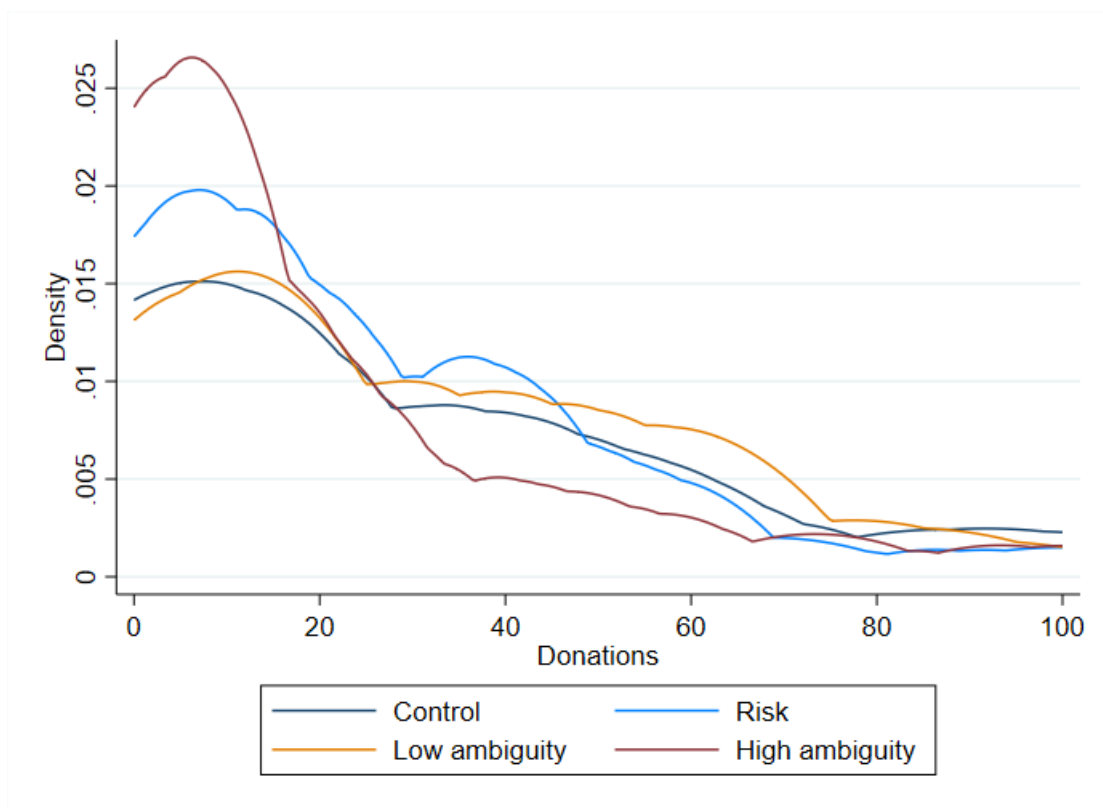


Table 2.2 – Tobit regressions on the determinants of the level of donation

	(1)	(2)
RT	2.61 (9.39)	5.38 (10.62)
LAmbT	6.72 (8.97)	8.48 (9.72)
HAmbT	-7.57 (8.62)	-5.56 (9.88)
Age		-0.12 (0.19)
Female		12.77** (5.03)
Gender, N/A		-37.22** (14.63)
<i>Income, ref. Less than 800 €</i>		
Income, From 800 to 1200 €		-3.30 (6.10)
Income, From 1200 to 1800 €		21.13*** (6.01)
Income, From 1800 to 2500 €		-1.87 (6.01)
Income, Above 2500 €		-0.24 (8.62)
Income, N/A		-10.41 (9.58)
Previous donations to an NGO		6.20 (6.32)
NEP score		0.20 (0.35)
Risk aversion coefficient		-2.51 (5.14)
Constant	18.50*** (8.51)	-2.20 (19.88)
Observations	217	217
Pseudo R-squared	0.003	0.024

Tobit regressions - left-censored

Robust standard errors in parentheses clustered at the session level.

*** p<0.01, ** p<0.05, * p<0.1

Notes: The dependent variable is the level of donations (continuous variable between 0 and 100). 4 participants (1.97%) did not want to reveal their gender. 28 participants (13.8%) did not want to reveal their income. LAmbT and HambT are the treatment dummy variables. The risk aversion coefficient corresponds to the CRRA coefficient estimated with the Holt & Laury measure (the higher, the more risk averse). The NEP score is a continuous variable and a measure of environmental attitudes. The variable previous donations to an NGO is a dummy variable = 1 if the participant has already donated to an NGO, and = 0 if not.

parameters less noisy).

Column (1), in Table 2.2, confirms the results previously discussed such that there is no impact of risk, “low” ambiguity, or “high” ambiguity on donations compared to the control group. When adding control variables in Column (2), we confirm that we do not find any treatment effects. Control variables include age, gender, income if the individual has previously donated to an NGO, and her pro-environmental preferences (NEP score).

By looking at this regression, we can also confirm the gender effect regarding donations found in the literature ([Eckel and Grossman, 1998](#)), such as women give more than men. We also find that participants with an income between €1200 and €1800 give more than participants with an income below €800. We do not find any effect of age on donations. Finally, we do not find any effect of pro-environmental preferences on donations.

2.5.3 Ambiguity attitudes and donations

Table 2.3 shows the results using left-censored Tobit regressions with unframed ambiguity attitudes, where the dependent variable is the level of donations while controlling for ambiguity attitudes (unframed ambiguity aversion, likelihood insensitivity, and pessimism). To study ambiguity attitudes, in these regressions, we only include ambiguity treatments (LAmbT and HAmbT) since ambiguity attitudes only have an impact on behavior under an ambiguous environment. In table 2.3, we exclude 15 participants in ambiguity treatments in addition to the participant already excluded (hence $N=96$). We drop participants yielding an ambiguity aversion or an insensitivity index higher than 1 and smaller than -1 , since, theoretically, both indexes are smaller than 1 and higher than -1 ([Baillon et al., 2018](#)).

In Table 2.3, columns (1) and (2) show that (unframed) likelihood insensitivity has a positive effect on donations (significant at a 5% level and at 10%, respectively). Columns (3) and (4) show that unframed pessimism does not impact donations under ambiguity. Since the parameter pessimism is constructed from ambiguity aversion and insensitivity indexes, we do not include the three parameters in the same regression.

Finally, all regressions show that HAmbT yields a negative effect on donations (compared

to LAmbT). These results seem to indicate that ambiguity attitudes do not have any effect on donations in ambiguity environments, except for a marginally significant likelihood insensitivity. However, in Table 2.3, we only focus on unframed ambiguity attitudes.

Ambiguity attitudes depend on sources of uncertainty (Baillon et al., 2018, 2021). They are context dependent and do not stay constant across different environments and levels of ambiguity. Hence, it is interesting to focus on analyzing the impact of (framed) ambiguity attitudes on donations per treatment (i.e., on specific environments and levels of ambiguity). Moreover, focusing on risk and ambiguity attitudes will allow studying the impact of these different variables according to a specific environment.

Table 2.3 – Impact of ambiguity attitudes on donations

	(1)	(2)	(3)	(4)
HAmbT	-15.76*** (3.97)	-13.20*** (4.04)	-16.28*** (3.73)	-13.34*** (4.57)
(Unframed) ambiguity aversion	5.92 (7.06)	3.37 (9.34)		
(Unframed) insensitivity	14.49** (6.83)	11.99* (7.20)		
Risk aversion coefficient	-3.49 (6.13)	-8.22* (4.47)	-3.77 (6.19)	-8.19* (4.64)
(Unframed) pessimism			13.35 (16.46)	11.85 (16.71)
Constant	19.48*** (3.47)	-11.58 (22.53)	19.70** (8.13)	-12.94 (25.86)
Controls	No	Yes	No	Yes
Observations	96	96	96	96
Pseudo R-squared	0.01	0.04	0.01	0.03

Tobit regressions - left-censored

Robust standard errors in parentheses clustered at the session level. Reference is LAmbT

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Tobit regressions - left-censored. The dependent variable is the level of donations and is a continuous variable between 0 and 100. HAMB is a dummy variable = 1 when it is the high ambiguity treatment and equal to 0 when it corresponds to the low ambiguity treatment. Unframed ambiguity attitudes are continuous variables that measure attitudes under full uncertainty. Ambiguity aversion and likelihood insensitivity are continuous variables comprised between -1 and 1. The higher the ambiguity aversion coefficient, the more ambiguity averse is the participant. If the index is negative, the participant is ambiguity lover. The higher the insensitivity index, the more insensitive to likelihood variations is the participant. The risk aversion coefficient corresponds to the CRRA coefficient estimated with the Holt & Laury measure (the higher the more risk averse). Pessimism is a continuous variable between 0 and 1, where 0 indicates extreme optimism and 1 extreme pessimism. Controls include age, gender, previous donation to an NGO, NEP score, income.

Risk treatment

Table 2.4 presents two regression analyses taking only into account the risk treatment (N=53). We seek to understand under a risky environment which factors have an effect on donations. Column (1) shows no effect of risk aversion on donations. However, while adding controls, the parameter becomes significant: risk aversion positively impacts donations. This is a counter-intuitive result. However, some papers find the same effect (Cettolin et al., 2017, Fahle and Sautua, 2021). This result contradicts hypothesis 4, since this hypothesis expects risk aversion to decrease donations under risk. We find that it increases donations.

Table 2.4 – Risk attitudes on the level of donations under risk

	(1)	(2)
Risk aversion coefficient	13.73 (8.89)	26.67*** (9.25)
Excuse behavior		-0.15 (0.30)
Constant	27.83*** (4.75)	40.51* (20.57)
Controls	No	Yes
Observations	53	53
Pseudo R-squared	0.004	0.059

Tobit regressions

Robust standard errors in parentheses clustered at the session level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Tobit regressions, left-censored, on the risk treatment subsample only. The dependent variable is a continuous variable on the level of donations between 0 and 100. The risk aversion coefficient corresponds to the CRRA coefficient estimated with the Holt & Laury measure (the higher the more risk averse). Excuse behavior is a continuous variable such that the higher, the more the participant uses risk as an excuse not to give. Controls include age, gender, previous donation to an NGO, NEP score, and income.

Low ambiguity treatment

In this section, we analyze the effect of ambiguity attitudes. Table 2.5 presents different regressions under LAMB-T, including risk and ambiguity attitudes as explanatory variables. We find that neither ambiguity aversion, likelihood insensitivity, pessimism, nor risk aversion has a

significant impact on donations under a “low” ambiguity environment.

The findings suggest that at a “low” level of ambiguity, ambiguity attitudes do not seem to matter in explaining the level of charitable giving. Nevertheless, we find a negative and significant effect of excuse-driven behavior on donations in situations involving ambiguity, which confirms [Garcia et al. \(2020\)](#)’s finding.

Table 2.5 – Ambiguity attitudes on the level of donations under “low” ambiguity

	(1)	(2)	(3)	(4)
(Framed) Ambiguity aversion	4.70 (8.30)	-7.99 (12.70)		
(Framed) Likelihood insensitivity	-7.41 (11.55)	-5.32 (8.96)		
Risk aversion coefficient	6.77 (11.75)	4.12 (9.17)	8.00 (10.48)	5.24 (12.80)
Excuse behavior	-0.85*** (0.18)	-0.78** (0.36)	-0.81*** (0.17)	-0.77** (0.38)
(Framed) Pessimism			15.16 (14.90)	-16.68 (28.47)
Constant	32.96*** (7.22)	-4.77 (13.53)	21.28*** (4.94)	5.36 (16.04)
Controls	No	Yes	No	Yes
Observations	54	54	54	54
Pseudo R-squared	0.013	0.059	0.013	0.058

Tobit regressions, left-censored.

Robust standard errors in parentheses clustered at the session level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Tobit regressions, left-censored, using only the low ambiguity treatment. The dependent variable is the level of donations and is a continuous variable between 0 and 100. Framed ambiguity attitudes are continuous variables measured under a “low” ambiguity environment. Ambiguity aversion and likelihood insensitivity are continuous variables comprised between -1 and 1. The higher the ambiguity aversion coefficient, the more ambiguity averse is the participant. If the index is negative, the participant is ambiguity lover. The higher the insensitivity index, the more insensitive to likelihood variations is the participant. The risk aversion coefficient corresponds to the CRRA coefficient estimated with the Holt & Laury measure (the higher the more risk averse). Excuse behavior is a continuous variable, the higher, the more the participant uses ambiguity as an excuse not to give. Pessimism is a continuous variable between 0 and 1, where 0 indicates extreme optimism and 1 extreme pessimism. Controls include age, gender, previous donation to an NGO, NEP score, and income.

High ambiguity treatment

Finally, in this section, we study the impact of ambiguity attitudes under a “high” ambiguity environment. We only include participants belonging to the HAmbT. Table 2.6 presents Tobit regressions under HAmbT, where we analyze the impact of ambiguity attitudes under “high” ambiguity. Columns (1) and (2) (respectively, with and without controls) show no effect of likelihood insensitivity, however, it shows a marginally significant and negative impact of ambiguity aversion on donations. In Column (3), we find that the impact of pessimism on donations is negative and significant. Moreover, when adding controls (Column 4), pessimism still has a significant effect on donations, beliefs seem to have a stronger impact on donations than ambiguity aversion. Finally, all regressions suggest a negative effect of excuse-driven behavior. In these regressions, there is a marginally significant and negative effect of risk aversion.

These results suggest that pessimism has a negative impact in a “high” ambiguity environment. This result partially supports hypothesis 4. Pessimism will play a role in donations only under a “high” ambiguity environment.

Result 4: Pessimism will decrease donations only under a high ambiguity environment.

Finally, in tables 2.4, 2.5, and 2.6, we find different effects of risk aversion. Under risk, risk aversion will increase donations, however, there is no evidence of an impact of risk aversion under ambiguity.

Result 5: Risk aversion increases donations under risk. It does not have an effect under ambiguity.

2.5.4 Correlation between coefficients of risk and ambiguity aversion

We do not find any significant correlation between the risk aversion coefficient and the unframed ambiguity aversion coefficient, as this result suggests the independence between risk and ambiguity attitudes as found in [Attanasi et al. \(2014\)](#). However, when we focus on framed ambiguity attitudes and risk aversion, we find a negative and small correlation between the risk aversion and the framed ambiguity coefficient (Spearman’s $\rho = -0.23$, $p\text{-value} \leq 0.05$).

Table 2.6 – Ambiguity attitudes on the level of donations under “high” ambiguity

	(1)	(2)	(3)	(4)
(Framed) Ambiguity aversion	-16.30* (9.33)	-10.25* (5.77)		
(Framed) Likelihood insensitivity	-4.03 (6.86)	-3.67 (6.57)		
Excuse behavior	-0.76** (0.29)	-0.81** (0.34)	-0.78*** (0.28)	-0.80** (0.36)
Risk aversion coefficient	-4.33** (1.63)	-0.68 (3.65)	-3.47 (3.37)	0.01 (5.10)
(Framed) Pessimism			-35.89** (14.57)	-26.86** (11.61)
Constant	11.45** (5.20)	-74.24*** (17.26)	28.08*** (5.22)	-58.23*** (17.53)
Controls	No	Yes	No	Yes
Observations	57	57	57	57
R-squared	0.035	0.094	0.035	0.096

Tobit regressions, left-censored.

Robust standard errors in parentheses clustered at the session level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: OLS regressions using only the high ambiguity treatment. The dependent variable is the level of donations and is a continuous variable between 0 and 100. Framed ambiguity attitudes are continuous variables measured under a “high” ambiguity environment. Ambiguity aversion and likelihood insensitivity are continuous variables comprised between -1 and 1. The higher the ambiguity aversion coefficient, the more ambiguity averse the participant is. If the index is negative, the participant is ambiguity lover. The higher the insensitivity index, the more insensitive to likelihood variations the participant is. The risk aversion coefficient corresponds to the CRRA coefficient estimated with the Holt & Laury measure (the higher, the more risk averse). Excuse behavior is a continuous variable, the higher, the more the participant uses ambiguity as an excuse not to give. Pessimism is a continuous variable between 0 and 1, where 0 indicates extreme optimism and 1 extreme pessimism. Controls include age, gender, previous donation to an NGO, NEP score, and income.

We find a small and positive correlation (Pearson correlation = 0.40, $p\text{-value} \leq 0.01$) between the framed ambiguity aversion and unframed ambiguity aversion. There is a significant and moderate correlation, thus, it is not strong, supporting the idea that ambiguity aversion is partially context-dependent. This confirms that the source of information and context changes an individual’s ambiguity aversion level. Therefore, this result suggests that it is necessary to elicit framed ambiguity attitudes (as opposed to unframed) since these are more accurate for measuring attitudes toward ambiguity.

2.6 Discussion and conclusion

This experiment seeks to study the impact of levels of uncertainty on donations. Our results suggest that levels of uncertainty do not have a noticeable impact on mean donations or the distribution of donations compared to situations without uncertainty. However, we observe that when in the presence of a “high” level, there is a significant decrease in mean donations compared to situations involving risk and “low” ambiguity. This finding implies that if the objective is to encourage altruistic behaviors, there may not be a need to excessively prioritize reducing ambiguity, except when the ambiguity level is “high”. We also study the impact of ambiguity attitudes on donations.⁹ We find a positive effect of risk aversion on donations only in a risky environment (Risk Treatment) (Cettolin et al., 2017, Fahle and Sautua, 2021). This effect is found since an increase in risk aversion increases the concavity of the utility function of giving. Therefore, if the utility function is more concave, the expected marginal utility of donating will be higher, leading the giver to donate more. Moreover, if the dictator reflects her preferences on the recipients’ preferences and there is an increase in risk aversion, she will increase her donation.

We also find that ambiguity aversion has a marginally negative impact only under a “high” level of ambiguity. We also show that pessimism is only correlated with donations under “high” ambiguity; this effect is larger than the one of ambiguity aversion. It may be possible that more than disliking ambiguity, subjective beliefs have a larger effect on donations. This result indicates that the overweighting of the probabilities of low payoffs has a negative impact on donations. This could be explained because a “high” level of ambiguity may increase the effect of subjective beliefs since individuals rely less on available information. On the contrary, when there is a “low” level of ambiguity, subjective beliefs about the probabilities of different events may play a minor role, and a “low” ambiguity level will dampen any effect from subjective beliefs. Therefore, a “high” level of ambiguity may increase the effect of ambiguity attitudes, such as ambiguity aversion and pessimism leading to a decrease in mean donations. These results suggest that there

9. This experiment uses compound lotteries and fails to control for attitudes to compound objective lotteries. However, we control for ambiguity attitudes, and Halevy (2007) shows that attitudes toward ambiguity and compound objective lotteries are tightly associated.

might be a threshold for which ambiguity and ambiguity attitudes have a negative impact on donations. An increase in ambiguity may have an amplifying effect on pessimistic beliefs. If an individual is pessimistic, an increase in ambiguity will probably reinforce the effect of pessimism, decreasing donations. On the contrary, if an individual is optimistic, an increase in ambiguity may reinforce the effect of optimism, increasing donations.

We do not find any effect of risk on donations nor an excuse-driven behavior under risk, as opposed to the literature ([Krawczyk and Le Lec, 2010](#), [Brock et al., 2013](#), [Freundt and Lange, 2017](#)). In those studies, risk also lies on the recipients' side. However, they use another mechanism for introducing ambiguity: the recipient faces a gamble where the probability of winning a prize depends on the amount donated by the dictator. The more the giver donates to the recipient, the higher the recipient's chances of winning the prize. In this paper, giving does not increase the probability of receiving a donation, the more the participant donates, the higher the amount the NGO will receive (in the case where the purple marble is not drawn). We show in our experiment that the coefficient relative to excuse behavior between a "low" ambiguity and a "high" ambiguity environment is quite similar, suggesting that more ambiguity does not increase the effect of excuse-driven behavior. This result suggests that individuals do not use the increase in the ambiguity level as an excuse to give less, as in [Garcia et al. \(2020\)](#); rather, it is due to the effect of pessimism.

It is important to note that, as explained in the introduction, the action of donating bears ambiguity itself because of embezzlement, mismanagement, or the positive effect of pooling contributions. Introducing additional ambiguity in the experiment is not problematic regarding the results. The main objective of the experiment is to examine how different levels of ambiguity have an impact on donations while we keep the donation action consistent across all the treatments and the same recipients. The objective of the experiment is to explore how individuals respond to varying levels of ambiguity. Therefore, by maintaining uniformity in the donation action, we are able to isolate the effect of levels of uncertainty.

This paper aims to add evidence to the inconclusive literature about the effect of uncertainty on charitable giving.

In the context of charitable giving, we argue that policymakers and/or NGOs should not exclusively concentrate on reducing uncertainty. Nevertheless, if the objective is to encourage donations, it is necessary to diminish uncertainty in situations characterized by extreme ambiguity, such as the misappropriation of funds or organizational mismanagement. To address this issue, NGOs may provide transparent reports outlining the allocation of donations and conduct assessments of their initiatives to exhibit their effectiveness and rectify misperceptions regarding the impact of donations. Further research should focus on studying experimentally the existence of an ambiguity threshold for which ambiguity attitudes have an impact on altruistic behaviors.

2.A Numerical Application

In order to illustrate our results, we are going to assume two different types of utility functions. This is done in order to illustrate that according to utility functions, the different levels of donations under risk or under ambiguity can be higher or lower than the level of donations under certainty.

We assume in the following equations that $Y = \varepsilon d^A + Y_0$. Furthermore, we parameterize the value of $Y_0 = 340$. Y_0 represents the exogenous level of donations, therefore, we calculate it by taking the mean donations in our experiment $\bar{d} = 26.25$, multiplied by $\varepsilon_0 = 1.2$ which is equal to the expected value of the lottery under risk, multiplied by the mean of participants in each session which is equal to 10.9.

First, let's assume a risk-averse individual with a CRRA utility function, such as $v_1(Y) = \ln(Y)$, with a relative risk aversion coefficient equal to 1.

Second, let's assume a risk-averse individual with a CARA (IRRA) utility function, such as $v_2(Y) = -\frac{1}{\beta} \exp(-\beta Y)$, with a relative risk aversion coefficient equal to $\beta \times d^A$.

2.A.1 Comparison of the level of donations under certainty vs. risk

We define a function:

$$f(d) = \frac{v'(d^R + Y_0) + v'(2d^R + Y_0)}{v'(1.2d^R + Y_0)}$$

For which the following inequality is true if and only if $d^C > d^R$, following equation (2.12):

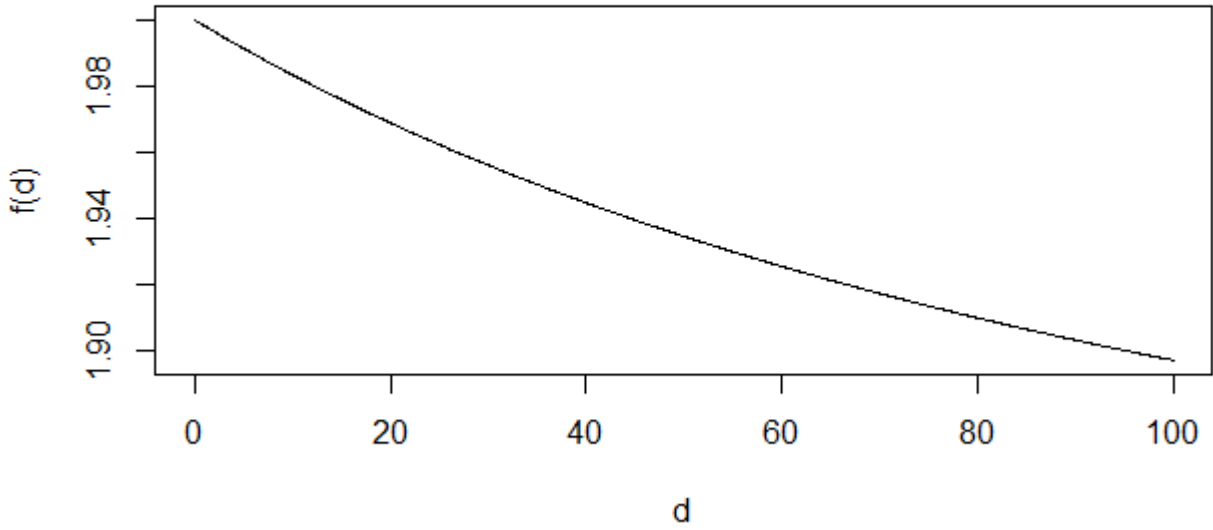
$$2 > f(d)$$

First case: $v(Y) = \ln(Y)$

We assume that $v(Y) = \ln(Y)$, therefore, we replace $f(d)$ by:

$$f(d) = \frac{1/(d^R + 340) + 1/(2d^R + 340)}{1/(1.2d^R + 340)}$$

Figure A1 – Function $f(d)$ with $v(Y) = \ln(Y)$



In figure A1, we observe that the function is comprised between 2 and 1.90 for values of $d \in [0, 100]$. This means that for a function $v(Y) = \ln(Y)$, equation (2.12) is always verified, therefore $d^C > d^R$.

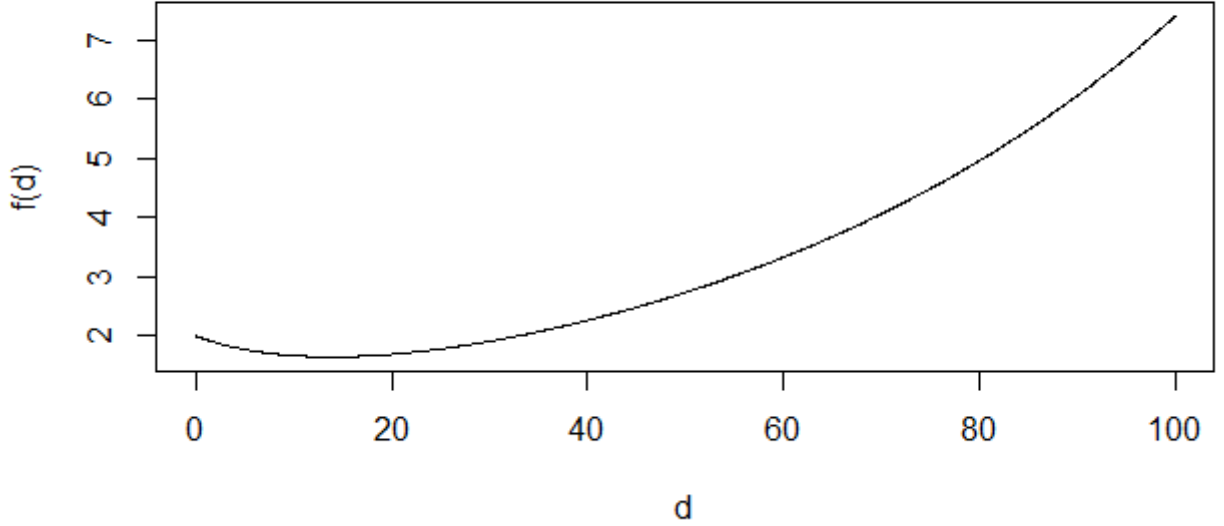
Second case: $v(Y) = -\frac{1}{\beta} \exp(-\beta Y)$

We assume that $v(Y) = -\frac{1}{\beta} \exp(-\beta Y)$, therefore, we replace $f(d)$ by:

$$f(d) = \frac{\exp(-\beta(d^R + 240)) + \exp(-\beta(2d^R + 240))}{\exp(-\beta(1.2d^R + 240))}$$

β represents the level of absolute risk aversion. We modify this parameter with two different levels of risk aversion, one low and one medium, such as $\beta = 0.1, 0.5$

Figure A2 – Function $f(d)$ with $v(Y) = -\frac{1}{\beta}\exp(-\beta Y)$ and $\beta = 0.1$

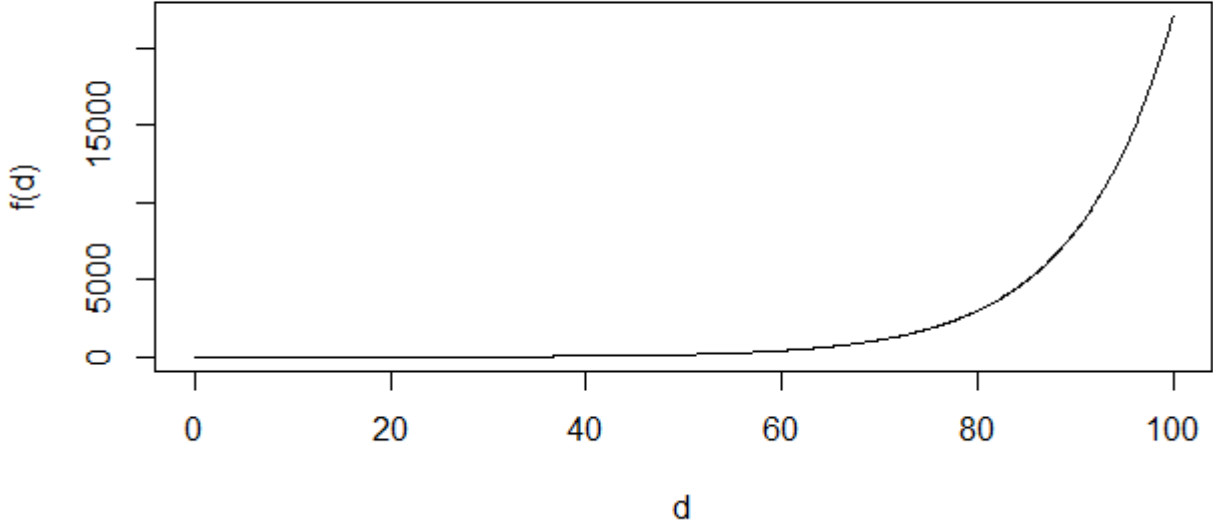


In Figure A2, we observe that the function is lower than 2 between 0 and 32.81. It is higher than 2 if d^R is higher than 32.81. This means that $d^C > d^R$ if $d^R < 32.81$.

In Figure A3, the level of risk aversion increases. We observe that the function is lower than 2 between 0 and 6.56. It is higher than 2 if d^R is higher than 6.56. This means that $d^C > d^R$ if $d^R < 6.56$.

These results show that depending on the individual's preferences, the level of donations under certainty can be either higher or lower than under risk. Note that we are not able to make further conclusions about the exact level of donations without making assumptions about the functional form of $u(Y)$. The different cases and results show that depending on the specific preferences of the individual (public and private) will determine the comparison of the level of donations.

Figure A3 – Function $f(d)$ with $v(Y) = -\frac{1}{\beta} \exp(-\beta Y)$ and $\beta = 0.5$



2.A.2 Comparison of the level of donations under certainty vs. ambiguity

We define a function:

$$g(d) = \frac{(1 - \delta)[p\underline{\varepsilon}v'(\underline{\varepsilon}d^A + Y_0) + p\varepsilon v'(\varepsilon d^A + Y_0)] + \bar{\varepsilon}v'(\bar{\varepsilon}d^A + Y_0)((1 - \delta)\bar{p} - \delta)}{\delta\bar{\varepsilon}v'(\bar{\varepsilon}d^A + Y_0) - \delta\underline{\varepsilon}v'(\underline{\varepsilon}d^A + Y_0)}$$

For which the following inequality is true if and only if $d^C > d^A$, following equation (2.14):

$$\alpha > g(d)$$

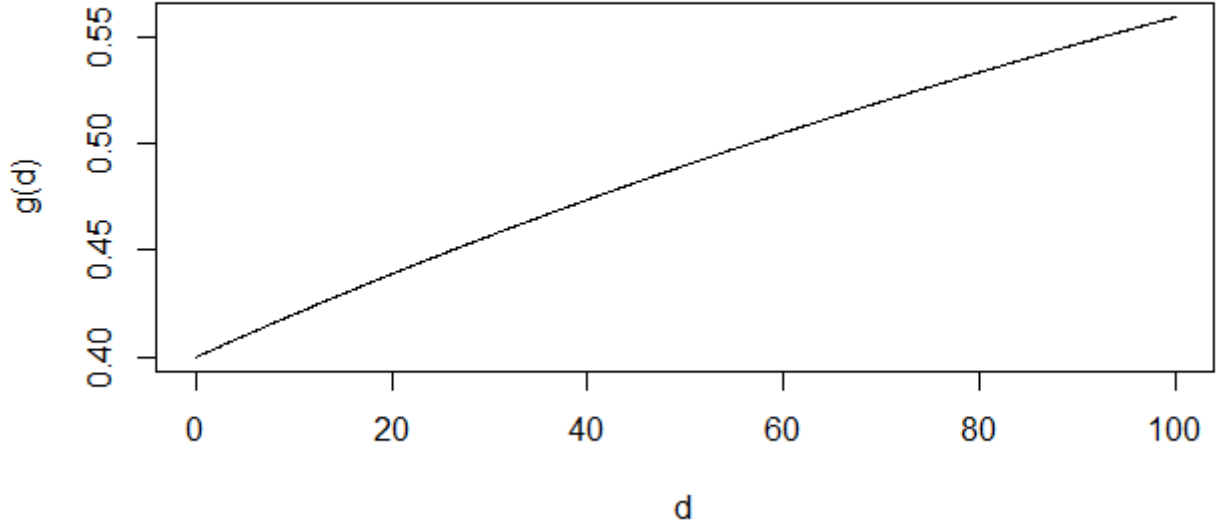
First case: $v(Y) = \ln(Y)$

We assume that $v(Y) = \ln(Y)$, therefore we replace $g(d)$ by:

$$g(d) = \frac{(1 - \delta)0.6(1/(d^A + 340)) + (1/(2d^A + 340))[(1 - \delta)0.3 - \delta]2}{2\delta(1/(2d^A + 340))}$$

In the experiment, there are two different ambiguity scenarios, $\delta = \{0.3, 0.7\}$.

Figure A4 – Function $g(d)$ with $g(Y) = \ln(Y)$ and $\delta = 0.3$



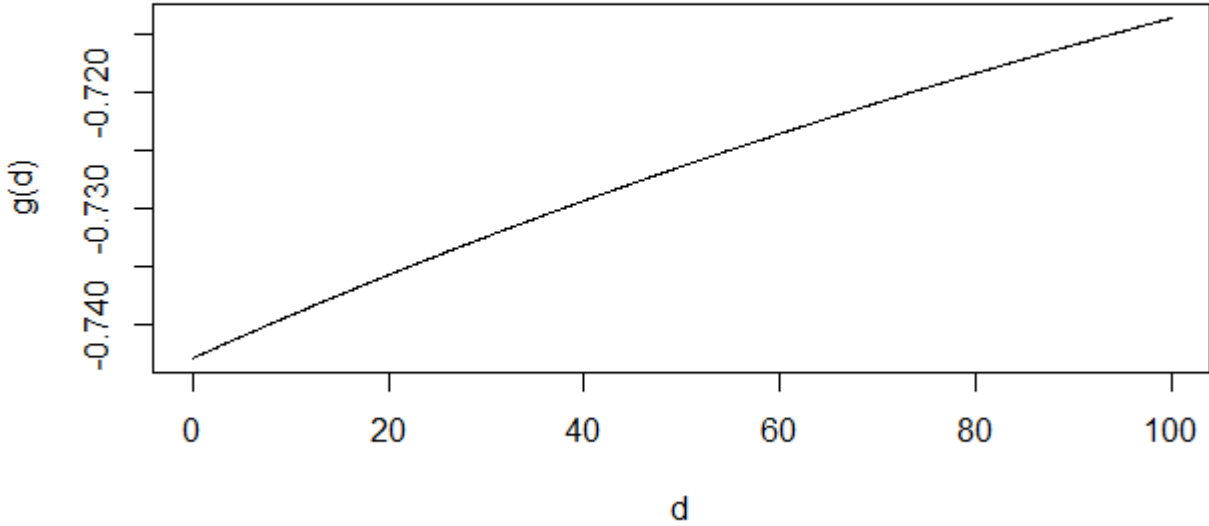
In Figure A4 we can observe that the function $g(d)$ takes values between 0.4 and 0.6, therefore, in this case, if the individual is sufficiently pessimistic, she will donate more under certainty than under a low level of ambiguity.

In Figure A5, if the decision is taken under a high level of ambiguity, such as $\delta = 0.7$, we can observe that the function $g(d)$ takes negative values. Therefore, if the individual's preferences are represented by this utility function, the individual will always donate more than under a high level of ambiguity.

Second case: $v(Y) = -\frac{1}{\beta} \exp(-\beta Y)$

We assume that $v(Y) = -\frac{1}{\beta} \exp(-\beta(Y))$, therefore we replace $g(d)$ by:

$$g(d) = \frac{(1 - \delta)0.6 \exp(-\beta(d^A + 340)) + 2 \exp(-\beta(2d^A + 340)) [(1 - \delta)0.3 - \delta]}{2\delta \exp(-\beta(2d^A + 340))}$$

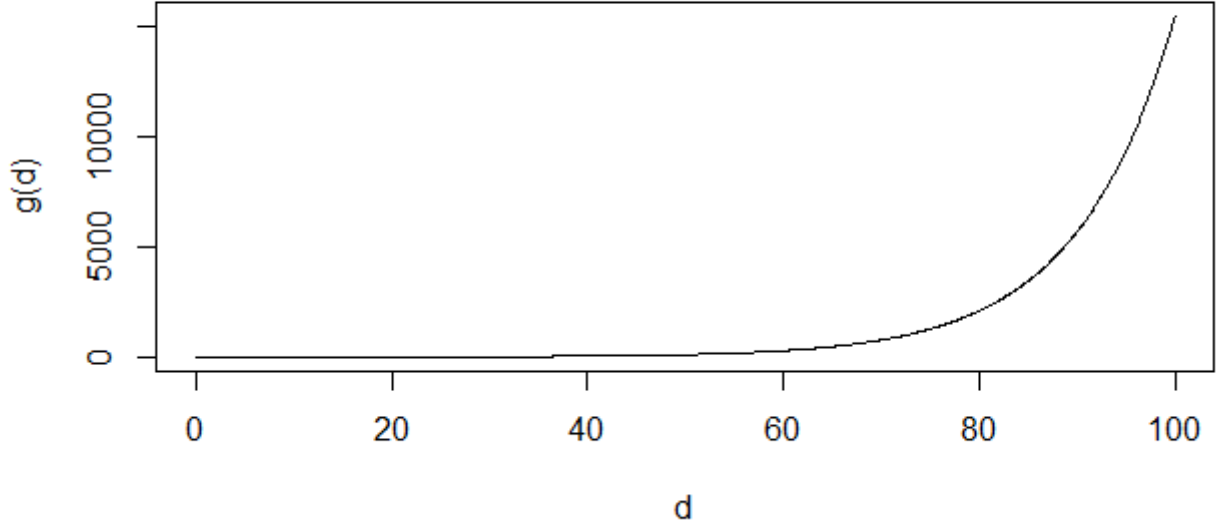
Figure A5 – Function $g(d)$ with $g(Y) = \ln(Y)$ and $\delta = 0.7$ 

Note that this function depends on β , the level of absolute risk aversion. We are going to assume two possible values of $\beta = 0.1, 0.5$ in order to illustrate different levels of risk aversion.

In Figure A6, the decision is taken under a low level of ambiguity ($\delta = 0.3$), and the individual possesses a low level of risk aversion $\beta = 0.1$. If $d = 6.19$, the function is equal to 1, in this case, the individual donates the same amount in both situations. This means that for $d^A < 6.19$, it is possible that the individual donates more under certainty than under a low level of ambiguity, depending on the level of pessimism. However, if $d^A > 6.19$, the individual will always donate more under ambiguity than under certainty.

In Figure A7, the decision is taken under a low level of ambiguity ($\delta = 0.3$), and the individual possesses a medium level of risk aversion $\beta = 0.5$. If $d = 1.24$, the function is equal to 1, in this case, the individual donates the same amount in both situations. This means that for $d^A < 1.24$ it is possible that the individual donates more under certainty than under a low level of ambiguity, depending on the level of pessimism. However, if $d^A > 1.24$, the individual will always donate more under ambiguity than under certainty.

Figure A6 – Function $g(d)$ with $g(Y) = -\frac{1}{\beta} \exp(-\beta(Y))$, $\delta = 0.3$, and $\beta = 0.1$



In Figure A8, the decision is taken under a high level of ambiguity ($\delta = 0.7$), and the individual possesses a low level of risk aversion $\beta = 0.1$. If $d = 26.78$, the function is equal to 1, in this case, the individual donates the same amount in both situations. This means that for $d^A < 26.78$, it is possible that the individual donates more under certainty than under a high level of ambiguity, depending on the level of pessimism. However, if $d^A > 26.78$, the individual will always donate more under ambiguity than under certainty.

In Figure A9, the decision is taken under a high level of ambiguity ($\delta = 0.7$), and the individual possesses a medium level of risk aversion $\beta = 0.5$. If $d = 5.36$, the function is equal to 1, in this case, the individual donates the same amount in both situations. This means that for $d^A < 5.36$, it is possible that the individual donates more under certainty than under a high level of ambiguity, depending on the level of pessimism. However, if $d^A > 5.36$, the individual will always donate more under ambiguity than under certainty.

Figure A7 – Function $g(d)$ with $g(Y) = -\frac{1}{\beta} \exp(-\beta(Y))$, $\delta = 0.3$, and $\beta = 0.5$

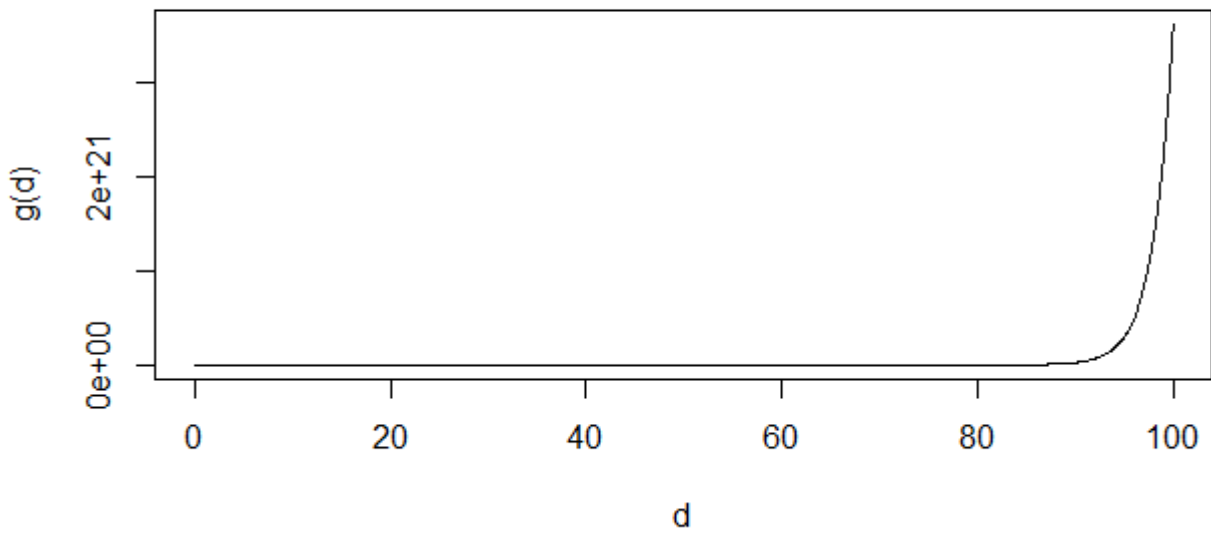


Figure A8 – Function $g(d)$ with $g(Y) = -\frac{1}{\beta}\exp(-\beta(Y))$, $\delta = 0.7$, and $\beta = 0.1$

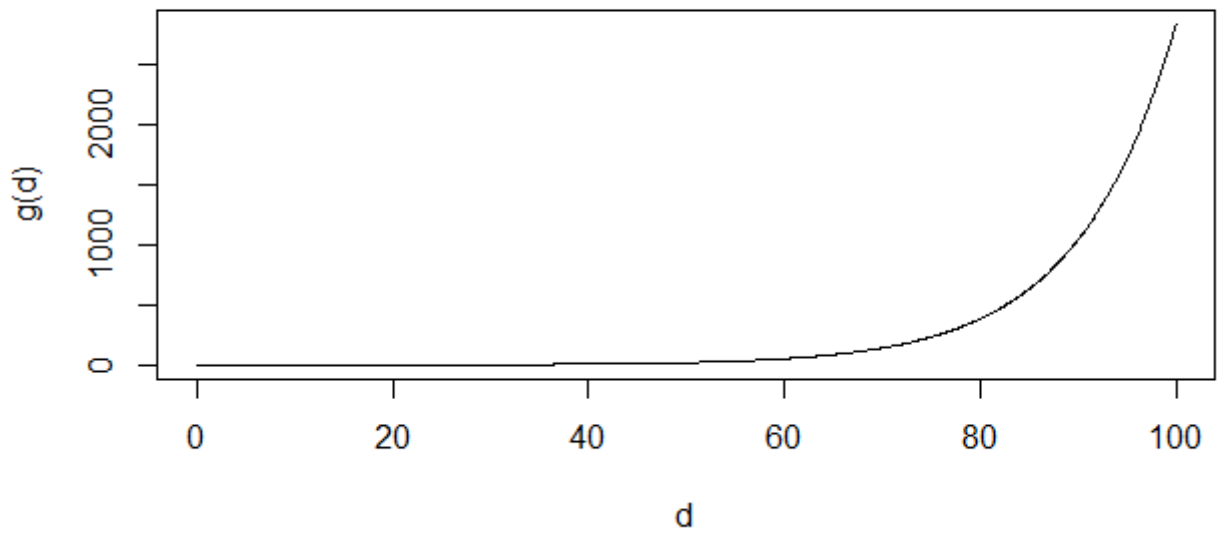
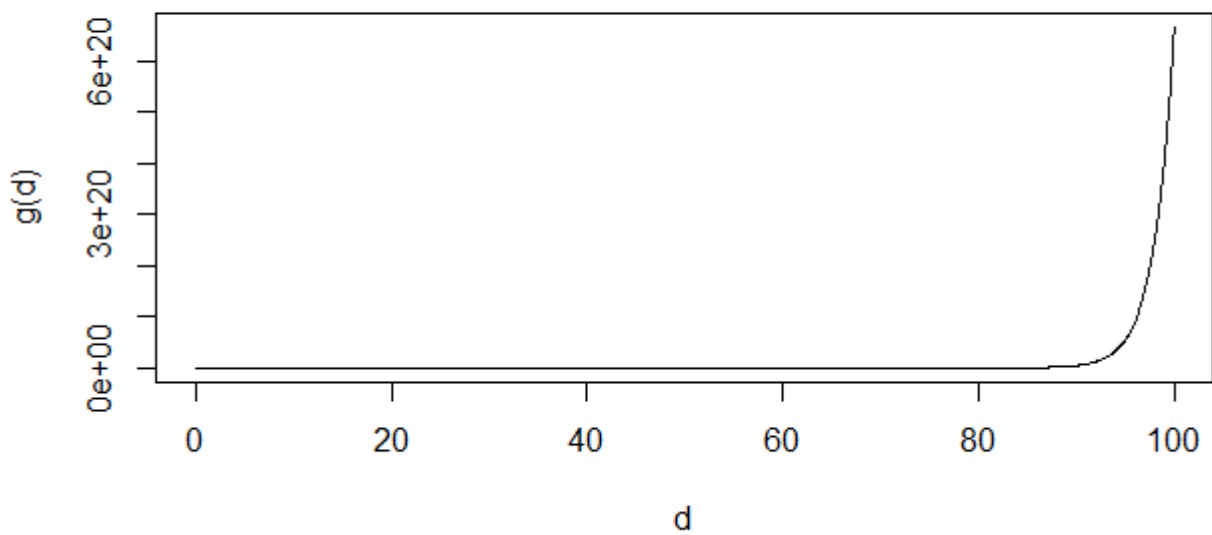


Figure A9 – Function $g(d)$ with $g(Y) = -\frac{1}{\beta} \exp(-\beta(Y))$, $\delta = 0.7$, and $\beta = 0.5$



2.C High ambiguity treatment instructions

The instructions were available on the screen and in paper format. They were carefully explained by the experimenter at the beginning of the experiment and at each task of the experiment. Participants had the possibility to ask any questions at the end of the explanation and at any time during the experiment. They did not know the procedure for the constitution of the urn before the beginning of the experiment.

Welcome!

Thank you for agreeing to participate in this experiment! You are participating in an experiment where you can earn money based on your choices. Your earnings will also depend on different events. Each participant makes their decisions individually on their computer.

The answers to these questions are important to us and will be completely anonymous and confidential.

This experiment consists of **six** completely independent parts.

Throughout the experiment, and based on your decisions, you can earn ECUs.

Your earnings are expressed in ECUs. Your total earnings for the experiment correspond to the total amount of ECUs accumulated.

At the end of the experiment, your ECU earnings will be converted to euros at the rate of 100 ECUs= € 7.50 euros (1 ECU= € 0.075).

The “donations” part of the experiment will guarantee you ECU earnings.

Of the six parts of this experiment, **four parts can also allow you to earn additional money: the “risk” part, the “colors” part, the “association” part, and the “lottery” part.** We will explain the procedure at the beginning of each part determining your earnings.

The experiment has a total of 290 decisions. Each decision has been randomly assigned a number. We will ask you to choose a number between 1 and 290 that corresponds to the decision that determines your payment. At the end of the experiment, you will know what decision it is. At the beginning of each part, we will remind you that the decisions made in this part are part of the 290 decisions that

can earn you additional money.

As a thank you for your participation, you will receive 7 euros in addition to the earnings accumulated in the experiment.

The total payment of your earnings in euros will be made in cash and privately at the end of the experiment.

The following two parts will appear randomly.

Stage “Risk”

In this part of the experiment, your choices will have no impact on the following parts of the experiment and will only impact your earnings.

You will have to make 10 decisions. On the next screen, you will find 10 lines, each corresponding to a decision.

The decision for each line is to indicate the option you prefer between option A and option B.

You can change from one option to another only once.

Note that in this part of the experiment, the decisions you make will not impact your earnings determined in the “donation” part of the experiment. If this part of the experiment is chosen, you can earn an additional gain based on your decisions.

This part of the experiment may determine your additional earnings based on the number you chose at the beginning of the experiment.

Stage “Colors”

In this part of the experiment, you will successively see six tables.

In each of the six tables, you have 20 decisions to make. For each decision, you must choose **the option that you prefer** between option A and option B.

Within a single table, option A remains the same throughout the 20 decisions you have to make.

Regarding option B, the probability (chances) of winning ECUs increases with each row.

Once you have chosen option B, you can no longer choose option A for subsequent decisions.

If one of the tables in this section is chosen to determine your additional payment, then at the end of the experiment, we will randomly draw one marble from 30 marbles. Three colors of marbles are present in the urn: blue, violet, and orange.

You do not know the number of marbles for each color (**unknown probabilities**).

You will be paid based on your decisions and the marble's color drawn at random.

Note, in this part of the experiment, the decisions you make will not affect your gain determined in the "give" part. If this part is chosen, you can receive an additional gain based on your decisions, and the marble's color will be randomly drawn at the end of the experiment.

This part of the experiment is likely to determine your additional gain based on the number you chose at the beginning of the experiment.

Stage "Donation"

In this section, we will propose that you donate to an environmental association of your choice.

We will present you with a list of environmental associations. You must choose one from the following list. Your donations will actually be transferred to the association you have chosen.

We have specified for each association its mission, as specified on its website. The associations are presented in alphabetical order.

Greenpeace: "Greenpeace is an international network of independent organizations that act based on non-violent principles to protect the environment, biodiversity, and promote peace. It relies on a movement of engaged citizens to build a sustainable and equitable world."

WWF: "Since 1973, WWF France, a public utility foundation, has acted on a daily basis to offer future generations a living planet. We act to curb environmental degradation and build a future where humans live in harmony with nature."

Zero Waste France: "They defend an ambitious zero waste, zero waste approach, which prioritizes source reduction. Their vision is part of a global ecological transition, respect for human rights and a better consideration of the most disadvantaged populations and future generations."

--

We will now explain how you can make your donation.

We give you an amount of 100 ECUs and you must choose an amount that you want to donate to the association you have chosen, this amount must be between 0 and 100 ECUs.

You will keep the remaining ECUs for certain that you have decided not to donate to the association.

The total number of ECUs is equal to 100, that is, the sum of ECUs Kept (EG) by you and the ECUs Given (ED) must be equal to 100 ($EG + ED = 100$).

The ECUs that the association will receive will depend on the ECUs that you have given and the color of the marble that will be drawn at the end of the experience.

This amount will be actually paid to the association of your choice.

— —

We will now explain the random draw that will take place at the end of the experiment.

The exact amount you will give will not always reach the NGO. **Three outcomes are possible:** either the association will receive 0 ECUs, or it will receive the exact amount you have given the NGO, or it will receive double the ECUs you have given the NGO.

We will draw a marble from an unknown or known composition urn.

In order to determine which urn we will draw the ball from, we will conduct a pre-draw to determine whether we will use the known or unknown composition urn.

This first urn is composed of 10 balls: 3 orange balls and 7 white balls.

If the white ball is drawn: with **70%** chances, we have **no information** about the probabilities of the three outcomes: we will draw a marble from an unknown composition urn.

If the orange ball is drawn: with **30%** chances, we know the exact **probabilities** of each outcome: we will draw a marble from a known composition urn.

These probabilities are:

There is a **60%** chance that the association will receive **exactly the number of ECUs** that you have decided to give it (ED). This will happen if a blue marble is drawn at the end of the experiment. There are 18 blue marbles among the 30 marbles in the known composition urn.

There is a **30%** chance that the association will receive **twice the number of ECUs** that you have decided to give it ($2 \times ED$). This will happen if an orange marble is drawn at the end of

the experiment. There are 9 orange marbles among the 30 marbles in the known composition urn.

There is a **10%** chance that the association will receive **nothing** ($0 \times \text{ED}$), regardless of the ECUs you have decided to give it. This will happen if a purple marble is drawn at the end of the experiment. There are three purple marbles among the 30 in the known composition urn.

At the end of the experiment, **one of the three outcomes will occur**.

The realization of one of the outcomes will depend on the color of the marble, which will determine the amount of donation the NGO will receive.

This part of the experiment will determine your gain independently of the number chosen at the beginning of the experiment. This part will not determine your additional gain.

Stage “lottery”

This part of the experiment is completely independent of the choices made in the donation part.

In this part of the experiment, two tables will appear successively.

In each table, you will have to make 20 decisions (each table has 20 lines).

Each decision involves choosing your preferred option between options A and B.

Option A **does not change** depending on the decisions (lines), whereas choosing option B means the amount you (or the organization) can win **changes**.

If you choose option A, a lottery will be drawn, and based on the result, the organization will receive additional ECUs (either 0, 30, or 60 ECUs).

If you choose option B, the organization (you) will win additional ECUs for sure.

The decisions you make can impact your payment and the amount received by the NGO.

Note: In this part of the experiment, the decisions you make will not impact the amount (ECUs given) that the organization will receive, which was determined in the “donation” part of the experiment, nor your kept ECUs (you will receive your kept ECUs from the “donation” part of the experiment for sure).

If this part of the experiment is chosen, you or the organization can earn additional money based on your decisions and the color of the marble drawn at the end of the experiment.

This part of the experiment may determine your additional earnings based on the number you chose at the beginning of the experiment.

Reminder:

If the known composition urn is drawn (30% chance), then we will present you with an urn with 30 marbles and three colors: Blue (18 marbles), violet (3 marbles), and orange (9 marbles).

If the unknown composition urn is drawn (70% chance), then we do not know the number of marbles for each color (unknown probabilities).

You and the organization will be paid based on your decisions and the color of the marble drawn at the end of the experiment.

Stage “NGO”

In this part of the experiment, you will see six tables in succession.

In each of the six tables, you have 20 decisions to make. You must choose the **option that you prefer** between option A and option B.

Be careful, once you have chosen option B, you cannot choose option A anymore.

Within the same table, option A remains the same throughout the 20 decisions you have to make. As for option B, the probability (the chances) of winning ECUs increases with each line.

If one of the tables in this part is chosen, then the marble's color drawn at the end of the experiment will determine your additional gain.

Reminder: If the known composition urn is drawn (30% chance), then we will present you with an urn with 30 marbles and three colors: Blue (18 marbles), violet (3 marbles), and orange (9 marbles).

If the unknown composition urn is drawn (70% chance), then we do not know the number of marbles for each color (unknown probabilities).

Note: In this part of the experiment, the decisions you will make will not affect the amount (ECUs given) that the association will receive, nor your ECUs kept (you receive your ECUs kept from the *donation* part of the experiment). If this part of the experiment is chosen, you can obtain an additional gain based on your decisions and the color of the marble drawn at the

end of the experiment.

This part of the experiment is likely to determine your additional gain, based on the number you chose at the beginning of the experiment.

The amount that the association will receive only depends on the choice you made in the previous part and the color of the marble drawn at the end of the experiment.

2.D New Environmental Paradigm scale

This survey was originally created by (Dunlap et al., 2000).

In this part of the experiment, you will find sentences about the relationship between humans and the environment. For each sentence, indicate if you don't know - if you strongly disagree - if you somewhat disagree - if you strongly agree - if you strongly agree.

1. We are approaching the limit of the number of people the Earth can support.
2. Humans have the right to modify the natural environment to suit their needs.
3. When humans interfere with nature it often produces disastrous consequences.
4. Human ingenuity will insure that we do not make the Earth unlivable.
5. Humans are seriously abusing the environment.
6. The Earth has plenty of natural resources if we just learn how to develop them.
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
9. Despite our special abilities, humans are still subject to the laws of nature.
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
11. The Earth is like a spaceship with very limited room and resources.
12. Humans were meant to rule over the rest of nature.
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue on their present course, we will soon experience a major ecological catastrophe.

Behavior related to donations

Have you already donated to an NGO?

[If the participant answered "yes" to the previous question]

How often do you donate?

- Several times a year
- Approximately once a year

- Every 2-3 years
- Less than every 2-3 years
- Never

Was the donation(s) directed to an environmental association?

When you make a donation, how much do you give on average (in euros)?

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CORRECTING NEGATIVE EXTERNALITIES: AN EXPERIMENT ON THE ACCEPTABILITY OF TAXES AND REGULATORY STANDARDS¹

Abstract

This paper investigates the acceptability of public policies seeking to mitigate negative externalities through a majority vote. We use an unframed laboratory experiment where participants face a negative externalities game, and we introduce public policies through taxation policies and bans with available alternatives. The participants are asked to vote for or against the policy implementation before and after experiencing the game and a policy trial. We explore the influences of policy trial experiences, cultural worldviews, and the support of bans and taxes on policy decisions. The results indicate that support for regulatory standards is higher than for taxes. We also find that experience from a policy trial affects regulatory standards' acceptability exclusively. Moreover, the study demonstrates that hierarchical cultural worldviews decrease support only for taxation policies.

1. This chapter is a joint project with Alexandre Cambo.

3.1 Introduction

To limit negative externalities, policymakers can use market-based instruments to ensure the internalization of the supplementary costs relative to the negative externality. Negative externalities occur when the production or consumption of a good has a negative impact (generates a cost) on a third party without any compensation. The most known examples of negative externalities are environmental, such as deforestation, water pollution, or air pollution. The latter is the world's most important health risk and a major cause of environmental degradation. Worldwide, premature deaths associated with PM2.5 fine particles pollution have increased.² In order to correct negative externalities, it is possible to implement a price policy, such as a corrective tax or a subsidy. Another remedy is the implementation of regulatory standards, where the government imposes the production/consumption of the socially optimal quantity. Theoretically, price policies and regulatory standards properly calibrated yield the same result, attaining the social optimum.

However, public policies may fail in practice because of inadequate implementations or unintended consequences. They can also fail because of a lack of public support, which can be explained for some reasons. For instance, the population might not be aware of the policy's implications and mechanisms, the policy can go against individual interests, or a lack of communication from policy-makers generating a misunderstanding of the policy. Culture can shape political convictions and beliefs that will thus influence the support for public policies. Political polarization and lack of trust in government may lead to a lack of public support based on political affiliation, independently of the actual efficacy of the policy. Understanding the different determinants of public support is necessary before implementing a public policy to avoid side effects such as social movements that can undermine social cohesion or confidence in government. For example, Australia's carbon tax was implemented in July 2012 despite the lack of public support. A majority of Australians (62 %) agreed that "The carbon tax will have no significant

2. OECD (2020), *Environment at a Glance 2020*, OECD Publishing, Paris, <https://doi.org/10.1787/4ea7d35f-en>.

impact on reducing the total worldwide volume of carbon dioxide put into the atmosphere”.³ Finally, in July 2014, the Australian government abolished the policy. For example, France’s yellow vests movement presents a case of a lack of public support regarding the implementation of a public policy. In 2018, the Yellow Vest movement initiated widespread protests in response to the increase in gasoline prices, which was carried out within the framework of an environmental public policy and resulted from a non-degressive tax. Consequently, the government was compelled to abandon the policy implementation. In this paper, we propose an unframed experiment where we study the acceptance rate of public policies through a majority vote to understand the different determinants of the acceptance rate of public policies.

It is essential to study the acceptability of public policies since their rejection prevents attaining the maximization of social welfare and the correction of negative externalities that can cause avoidable costs to the population. It can result in the removal of the policy, which can be costly for the government. For instance, the “Red caps” (*Bonnets rouges*) movement emerged as a protest in Brittany (France), in 2013, opposing the *écotaxe* – a tax designed to address the negative environmental externalities trucks produce. The abandonment of the tax posed a burden on the government, as the tolls constructed to collect the tax were installed yet remained unused. The state was required to pay a termination indemnity of 776.79 million euros for abandoning the partnership contract with the tax collector operator.⁴

The lack of public support regarding environmental public policies may explain why it is difficult to fight against climate change nowadays. Theoretically, the introduction of a public policy aiming to correct negative externalities increases social welfare through the internalization of the negative externality by the polluting agent. However, these policies might also have negative consequences individually, such as distributional impacts. On one hand, carbon taxes or regulations impose costs on polluters or high-emission industries which can be reflected in an increase in prices for consumers. Moreover, flat taxes borne directly by consumers increase

3. Robson, A. (2014), Australia’s Carbon Tax: An Economic Evaluation. *Economic Affairs*, 34: 35-45. <https://doi.org/10.1111/ecaf.12061>

4. Rapport public annuel 2017 - Tome I - L’écotaxe poids lourds : un échec stratégique, un abandon coûteux - février 2017, Cour des comptes. <https://www.ccomptes.fr/fr/publications/le-rapport-public-annuel-2017> - Link available on April 19, 2023.

inequalities since high-income individuals can easily pay the tax and it is seen as a burden for low-income individuals and unfair. On the other hand, regulations can be seen as highly restrictive in terms of freedom of choice, but also prohibiting the consumption of a good leads generally to forcing individuals to switch to greener options which are usually more expensive than the polluting ones, also leading to a sense of unfairness highlighting the unequal access to resources. For example, if we think about transportation mode choice, banning polluting cars would force individuals to switch to electric vehicles, which are usually more expensive; or to use public transportation, however, this option is not always possible for some individuals because of its availability. Even though, theoretically, the different public policies have the same objective which is maximizing social welfare, different public policies do not yield the same fairness implications which can lead to different levels of acceptability.

Furthermore, the rejection of environmental public policies may not be exclusively due to climate skepticism, as it can be shown by the yellow vests movement. This movement initially appeared to be “anti-environmental”, however, the yellow vests were not rejecting environmental policies due to climate skepticism but would be bearers of an alternative vision of ecology, more “popular” and aiming at articulating the demand for social justice and environmental justice, since they do not appear to be more or less ecologist than the rest of the population.⁵ Drawing upon this example, conducting a laboratory experiment that explores the acceptability of environmental policies without explicitly framing it in an environmental context becomes relevant since it allows us to study the motivations that influence policy acceptance beyond climate skepticism. It allows us to have a more comprehensive understanding of the factors that shape policy support.

One way to increase public support is to raise awareness and improve information concerning public policies. The objective is to ensure that individuals are well-informed about the benefits of a public policy before its implementation. [Dechezleprêtre et al. \(2022\)](#) find that informing about climate policies significantly increases support for climate policies. One way to rise information

5. Dormagen, J., Michel, L. & Reungoat, E. (2021). Quand le vert divise le jaune: Comment les clivages sur l'écologie opèrent au sein des Gilets jaunes. *Écologie & politique*, 62, 25-47. <https://www.cairn.info/revue-2021-1-page-25.htm>.

about policies is through a policy trial. A policy trial increases the comprehension of the policy and makes its benefits more apparent.

This paper aims to answer the following questions under the framework of available options (or imperfect substitutes) to the polluting good: Does acceptability vary across different policy instruments? Does experience from a policy trial influence acceptability? Do individual attributes impact the acceptability of different policies? We seek to compare the acceptability of regulatory standards and taxes to evaluate individuals' responses to future restrictions. Furthermore, we seek to study the extent to which users are biased toward public policies according to their beliefs. To that aim, we conduct a laboratory experiment in which participants face a negative externalities game. To examine the impact of public policies, we introduced two distinct policy interventions - taxation and regulatory standards - to each experimental treatment, subjecting the participants to a policy trial. Furthermore, we ask the participants to vote for or against public policy implementation. Our unframed experiment simulates the transportation market by presenting participants with options corresponding to different transportation modes, such as electric vehicles, public transportation, and diesel or petrol vehicles. It is important to note that the experiment is conducted in an entirely unframed context. This gives us the advantage that the results can be widely applied to any market generating negative externalities.

In addition to acceptability, we seek to understand the psychological determinants driving a public policy rejection. The cultural construction of opinions may play a role in the beliefs and perception of public policies. The idea is that cultural commitments are formed before beliefs. Cultural worldviews shape how people access, process, and assess policy information ([Kahan et al., 2011](#), [Cherry et al., 2017](#)). We seek to verify if cultural worldviews have an impact on the acceptability of public policies and see if this effect is stable after experiencing the game and a policy trial. Increasing the understanding of regulatory standards and taxation policies through a policy trial could diminish the importance of beliefs about policies through the comprehension of the mechanisms and positive impact of public policies. The novelty of this paper, compared to [Cherry et al. \(2017\)](#), is that we enlarge the possibilities of choice by proposing a market with three different goods and adding heterogeneity. In contrast to previous experimental literature,

we propose bans with available alternatives, offering a more realistic representation of public policy scenarios. For example, if we focus on transportation mode choice, support for climate public policies is more likely to be higher in a city with public transport available than in a city with none (Dechezleprêtre et al., 2022).

In this paper, we find an increase in the acceptability of regulatory standards after a policy trial. However, we do not find this effect after a taxation trial. We also find that regulatory standards are more accepted than taxation policies. Furthermore, we find that possessing hierarchical worldviews might decrease the acceptability of public policies, yet in our results, individualistic worldviews do not impact public policy support. Our results suggest that it is difficult to change people’s preferences, even after pedagogical efforts, when specific policy aversion is high.

The paper is organized as follows: section 3.2 presents the literature review, section 3.3 presents the experimental design, section 3.4 details the predictions of the experiment, and section 3.5 presents the results. Finally, section 3.6 concludes.

3.2 Literature review

This paper is related to the literature on attitudes towards climate policies (see the review by Fairbrother, 2022) and attitudes on the acceptability of carbon taxes (see the review by Carattini et al., 2018).

The experimental literature focuses mainly on laboratory experiments. Our paper contributes to this literature. Some papers study the acceptability across public policies in an unframed setup, such as Cherry et al. (2012, 2017) and Heres et al. (2017), where the authors find that subsidies are more accepted than taxes. This result appears as a paradox since economists regard taxation as the least costly policy per unit of pollution abatement (Fairbrother, 2022). Cherry et al. (2012) find that individuals support more taxes than regulatory standards, claiming that the most coercive policy instrument usually receives the least support. However, Cherry et al. (2017) do not find any difference in the acceptability.

Some surveys have studied the acceptability across climate policies. For example, in a survey,

[Dechezleprêtre et al. \(2022\)](#) find that carbon taxes and taxes on fossil fuels appear to be amongst the least popular policies, and there is higher support for bans than for taxes. They find that the preference for different policy instruments varies across countries. Overall, support is the lowest in Australia, France, and Germany and the highest in China and India. [Douenne and Fabre \(2022\)](#) find that French people will largely reject a tax and a dividend policy. [Douenne and Fabre \(2020\)](#) find a significant rejection of the carbon tax, but most support stricter norms and green investments. Furthermore, surveys focus on the determinants of support for policies. In [Kallbekken and Sælen \(2011\)](#), the authors find that beliefs about environmental consequences influence support for environmental taxes. [Carattini et al. \(2017\)](#) find that distributional and competitiveness concerns reduce the acceptability of energy taxes. [Douenne and Fabre \(2020\)](#) show that changing people's beliefs can increase support. [Dechezleprêtre et al. \(2022\)](#) study the support for other climate policies such as a tax on flying or subsidies for low-carbon technologies. These studies highlight the importance of beliefs about the impact of public policies in their lack of support. It is, therefore, necessary to study mechanisms to correct any misperceptions of the impact of public policies and account for individuals' beliefs.

The experimental literature also focuses on the determinants of support for climate policies. [Janusch et al. \(2021\)](#) and [Cherry et al. \(2014\)](#) studies how increasing comprehension of public policies through the implementation of a policy trial impacts acceptability. The authors study the impact of trial runs on the acceptability of a toll and an environmental tax, respectively, through a majority vote. Both studies find a positive impact of a policy trial on acceptability. [Cherry et al. \(2017\)](#) study the support across different instruments after having experienced the policy, they find that the level of policy aversion declines over time. However, they do not study how experiencing the instrument-specific regulatory standard impacts support, they also find that experience with efficiency-enhancing instruments increases the probability of supporting an instrument. However, it does not have any significant effect on the tax models. [Cherry et al. \(2017\)](#) and [Janusch et al. \(2021\)](#) focus on the impact of cultural worldviews on perceptions of social issues and policy on policy support. In the latter, the authors study how worldviews play a role in the acceptability of a toll with a heterogeneous impact of the toll among the

participants. Tiezzi and Xiao (2016) examine the effect of delaying the benefits of taxation on support for taxes. They find that people are less willing to accept Pigouvian taxes when negative externalities are delayed.

Our experiment aims to enrich this literature by studying the acceptability of different public policies experimentally after experiencing a policy trial and the role of cultural worldviews in support of public policies. As seen above, the literature studies these research questions, however, not in the same experiment. The novelty of this paper is that we propose a market with imperfect substitutes to the polluting goods, which has not been studied to our knowledge. Finally, we analyze how experiencing the game and a policy trial can change the impact of cultural worldviews on the acceptability of instrument-specific policy, verifying the evolution of the impact of worldviews on the support of corrective policies.

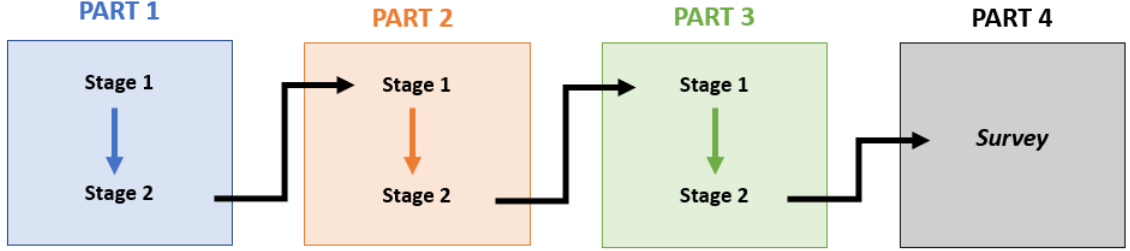
3.3 Experimental design

3.3.1 The game

The experiment aims to investigate if the acceptability of a public policy increases after experiencing its implementation. This design consists of two treatments: taxation and regulatory standards treatment.

At the beginning of the experiment, the computer randomly constitutes groups of six participants and assigns to the player a number: $player = \{1, \dots, 6\}$. The composition and the number remain the same throughout. The game comprises three parts, each consisting of two stages: one vote (stage 1) and the negative externalities game (stage 2) as explained in Figure 3.1. In each part of the experiment, participants have to vote for or against the implementation of a public policy before having played the game under different configurations of the game (implementation or non-implementation of the policy).

Figure 3.1 – Summary of the experiment



Stages

Stage 1: Vote

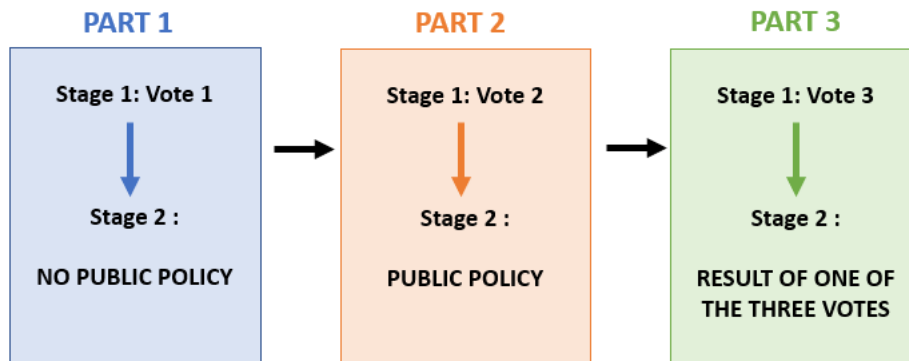
Stage 1 consists of participants voting for or against implementing the public policy, depending on the treatment. It is important to note that there are only three votes in the experiment. The votes are only considered in Stage 2 of Part 3; this will be explained later in this section.

Stage 2: negative externalities game

We create a negative externalities game where participants can choose one option among options A, B, or C, each option representing the purchase of a good. Option C yields a negative externality to all the members of the group which can be corrected through a Pigouvian tax or a ban (regulatory standards). At the beginning of each round, the participant is endowed with 100 ECU (Experimental Currency Units). The game comprises five rounds for each part of the experiment (15 rounds in total). We included five rounds in each part of the experiment in order to create a learning effect so that the participants could understand the effect of the negative externality and of the implementation of a policy. Having a repeated game allows the participants to understand the positive impact of the public policy. At the end of each round, the participants know their payoff from the previous round and the number of group members that choose each option.

The public policy may or may not be implemented depending on the part of the experiment. In the first part of the experiment, no public policy is implemented in order for the participants to experience the negative externalities game and understand the mechanisms of negative exter-

Figure 3.2 – Summary of the game



nalities. In the second part of the experiment, the public policy (depending on the treatment) is implemented; this part of the experiment represents a policy trial. It allows the participants to understand the benefits of the implementation of the policy. Finally, in order to take into account the votes of each part of the experiment, in the third part a volunteer participant randomly chooses one of the three votes, and the result of the drawn vote is implemented in the third part of the experiment for every group in the session. The summary of the main task is shown in Figure 3.2.

Payoff

The payoff function in each round is given by the initial endowment, the earnings, the cost of each option, and the option choice of the other group members. The costs of all options and the gross gains for options A and C are constant for every type of player and over time. Option C generates the negative externality. If one group member selects option C, they impose an additional 15 ECU cost on themselves and to the other members of her group. If two members choose option C, each player incurs a 30 ECU supplementary cost, and so on. Heterogeneity is introduced to represent different preferences across individuals, as the earning from option B vary for each player type from 1 to 6, they are constant over the game. The game is constructed such that any participant's dominant strategy is selecting option C, resulting in a Nash equilibrium when all participants choose option C. The second best option for players 1, 2, and 3 is option

Figure 3.3 – Earnings and costs for Player i

Player $i=\{1,...,6\}$

	Option A	Option B	Option C
Earning_{i}	200 ECU	X_i ECU $X_i = \{80, 90, 100, 125, 135, 145\}$	200 ECU
Cost	100 ECU	20 ECU	50 ECU
Loss	0 ECU	0 ECU	15 ECU

Initial endowment in each round: 100 ECU

X_i ECU denotes the earnings for player i , respectively.

A, while for players 4, 5, and 6, is option B. The Nash equilibrium and the social optimum of the game are further discussed in subsection 3.3.3.

The payoff of the participant when there is no implementation of the public policy is represented by the following:

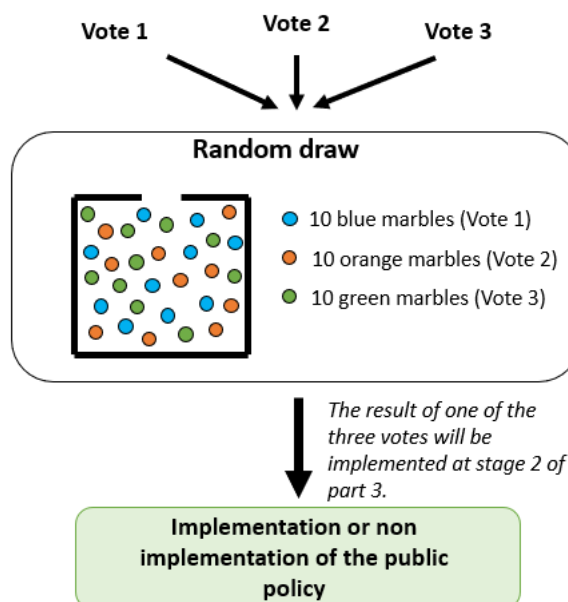
$$\pi_{ik} = w_0 + g_{ik} - c_{ik} - \sum_{i=1}^6 n_{ic} \times 15, i = \{1, ..., 6\}, \quad k = \{A, B, C\}$$

Where π_{ik} denotes the payoff of player i having chosen option k . w_0 denotes the initial endowment of 100 ECU, g_{ik} denotes the gross gain of participant i for choosing the option k , c_{ik} is the cost of participant i for choosing option k , and n_{ic} is the number of members of the group having chosen option C (including player i). We will explain the participant's payoff when the public policy is implemented in subsections 3.3.2 and 3.3.2.

Policy implementation procedure

In Stage 2 of the third part of the experiment, the result of one of the three votes is implemented. We implement this procedure in order to take into account the first two votes. During the *third part* of the experiment, after Stage 1 (vote 3) and before Stage 2, the experimenter creates an urn composed of 30 marbles: 10 blue, 10 orange, and 10 green. A volunteer participant randomly chooses one marble from the urn. If the blue marble is chosen, the first vote result of each group is implemented. If it is an orange marble, the result of vote 2 is implemented, and finally if it is a green marble, the result of vote 3 is implemented for each group. As a result, the public policy may or may not be implemented in Stage 2 of the third part of the experiment, depending on the draw and the voting outcomes. The procedure is summarized in Figure 3.4. In case of a tie within a group (three for and three against the implementation of the public policy), the experimenter will roll a die. If it is an odd number, the public policy will not be implemented; if it is an even number, the policy will be implemented.

Figure 3.4 – Random draw



3.3.2 Treatments

Regulatory standards treatment

In the regulatory standards treatment, participants are asked to vote for or against the implementation of a regulatory standard in the last part of the experiment (Part 3 - Stage 2). In the parts where the regulatory standard is implemented, the participants can no longer choose option C, but only option A or option B.⁶ In this case, there is no negative externality or supplementary loss to the participants.

Under the regulatory standard, the payoff function π_{ik} for player i becomes:

$$\pi_{ik} = w_0 + g_{ik} - c_{ik}, i = \{1, \dots, 6\}, \quad k = \{A, B\}$$

Where π_{ik} denotes the payoff of player i having chosen option k . w_0 denotes the initial endowment of 100 ECU, g_{ik} denotes the gain of player i for choosing the option k , c_{ik} is the cost of participant i for choosing option k .

Taxation treatment

In the taxation treatment, we introduce a Pigouvian tax. The agent that generates the negative externality pays the tax and therefore takes into account the costs imposed on a third party. Under the framework of negative externalities, the external cost (the cost imposed on a third party) is not taken into account as a private cost by the agent producing the negative externality. The Pigouvian tax corresponds to the marginal external cost. In this game, the total external cost equals the negative externality imposed on the *other* members of the group multiplied by the number of group members having chosen option C. Therefore, choosing option C generates a supplementary cost to each other group member equal to 15; there are six group members, and the externality is imposed on all the members of the group, excluding the participant having

6. This policy seems highly restrictive. However, we decided to implement it in order to represent existing cases (see subsection 3.3.5).

chosen option C.⁷ Considering a group of six members, the total external cost is equal to 75 ($15 \times 5 \times 1$) for one member having chosen option C. It is equal to 150 ($15 \times 5 \times 2$) for two members having chosen option C, etc.

The total external cost (EC) is equal to:

$$EC = \sum_{i=1}^6 n_{ic} \times 75$$

where n_c is the number of participants choosing option C, the marginal external cost is equal to 75.

At every voting stage (Stage 1), participants have to vote for or against implementing a tax in Stage 2 of the third part of the experiment. In the parts where the tax policy is implemented, if the participant chooses option C, she will have to pay a Pigouvian tax of 75 ECU.⁸ At the end of each round, the collected amount of taxes is equally redistributed among the six group members.⁹ For example, if only one group member chose option C, thanks to the redistribution, each participant will receive a supplementary payoff of $\frac{75}{6} = 12.5$ ECU. If two group members choose option C, each group member will receive $\frac{2 \times 75}{6} = 25$ ECU, etc.

Under the taxation policy, the payoff function π_i for player i is:

$$\pi_{ik} = w_0 + g_{ik} - c_{ik} - \sum_{i=1}^6 n_{ic} \times 15 - t_k + \frac{\sum_{i=1}^6 n_{ic} \times t_c}{6}$$

with $i = \{1, \dots, 6\}$, and $k = \{A, B, C\}$.

Where π_{ik} denotes the payoff of player i having chosen option k . w_0 denotes the initial endowment (100 ECU), g_{ik} corresponds to the gain of player i for choosing the option k . c_{ik} is the cost for the player i , having chosen option k . n_c is the number of participants in the group that chose option C. Finally, t_k is the tax that the player i has to pay for choosing option k ,

7. We do not consider the supplementary loss that the participant that chooses option C incurs since it is considered a private cost for herself or an externality.

8. The theoretical justification of the level of the Pigouvian tax can be found in our theoretical model in Appendix 3.A.

9. We decided to equally redistribute the amount of tax collected as done in the literature (Cherry et al., 2012, 2017, Heres et al., 2017).

with $t_A = 0$, $t_B = 0$ and $t_C = 75$. The total amount collected from the tax is $n_c \times 75$.

3.3.3 Strategies: Nash equilibrium and social optimum

Negative externalities result in a discrepancy between private costs and social costs. In other words, the cost incurred by an individual or firm engaged in an economic activity may not reflect the true cost to society as a whole. This can lead to market failure, where the market fails to allocate resources efficiently. In this case, the quantity produced or consumed of the good generating the negative externality will be larger than at the social optimum. The Nash Equilibrium is defined by the correspondence of each individual's best response function simultaneously. The theoretical model is shown in the following. Our detailed theoretical model in Appendix 3.A shows the predictions.

Following the experimental design, the participants can choose between three different options. Let's assume that two strategies (two options) always dominate one strategy (one option), either option A or B. The economy is composed of N individuals. We denote x_i , a variable equal to 1 if the individual chooses option C and equal to 0 if not. w_0 represents the salary, g_{ik} corresponds to the gain of individual $i = 1, \dots, N$, yielded from choosing option $k = A, B$. c_{ik} is the cost of individual $i = 1, \dots, N$, from choosing option $k = A, B$. g_C denotes the gain from choosing option C and c_C is the cost. E denotes the externality produced from choosing option C.

The following maximization program gives the individual's problem with strategic interactions at the Equilibrium. This program does not take into account the supplementary external costs of choosing option C:

$$\max_{x_i} U(x_i) = x_i \times (w_o + g_C - c_C - E) + (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - \sum_{j \neq i}^N x_j E$$

The solution to the individual's problem, denoted x_i^* , is defined by:

$$x_i^* = \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq 0 \\ 0 & \text{otherwise.} \end{cases}$$

Replacing the parameters given by the experimental design, we show that $x_i^d = 1$ since the following inequality is verified for any player:

$$g_C - g_{ik} + c_{ik} - c_C - E \geq 0$$

Showing that under the framework of this experiment when no public policy is implemented, the dominant strategy of each individual is to choose option C. Therefore, the Nash Equilibrium corresponds to the configuration where every player chooses option C.

The following maximization program gives the maximization of a social welfare function represented by the sum of utilities:

$$\max_{x_i, \dots, x_N} W = \sum_{i=1}^N x_i \times (w_0 + g_C - c_C - E) + \sum_{i=1}^N (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - N \sum_{j \neq i}^N x_j E$$

The simultaneous solutions to the social planner's maximization problem, denoted x_i^{sp} , is defined by:

$$\begin{aligned} x_1^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{1k} + c_{1k} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \\ &\vdots \\ x_i^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \\ &\vdots \\ x_N^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{Nk} + c_{Nk} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \end{aligned}$$

Replacing the experiment's parameters, we find that the following inequality is not verified for any of the players:

$$x_i^{sp} = \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq (N - 1)E \end{cases}$$

Therefore the strategies that maximize welfare among each group is that players 1, 2, and 3 choose option A, and players 4, 5, and 6 choose option B, because of heterogeneity introduced in the gain matrix. The social optimum yields a welfare of 645, higher than the welfare at the Nash Equilibrium, equal to 450. At the social optimum, there are no external costs; no players choose option C, therefore, there are no negative externalities. The model and the experimental design show that both treatments are equivalent since they both yield the same level of social welfare.

Introducing public policies aims to correct negative externalities by incentivizing individuals to adopt the strategies that yield the social optimum and maximize welfare. When implementing a public policy under this framework, the dominant strategies that result in the Nash Equilibrium are those that result in the social optimum. Figure 3.5 summarizes the strategies at the Nash equilibrium and the social optimum according to the implementation or non-implementation of a public policy.

3.3.4 Cultural worldviews

In the fourth part of the experiment, the participants must answer a post-experimental survey and some socio-demographic questions (age, gender, level of education, if the participant is a student or if she works). We use the short form of the survey from [Kahan et al. \(2011\)](#) in order to elicit individuals' cultural worldviews.

[Kahan et al. \(2011\)](#) develops the theory of cultural cognition, which suggests that individuals' views on societal risks are shaped by their cultural worldviews. This theory suggests that individuals form beliefs and attitudes based on their group identities and the values associated with those groups. Therefore, these worldviews would be directly linked to the acceptability of

Figure 3.5 – Nash equilibrium and social optimum

	No policy	Taxation	Regulatory standards
Nash equilibrium (NE)	NE = (C,C,C,C,C,C) Welfare = 360 Total External Cost = $75 \times 5 = 450$	NE = SO = (A,A,A,B,B,B) Welfare = 645 Total External Cost = 0	NE = SO = (A,A,A,B,B,B) Welfare = 645 Total External Cost = 0
Social optimum (SO)	SO=(A,A,A,B,B,B) Welfare = 645 Total External Cost = 0		

public policies. This survey measures individual worldviews across two dimensions: individualistic opposed to communitarian worldviews and hierarchical opposed to egalitarian worldviews. For individuals with individualistic worldviews, personal freedom, self-reliance, and limited government intervention are important. They can be more skeptical of public policies since for them it can be seen that their individual liberties are impeded. Those with a communitarian worldview value more social cooperation and collective responsibility, which would be more eager to the implementation of public policies. As explained by [Kahan et al. \(2011\)](#), “individualism measures attitudes toward social orderings that expect individuals to secure their own well-being without assistance or interference from society versus those that assign society the obligation to secure collective welfare and the power to override competing individual interests”. With statements such as: “The government should do more to advance society’s goals, even if that means limiting the freedom and choices of individuals”.

Furthermore, they define the dimension hierarchy-egalitarianism as “attitudes toward social orderings that connect authority to stratified social roles based on highly conspicuous and largely fixed characteristics such as gender, race, and class”. Individuals possessing hierarchical worldviews would respect authority and value traditional social structures, being more resistant to

public policies if they challenge hierarchies. On the contrary, those with egalitarian worldviews give more importance to social equality, they would be more accepting of public policies if they reduce inequalities. It is measured thanks to statements such as: “Society as a whole has become too soft and feminine”. The detailed survey is in Appendix 3.D.

3.3.5 Application: transportation mode choice

This experiment can be applied to a transportation mode choice framework. Decreasing CO₂ emissions has become a major pillar in terms of environmental objectives. It has mainly focused on transport since it represents a quarter of the European Union’s total CO₂ emissions, and road transport constitutes the highest proportion of overall transport emissions (in 2019, it emitted 72% of all European Union’s greenhouse gas emissions).¹⁰

As previously explained, the participants have the possibility to choose among three options: A, B, and C. In this unframed experiment, we could consider option A as an electric vehicle, option B represents public transportation, and option C a conventional vehicle (diesel or petrol cars). Option A and option C are constructed to yield the same gain, representing the utility of using a car. This earning is always higher than the gain from choosing option B, representing public transportation, which is less comfortable than using a car. Furthermore, the cost of using option A is the highest, representing higher prices for electric vehicles than for public transportation or conventional cars. The cost of choosing public transportation (option B) is the lowest. Furthermore, choosing option C yields a loss for every group member, which is not the case for other options. This loss represents a negative externality, and under this framework, air pollution from using diesel or petrol cars.

Moreover, we can illustrate different public policies thanks to this experiment. The regulatory standards treatment relates to banning polluting cars, for instance, in 2015, the “Zone à Faibles Emissions” (ZFE), or “low emission zone” was implemented in the Paris metropolitan area, with the aim of reducing polluting vehicles in the zone, with the aim of banning all polluting cars (diesel and petrol cars) by 2030 in the ZFE, implementing a zero-emissions policy. The tax

10. EEA Report No 2/2022. Decarbonizing road transport - the role of vehicles, fuels, and transport demand.

treatment relates to implementing a taxation policy or a toll for polluting cars as done in central London. Every diesel car produced before September 2015, and every petrol car produced before 2006, has to pay 12.5 pounds daily in order to enter central London. The effectiveness of this public policy has been demonstrated by a 44% reduction in toxic NO₂ concentrations in 2020.¹¹

3.3.6 Experimental procedures

The experiment was conducted at the Laboratoire d'Economie Expérimentale de la Défense (Courbevoie, France). The experimental laboratory is located in the Paris business district (La Défense), not within the university. Its location means that participants have heterogeneous characteristics and are not just students but also individuals working in the business district or living in the surrounding area. The experiment obtained approval from the ethics committee of the University of Paris Nanterre (CER-PN), and it was preregistered in *aspredicted.org*. 120 individuals took part in the experiment and were randomly assigned to one of the two treatment groups: 60 participants were assigned to the tax treatment, and 60 were assigned to the regulatory standards treatment. Sessions took place in October 2022 and January 2023. 47 participants were male (39.17%), the average age of the participants was 38.09 years old, and 35.83% of the participants were students. The experiment was developed using oTree ([Chen et al., 2016](#)).

At the end of the experiment, one round among the fifteen rounds was randomly chosen in order to determine the final payoff of the participant. The payoff exclusively depends on the negative externalities game. The session lasted, on average, one hour for the regulatory standards treatment and one hour and fifteen minutes for the taxation treatment. The average payoff was 16.60 euros (including a show-up fee of 7 euros). One ECU in the experiment equals 0.05 €. All participants received their payoff by bank transfer a few days after the experiment, the participants were aware before the inscription to the session that the experimental laboratory will pay them. Note that participants had at their disposal a calculator integrated into the experiment to facilitate calculations. After each option choice round, the participants had feedback on their

11. Press release, 5 times greater reduction in NO₂ in London than rest of the country, 7 August 2020, <https://www.london.gov.uk/press-releases/mayoral/5x-greater-reduction-in-toxic-no2-in-london> - Link available on May 6, 2023.

payoff and how the other group members behaved, they knew how many chose option A, B, or C.

The participants had to answer two comprehension questions: The result of which vote will be implemented in Stage 2 of Part 3? How many ECUs do you lose (without considering the cost of using the option you have chosen) if two participants in your group choose option C? 11 participants (9.17%) answered both questions incorrectly. We eliminated these participants from the database, which leaves us with 109 participants, 56 in the taxation treatment and 53 in the regulatory standards treatment. 47 participants (39.17%) answered at least one of the two questions incorrectly.

Likely, participants that answered one question incorrectly later understood the game’s mechanism. Before each voting stage, a reminder message was prominently written: “This vote could only be applied to Part 3”. In addition, feedback after each of the 15 rounds stated clearly how many group members chose option C and the additional cost that the choice yields. You can find screenshots of the reminder message and the feedback in Appendix 3.C. We ran the same analysis eliminating the 47 participants that answered at least one question incorrectly, and we found the same results as those presented in section 3.5. You can find the complementary analysis in Appendix 3.B.

We did not perform power calculations before doing the experiment, however, we can present an ex-post analysis using existing data prior to our experiment. We take the results from [Douenne and Fabre \(2020\)](#) survey, where 44% of the respondents support the banning of polluting vehicles in the city center, and only 14% of the respondents support the introduction of urban tolls, in order to be conservative, we assume a high standard deviation, 0.5 and 0.4 respectively, for both policies. The power analysis gives $n=37$ for each treatment for a power of 0.8 and a significance level of 95%.

3.4 Predictions

This experiment aims to test three main hypotheses. Our hypotheses are mainly taken from the literature.

Hypothesis 1 *Experience with the policy increases the level of acceptability.*

The implementation of a policy trial allows individuals to understand the policy in question, and it allows individuals to be aware of the benefits of a policy instrument. We assume that the level of acceptability will be higher for vote 2 than for vote 1. Between vote 1 and vote 2, participants play the game without any policy implementation. After having experienced the game and the impact of negative externalities, participants will understand how the game works, and how their choices and the others' choices will have a negative impact on their payoff. Furthermore, between vote 2 and vote 3, participants experience a policy trial (the implementation of the policy), increasing their comprehension of the policy and seeing more clearly the positive impact of a public policy, which is a limit for public support. This result is confirmed in both [Janusch et al. \(2021\)](#)'s and [Cherry et al. \(2014\)](#)'s experiments, in which participants voted to implement a policy before and after being subjected to a tax policy trial and adopted the tax more often in the later stages. In [Cherry et al. \(2017\)](#), there is an increase between votes: in vote 1, 55.2% of the participants voted in favor of the implementation of any of the proposed policies. In vote 2 they were 61%, and in vote 3, 67.1%. If we focus on the study by [Janusch et al. \(2021\)](#), in their 100% redistribution treatment, in vote 1, 37.5% of the participants voted in favor of the implementation of a toll, the rate increases to 75% in vote 2, and finally, in vote 3, it increases to 81.3%. We expect to find this effect in both treatments following the literature.

Hypothesis 2 *The level of acceptability will not be equal between taxes and regulatory standards.*¹²

12. The pre-registered hypothesis was “The level of acceptability is higher for taxes than for regulatory standards”. However, following the literature using surveys it does not seem to be an appropriate hypothesis; we decided to modify it.

We assume that taxation policies are likely to receive greater public support than regulatory standards. This is because regulatory standards are perceived as more coercive and restrictive in terms of limiting individual freedom of choices, whereas taxes may be viewed as less restrictive and more acceptable to the general population. Taxation can be perceived as less intrusive than regulation standards. Consumers can choose to continue consuming the good, while regulatory standards prohibit the consumption of the good completely, which can be perceived as more restrictive.

This hypothesis comes from the results of the experimental literature. [Cherry et al. \(2012\)](#), in which, when comparing the acceptability of subsidies, taxes, and quantity regulations in a market experiment, the less coercive policies are more popular than the latter. Meaning that subsidies are more accepted than taxes, and taxes are more accepted than attempts to regulate quantities. However, [Cherry et al. \(2017\)](#) find no significant differences in public support between taxes and quantity regulations. Moreover, [Douenne and Fabre \(2022\)](#), in a survey, found that the French largely reject taxes and dividend policies. [Douenne and Fabre \(2020\)](#) find that the French prefer green investments or regulations to a tax and dividend. In [Dechezleprêtre et al. \(2022\)](#), the authors find that regulatory standards are more supported than taxes. For example, they find that 43% of respondents support a ban on combustion-engine cars. Meanwhile, only 37% support a carbon tax with cash transfers. It is important to note that the ban is consistently more supported than the carbon tax across the studied countries.¹³

Hypothesis 3 *The level of acceptability is lower for participants with individualistic and hierarchical worldviews.*

This hypothesis comes from the literature on the effect of worldviews on the acceptability of policies ([Janusch et al., 2021](#), [Cherry et al., 2017](#)), which states that individuals that fit the “individualistic” or “hierarchical” worldviews tend to be less accepting of re-distributive measures such as taxes or coercive measures such as regulatory standards. We assume that participants

13. There is a lack of consensus in the literature, therefore, we decided to follow the results from the experimental literature.

possessing communitarian worldviews will support more government interventions than those with individualistic worldviews. Furthermore, we also assume that participants possessing egalitarian worldviews will support more government interventions than those with hierarchical worldviews. We study if the result holds in a negative externalities game with heterogeneity and if cultural worldviews have an impact over time on the acceptability of taxes and regulatory standards. Furthermore, we also seek to study if experiencing the game without a policy and with a policy trial decreases the impact of cultural worldviews. Since cultural worldviews shape opinions and beliefs about policies, we could expect that increasing the understanding of the benefits of a policy, through the introduction of a policy trial, would decrease the impact of worldviews. [Janusch et al. \(2021\)](#) finds a decrease in policy support if the participant possesses hierarchical and individualistic worldviews only in vote 2. Furthermore, [Cherry et al. \(2012\)](#) finds an impact of worldviews across all referendums.

3.5 Results

3.5.1 Descriptive statistics

Descriptive statistics of the socio-demographic characteristics of the participants by treatment are summarized in Table 3.1.

Figure 3.6 presents the proportion of participants who chose option C by period, by treatment, and whether the policy was implemented in Part 3 or not. In the regulatory standards treatment, we can observe that the proportion is equal to 0 for rounds 5 to 10 and for rounds 11 to 15 if the policy was implemented since option C was no longer available. In rounds 11 to 15 without policy implementation, between 40% and 60% of the participants chose option C, which is the proportion seen in rounds 1 to 5, suggesting that even after having experienced the policy trial, around half of the participants behaved as predicted by the Nash equilibrium (i.e., choosing option C). This suggests that the effect of a policy trial does not have an impact on future choices without policy implementation. In the tax treatment, without policy implementation, we observe the same behavior as in the regulation treatment; the proportion of participants that

Figure 3.6 – Share of participants having chosen option C, by period, by treatment, and whether or not the policy was implemented at the end of the experiment.



chose option C in rounds 1 to 5 and 11 to 15 stays constant.

Tables 3.2 and 3.3 present the summary of option choice by treatment. As explained in subsection 3.3.3, the dominant strategy, when the public policy is not implemented, corresponds to choosing option C. The socially optimal strategy depends on the type of player. If the player is assigned to player 1, 2, or 3, the socially optimal strategy is choosing option A; if the player is assigned to player 4, 5, or 6, the socially optimal strategy is choosing option B. If the public policy is implemented, the dominant strategy corresponds to the socially optimal one.

The results of Tables 3.2 and 3.3 suggest that most participants choose either their dominant strategy or the socially optimal one. However, we can see that a small proportion of participants do not behave as predicted. In Table 3.2, in Part 1, for players 1, 2, and 3, 6.4% of the participants

Table 3.1 – Summary statistics

	Regulatory standards	Tax	Total
Female (%)	58.5 (0.497)	64.30 (0.483)	61.5 (0.489)
Age	37.83 (17.49)	34.64 (14.45)	36.19 (16.00)
Level of education			
- No diploma(%)	1.89% (0.00)	0.00 (0.00)	0.92% (0.00)
- CAP/BEP (%)	3.77 (0.19)	0.00 (0.00)	1.83 (0.14)
- High school(%)	9.43 (0.30)	19.60 (0.40)	14.70 (0.36)
- Two-year degree(%)	13.20 (0.34)	16.10 (0.37)	14.70 (0.36)
- Bachelor(%)	24.50 (0.43)	14.30 (0.35)	19.30 (0.40)
- Master(%)	41.50 (0.50)	48.20 (0.50)	45.00 (0.50)
- Ph.D.(%)	5.66 (0.23)	1.79 (0.13)	3.67 (0.19)
Student(%)	37.7 (0.49)	41.10 (0.50)	39.40 (0.49)
In activity (%)	52.80 (0.50)	55.40 (0.50)	54.10 (0.50)
# of observations	53	56	109

Notes: Standard errors are in parenthesis. CAP/BEP are french vocational certificates obtained two years after the 8th/9th grade. Student is a dummy variable = 1 if the participant is a student. In activity is a dummy variable = 1 if the participant works. There are no significant differences in characteristics between the treatments (Chi-squared tests for all variables, except for age, continuous variable, for which we run a two-tailed t-test).

Table 3.2 – Summary of option choice in the regulatory standards treatment

	No policy (Part 1)	Policy (Part 2)	No policy (Part 3)	Policy (Part 3)
<i>Option B is not advantageous</i>				
Option A (Social optimum)	40.00%	93.60%***	31.11%	97.50%
Option B	6.40%	6.40%	8.89%	2.50%
Option C	53.60%	N/A	60.00%	N/A
Number of individuals	25	25	25	25
Observations	125	125	45	80
<i>Option B is advantageous</i>				
Option A	17.86%	33.57%***	12.50%	29.00%
Option B (Social optimum)	42.14%	66.43%***	47.50%	71.00%
Option C	40%	N/A	40%	N/A
Number of individuals	28	28	28	28
Observations	140	140	40	100

Chi-squared tests in the group comparisons between Stage 1 and Stage 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Notes: Share of participants' choice in the regulatory standards treatment. Note that the dominant strategy is option C if the policy is not implemented and equal to the strategy yielding the social optimum if the policy is implemented.

Table 3.3 – Summary of option choice in the taxation treatment

	No policy (Part 1)	Policy (Part 2)	No policy (Part 3)	Policy (Part 3)
<i>Option B is not advantageous</i>				
Option A (Social optimum)	46.67%	71.85%***	44.00%	76.36%
Option B	13.33%	11.11%	36.00%	10.91%
Option C	40.00%	17.03%***	20.00%	12.73%
Number of individuals	27	27	27	27
Observations	135	135	25	110
<i>Option B is advantageous</i>				
Option A	21.38%	21.38%	20.00%	22.60%
Option B (Social optimum)	36.55%	65.52%***	33.33%	69.57%
Option C	42.07%	13.10%***	46.67%	7.83%
Number of individuals	29	29	29	29
Observations	145	145	30	115

Chi-squared tests in the group comparisons between Stage 1 and Stage 2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$
Notes: Share of participants' choice in the taxation treatment. Note that the dominant strategy is option C if the policy is not implemented and equal to the strategy yielding the social optimum if the policy is implemented.

chose option B, which was the least advantageous strategy for this type of player. When the policy is implemented in Part 2, this proportion stays constant. For players 4, 5, and 6, 17.86% of the participants chose option A in Stage 1, this proportion increases to 33.57% in Part 2.

In Table 3.3, we observe that in Part 1, for players 1, 2, and 3, 13.33% of the participants chose option B, and the proportion decreases in Part 2. For players 4, 5, and 6, 21.38% of the participants choose option A, and slightly decreases in Part 2. We observe that even when the policy is implemented, participants continue choosing option C, even though a strategy dominates option C because of the implementation of the tax. This result suggests that a small share of participants prefer choosing the option generating negative externalities and paying a tax.

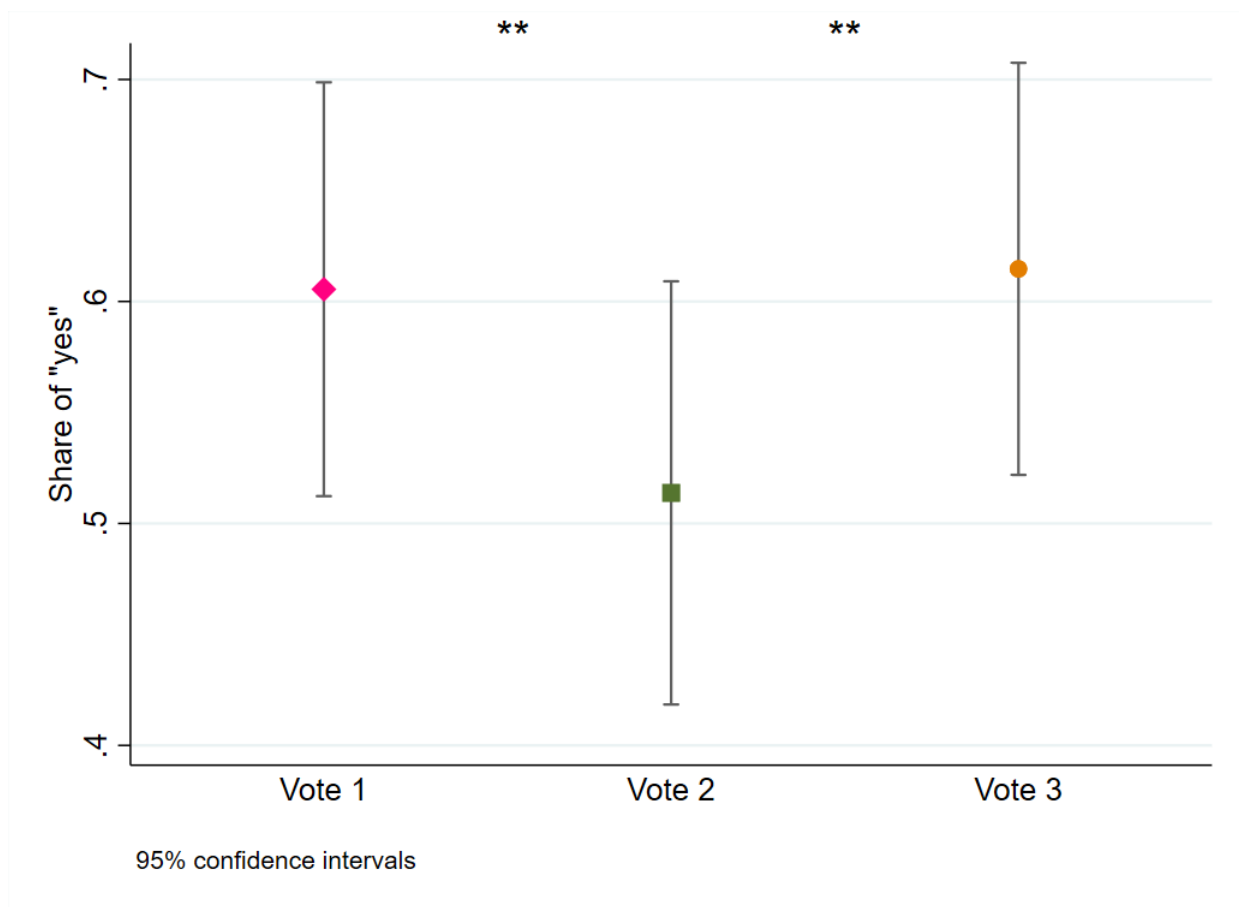
3.5.2 The acceptability of public policies

The impact of a policy trial

The following analysis is conducted based on the three parts of the experiment, taking into account the three votes. As a reminder, the first vote takes place at the beginning of the experiment, the second vote takes place after the five rounds of option choice without policy implementation, and the third vote takes place in Part 3, after the five rounds of option choice with policy implementation (after ten rounds from the beginning of the experiment).

Considering both treatments and the three votes, 57.8% of the participants voted favorably to implement the public policy. Figure 3.7 shows the share of participants having voted for the implementation of any public policy, focusing on each vote separately. In the initial vote (Part 1 of the experiment), 60.55% (s.d.= 0.49) of participants favored the implementation, indicating a consensus supporting public policies. Vote 2 slightly decreases in approval, with 51.37% (s.d.= 0.50) voting “yes”, there is a significant difference between vote 1 and vote 2 (a McNemar test yields a p-value= 0.04). While the third vote experienced a resurgence in support at 61.47% (s.d.= 0.49), there is a significant difference between votes 2 and 3 (a McNemar test yields a p-value= 0.02). These results collectively suggest that a majority of participants

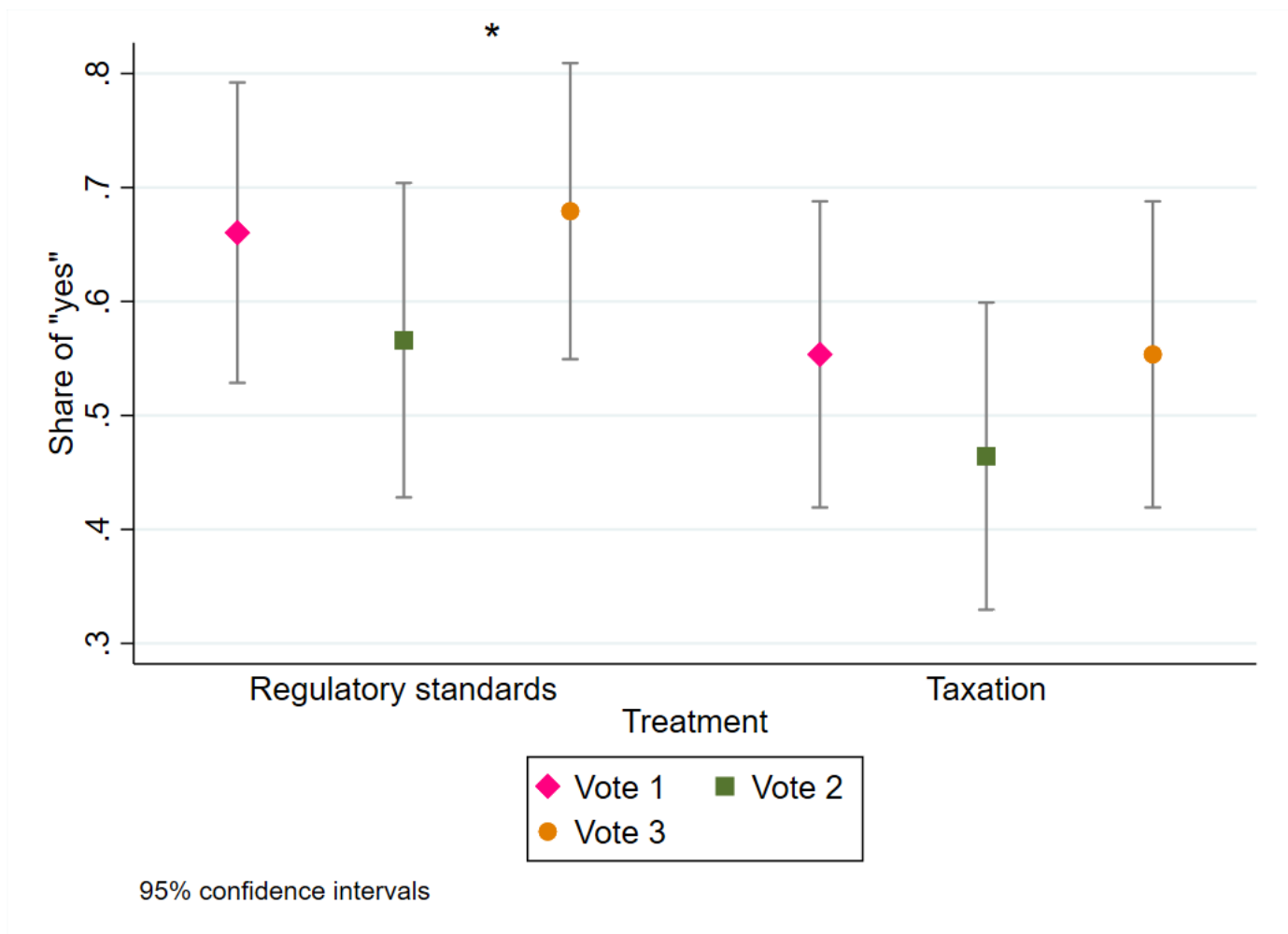
Figure 3.7 – Share of participants having voted for the implementation of the public policy



Notes: Stars represent the significance level for Exact McNemar significance probability.
*** $p < 0.01$, ** $p < 0.05$, $p^* < 0.1$. Grey lines correspond to 95% confidence intervals.

endorse the adoption of public policies. If we focus on Table 3.4, we use logit regressions clustered at the group level in a panel data set, the results from regression (1) shows that the part of the experiment has an impact on the acceptability of public policies. This result confirms the result previously discussed, we observe that the probability of voting “yes” in vote 2 decreases compared to vote 1. We also observe that the probability of voting “yes” in vote 3 increases compared to vote 2. The difference between votes 1 and 2 suggests that experiencing the game decreases support for any public policy. Between votes 2 and 3, we observe an increase in support, suggesting that experiencing the policy trial positively impacts acceptability.

Figure 3.8 – Share of participants having voted for the implementation of the public policy by vote and by treatment



Notes: Stars represent the significance level for Exact McNemar significance probability.
 *** $p < 0.01$, ** $p < 0.05$, $p^* < 0.1$. Grey lines correspond to 95% confidence intervals.

Figure 3.8 presents the share of participants who voted for the implementation of the public policy by treatment and by vote. If we focus on the taxation treatment, there is no significant difference between the votes. There is a difference of 8.93% in the share of participants that voted for the implementation of the taxation policy between vote 2 and 3. In the regulatory standards treatment, we observe a decrease in the acceptability of the implementation of the public policy in the second vote (compared to the first vote), however, this difference is not significant. We observe an increase in the acceptability in the third vote (compared to the second vote), this difference is significant (a McNemar test yields a p-value = 0.034, and an exact McNemar significance probability equal to 0.07), there is an increase in vote 3, the difference between vote 2 and vote 3 is of 11.32%. We observe that the acceptability is similar in vote 1 and vote 3. Table 3.4 presents the results of logit regressions clustered at the group level in a panel data set. In this table we confirm the results of the chi-squared tests; in regression (2), we observe that in the regulatory standards treatment, the probability of voting in favor of the regulatory standard increases compared to vote 2. On the contrary, in regression (3), we do not find any impact of being in period 1 or 3 compared to period 2, suggesting that the policy trial has no impact on the probability of voting “yes”. From these results, we find that hypothesis 1 is partially verified. Understanding the different mechanisms and the benefits of implementing public policies through a policy trial seems to significantly impact the acceptability of public policies, specifically on regulatory standards. Our results align with the literature ([Cherry et al., 2014, 2017](#) and [Janusch et al., 2021](#)), experience with policy trial increases the probability of accepting the policy. It is important to notice that there is a decrease in acceptability in vote 2 in both treatments. This may come from the fact that in vote 1 participants vote for or against the policy, without having experienced the game, vote 1 serves as a control for previous opinions on public policies. Between vote 1 and vote 2, participants experience the game (and not the public policy), the repetition of the game five times gives the participants time to notice that the best option for them is to choose option C. It might be possible that between the first two votes, participants realize that it is better for them to choose option C and that, individually it is not the best option to implement a public policy. Between vote 2 and vote 3, participants experience

Table 3.4 – Determinants of the acceptability of public policies

Dependent variable: Vote	(1) Global	(2) Regulatory standards	(3) Taxation
Tax treatment	-1.65 (1.11)		
Period = 1	1.09** (0.50)	1.23 (0.89)	0.98 (0.62)
Period = 3	1.20** (0.52)	1.49* (0.90)	0.98 (0.68)
Option B is advantageous	1.19 (0.95)	1.34 (1.68)	0.65 (0.96)
Age	-0.04 (0.03)	-0.09* (0.05)	-0.01 (0.03)
Female	-0.69 (0.96)	-1.56 (1.29)	0.28 (1.38)
Student	1.56 (1.34)	0.08 (2.57)	4.19** (1.83)
In activity	-0.09 (0.69)	-1.14* (0.58)	2.40 (1.62)
# option C: Part 1	-0.66* (0.34)	-1.53** (0.69)	-0.07 (0.52)
Others - option C: Part 1	0.08 (0.08)	-0.14 (0.23)	0.02 (0.10)
# option C: Part 2			-0.44 (0.54)
Others - option C: Part 2			-0.04 (0.18)
Constant	2.25 (2.50)	10.11*** (3.69)	-3.33 (3.60)
Number of clusters	20	10	10
Observations	327	159	168
Number of subjects	109	53	56

Robust standard errors clustered at the group level are in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: We use logit regressions clustered at the group level in a panel data set with three periods, each period corresponds to each part of the experiment. The dependent variable is a binary variable equal to 1 for a yes vote and 0 for a no vote. Regression (1) comprises both treatments, regression (2) only uses observations from the regulatory standards treatment, and regression (3) only uses observations from the tax treatment. *Tax treatment* is a dummy variable = 1 when it is the tax treatment. *Period* is a categorical variable, equal to 1 if it corresponds to vote 1, equal to 2 if vote 2, and equal to 3 if vote 3, the reference category is vote 2. In the controls, we include a dummy variable *Option B is advantageous* = 1 when the participant was assigned to player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. *Female* is a dummy variable = 1 if the participant is a female. *Student* is a dummy variable = 1 if the participant is a student. *In activity* is a dummy variable = 1 if the participant works. We include as controls *# option C: Part 1 and Part 2*, representing the number of times the participant chose option C in Part 1 and Part 2, respectively. We include the control *Others - Option C: Part 1 and Part 2*, representing the sum of the number of participants having chosen option C in each round of the first and second parts of the experiment within each group, respectively.

the public policy, noticing that their and the group's benefits increase implementing the policy. The policy is better understood, and benefits are more easily seen by the participants.

Result 1: There is an increase in the acceptability of regulatory standards after a regulatory standards policy trial. We do not find this effect after a taxation policy trial.

Table 3.5 – Determinants of the acceptability of public policies by vote

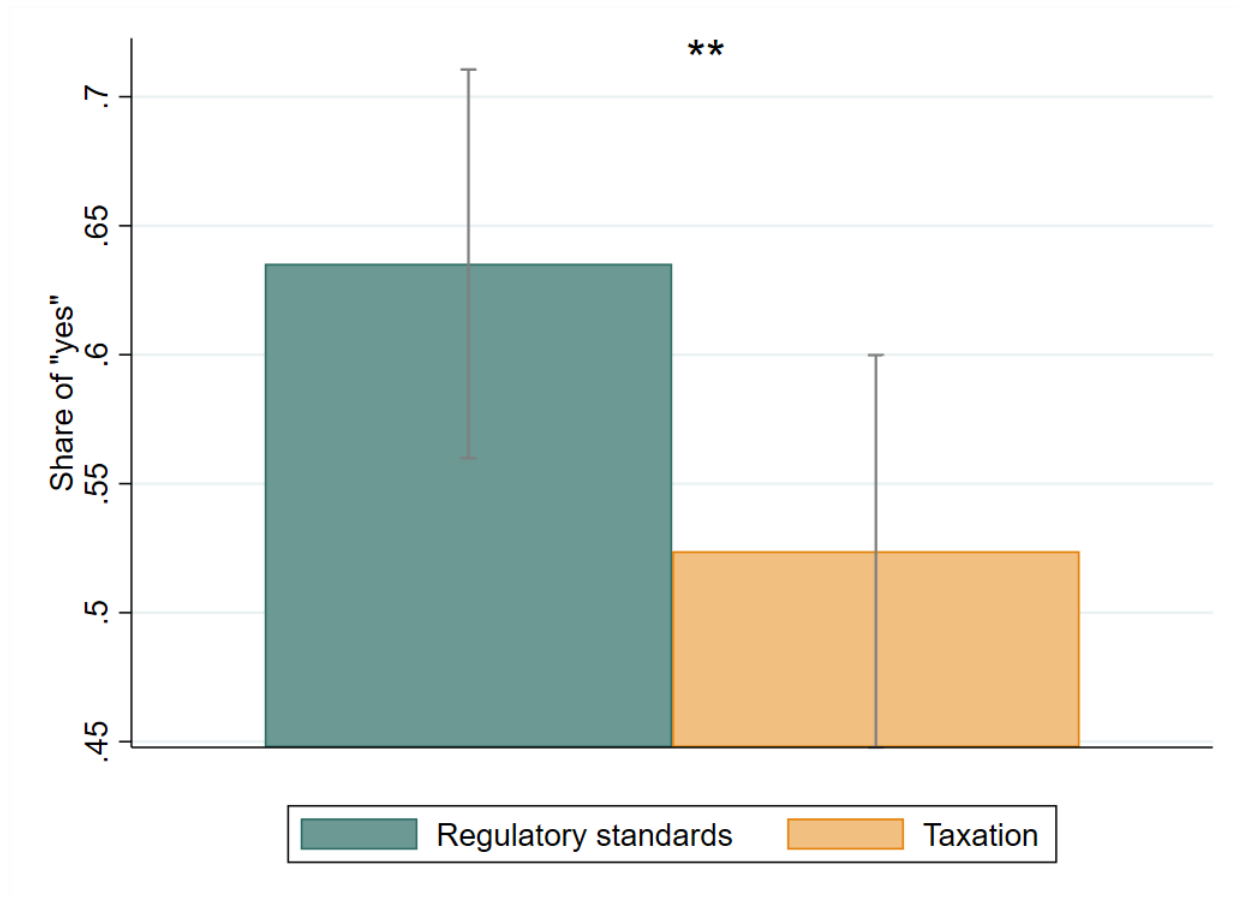
Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Tax treatment	-0.45 (0.44)	-0.58 (0.51)	-0.41 (0.42)	-0.49 (0.49)	-0.54 (0.35)	-0.74* (0.40)
Option B is advantageous		0.49 (0.44)		0.61 (0.42)		0.14 (0.44)
Age		-0.02 (0.02)		0.01 (0.02)		-0.03** (0.01)
Female		0.40 (0.41)		-0.51 (0.50)		-0.55 (0.44)
Student		0.70 (0.55)		1.01 (0.70)		0.21 (0.63)
In activity		0.14 (0.36)		0.18 (0.43)		-0.50 (0.37)
# option C: Part 1				-0.29* (0.17)		-0.31** (0.16)
Others - option C: Part 1				0.04 (0.04)		0.10** (0.04)
Constant	0.66** (0.32)	0.49 (1.01)	0.27 (0.28)	-0.29 (1.30)	0.75** (0.30)	2.32* (1.23)
Number of clusters	20	20	20	20	20	20
Observations	109	109	109	109	109	109
Pseudo R-squared	0.01	0.06	0.01	0.08	0.01	0.13

Robust standard errors clustered at the group level are in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Notes: Dependent variables are a binary variable equal to 1 for a yes vote and 0 for a no vote. For regressions (1) and (2) is the acceptability of taxes at vote 1; for regressions (3) and (4) is the acceptability at vote 2, and for regressions (5) and (6), is the acceptability at vote 3. We use logit regressions clustered at the group level. *Tax treatment* is a dummy variable = 1 when it is the tax treatment. In the controls, we include a dummy variable *Option B is advantageous* = 1 when the participant was assigned as player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. *Female* is a dummy variable = 1 if the participant is a female. *Student* is a dummy variable = 1 if the participant is a student. *In activity* is a dummy variable = 1 if the participant works. We include as a control *# option C: Part 1* representing the number of times the participant chose option C in Part 1. We include the control *Others - Option C: Part 1*, representing the sum of the number of participants having chosen option C in each round of the first part of the experiment within each group.

Figure 3.9 – Share of participants having voted for the implementation of the public policy by treatment



Notes: Stars represent the significance level for the chi-squared test.
 ***p < 0.01, **p < 0.05, p* < 0.1. Grey lines correspond to 95% confidence intervals.

Support for instrument-specific policies

Focusing on votes in Figure 3.8, on average, the acceptability of taxes remains lower than that of regulatory standards for any of the votes. In Figure 3.9, we observe the share of participants having voted for the implementation of the public policy, by treatment. Overall, regulatory standards (63.52%) are more accepted than a taxation policy (52.38%), this difference is significant (a Chi-squared test yields a p-value= 0.041). We conduct logit regressions clustered at the group level with each vote as a dependent variable, as presented in Table 3.5. We do not observe any effect on the probability of voting in favor of implementing a public policy depending on the treatment, except in vote 3 when adding the controls, there is a negative and marginally signif-

icant effect of being in the taxation treatment compared to the regulatory standards treatment. However, in table 3.4, in regression (1), we do not observe any impact of being in the taxation treatment compared to the regulatory standards on the probability of voting “yes” in favor of the public policy. As a result, hypothesis 2 is not supported.

Our findings deviate from those of [Cherry et al. \(2012\)](#), who report a preference for taxes over regulatory standards, and [Cherry et al. \(2017\)](#), who find no difference in preferences for taxes and regulatory standards. In contrast, our results align with [Dechezleprêtre et al. \(2022\)](#) that report higher support for bans on polluting vehicles over price mechanisms. They also align with [Douenne and Fabre \(2020\)](#), whose results indicate rejection of the carbon tax but majority support for stricter norms.

Result 2: Regulatory standards are more accepted than taxes.

Determinants of the acceptability of public policies

An analysis of the additional determinants influencing public policy acceptability is shown in Table 3.4. In regression (1), considering both treatments, we observe that the number of times the participant chooses option C in the first part of the experiment negatively impacts the probability of voting in favor of the policy. Focusing on instrument-specific determinants, we observe that the effect is still present in regression (2) (regulatory standards), however, the effect disappears in the taxation treatment. We also find that age and if the participant works have a negative impact on the acceptability of regulatory standards. Concerning regression (3), we only observe a positive impact on the acceptability of taxes if the participant is a student. Furthermore, in Table 3.5, we find that the number of times the other group members chose option C positively impacts the probability of voting in favor of the policy in vote 3. This result suggests that the more the participant suffers from negative externalities, the more she is inclined to support the public policy.

3.5.3 Does cultural worldviews impact the acceptability of public policies?

In this section, we study the impact of worldviews (individualistic-communitarian and hierarchical-egalitarian) on the acceptability of public policies. The average of the individualistic-communitarian variable is 20.14 (s.d.= 5.16).¹⁴ The median is 21. The higher the score, the more individualistic worldviews the participant possesses. 54 participants (49.54%) had a score below the median, meaning that we can classify them as “communitarians”, 8 participants (7.34%) possess a score equal to the median, meaning that they are not “individualists” nor “communitarians”, and finally, 47 participants (43.12%) were “individualists” (score over 21).¹⁵ Cronbach’s alpha for individualism is equal to 0.71. The average of hierarchical-egalitarian is 14.62 (s.d.=6.25), the higher the score, the more hierarchical worldviews the participant possesses. The median is 14. 55 participants (48.33%) are classified as “egalitarians” (score below 14), 6 (5%) are not classified as “egalitarians” nor “hierarchicals” (score equal to 14), and finally, 48 participants (44.04%) are “hierarchicals”. Cronbach’s alpha for hierarchy is equal to 0.81.

Tables 3.6 and 3.7 show the impact of worldviews on each vote by the type of policy. We observe that cultural worldviews do not have the same impact on the probability of voting for the implementation of a public policy, depending on the treatment. If we focus on regulatory standards in Table 3.6, we observe that individualistic worldviews do not impact support. Hierarchical worldviews only have an impact on the probability of voting for the implementation in vote 1, but the effect disappears when adding the controls.

If we focus on the taxation policy, we find that hierarchical-egalitarian worldviews have a negative impact on the acceptability of taxes across the three votes (Table 3.7). Our results indicate that hierarchical-egalitarian worldviews affect redistributive instruments, consistent with the findings of [Cherry et al. \(2017\)](#) and [Janusch et al. \(2021\)](#). However, they differ in the impact of individualistic worldviews, for which we do not find any impact on support. Our analysis suggests that the effect of hierarchical-egalitarian worldviews on the acceptability of taxation policies remains stable across votes, indicating that neither policy experience nor exposure to

14. Individualistic-communitarian and hierarchical-egalitarian worldviews are comprised between 6 and 36 .

15. We used the same method to classify the participants as in [Janusch et al. \(2021\)](#), using the median.

Table 3.6 – The impact of worldviews on the acceptability of regulatory standards

Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Individualistic-communitarian	0.94 (0.87)	1.00 (0.85)	0.66 (0.51)	1.06 (0.73)	0.05 (0.73)	0.45 (1.04)
Hierarchical-egalitarian	-1.57* (0.82)	-1.58 (1.01)	0.26 (0.74)	0.70 (1.17)	-0.68 (0.88)	-1.16 (1.29)
Option B is advantageous		1.01 (0.73)		0.41 (0.85)		-0.39 (0.83)
Age		-0.02 (0.03)		-0.04 (0.03)		-0.05** (0.02)
Female		-0.12 (0.94)		-0.83 (0.66)		-2.26*** (0.75)
Student		0.21 (1.06)		-0.52 (0.96)		-0.49 (1.04)
In activity		-0.65 (0.60)		-0.50 (0.60)		-1.25** (0.58)
# option C: Part 1				-0.71** (0.31)		-0.88*** (0.33)
Others - option C: Part 1				-0.02 (0.11)		-0.12 (0.12)
Constant	1.04 (0.70)	1.52 (2.11)	-0.12 (0.64)	3.47** (1.74)	1.03 (0.79)	9.15*** (2.47)
Number of clusters	10	10	10	10	10	10
Observations	53	53	53	53	53	53
Pseudo R-squared	0.14	0.20	0.02	0.20	0.02	0.27

Robust standard errors clustered at the group level are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variables are binary variables equal to 1 for a yes vote and 0 for a no vote. In columns (1) and (2) is the acceptability of taxes at vote 1; in columns (3) and (4) is the acceptability at vote 2, and in columns (5) and (6) is the acceptability at vote 3. We use Logit regressions clustered at the group level. *Individualistic-communitarian* is a dummy variable = 1 if the participant is individualistic, and = 0 if communitarian. *Hierarchical-egalitarian* is a dummy variable = 1 if hierarchical and = 0 if egalitarian. We include the control *Others - Option C: Part 1* in regression (4), representing the mean of participants within the group having chosen option C in the first part of the experiment. We include a dummy variable *Option B is advantageous* = 1 when the participant was assigned to player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. We also include as a control *# option C: Part 1*, which represents the number of times that the participant chose option C in Part 1.

Table 3.7 – The impact of worldviews on the acceptability of taxation policies

Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Individualistic-communitarian	-0.33 (0.55)	-0.17 (0.58)	-0.63 (0.60)	-0.74 (0.79)	-0.68 (0.46)	-0.59 (0.72)
Hierarchical-egalitarian	-1.31*** (0.47)	-1.15** (0.51)	-1.54*** (0.52)	-1.71*** (0.61)	-1.65** (0.66)	-1.50** (0.75)
Option B is advantageous		0.01 (0.67)		0.62 (0.46)		0.39 (0.57)
Age		-0.01 (0.02)		0.06** (0.03)		-0.02 (0.03)
Female		-0.14 (0.85)		-0.35 (0.98)		-0.17 (1.11)
Student		1.33 (0.90)		2.65* (1.41)		0.80 (1.54)
In activity		1.18 (0.81)		1.32 (1.11)		0.60 (1.05)
# option C: Part 1				-0.01 (0.34)		-0.06 (0.29)
# option C: Part 2						-0.04 (0.30)
Others - option C: Part 1				0.01 (0.06)		0.13** (0.05)
Others - option C: Part 2						-0.01 (0.09)
Constant	0.99* (0.52)	0.05 (1.02)	0.81* (0.49)	-3.26 (2.89)	1.31** (0.55)	0.12 (2.43)
# of clusters	10	10	10	10	10	10
Observations	56	56	56	56	56	56
Pseudo R-squared	0.01	0.12	0.11	0.20	0.13	0.22

Robust standard errors clustered at the level of each group are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variables are binary variables equal to 1 for a yes vote and 0 for a no vote. In regressions (1) and (2) is the acceptability of taxes at vote 1; in regressions (3) and (4) is at vote 2, and in regressions (5) and (6), is at vote 3. We use logit regressions clustered at the group level. *Individualistic-communitarian* is a dummy variable = 1 if the participant is individualistic, and = 0 if communitarian. *Hierarchical-egalitarian* is a dummy variable = 1 if hierarchical and = 0 if egalitarian. We include the control *Others - Option C: Part 1* in regression (4), which represents the mean of participants within the group having chosen option C in the first part of the experiment. We include *Others - option C: Part 2* in regression (6), which represents the mean of participants having chosen option C in Part 2 of the experiment. We include a dummy variable *Option B is advantageous* = 1 when the participant was assigned as player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. We also include as a control two variables *# option C: Part 1 and Part 2*, representing the number of times the participant chose option C in Part 1 and Part 2, respectively.

the tax change the impact of worldviews. This result aligns with [Cherry et al. \(2017\)](#), contrary to [Janusch et al. \(2021\)](#). The similarity in our result with [Cherry et al. \(2017\)](#) may come from the equal tax redistribution in both experiments, contrary to [Janusch et al. \(2021\)](#) in which the redistribution had a different impact on subjects.

Result 3: Hierarchical worldviews decrease the acceptability of taxes. They do not impact the acceptability of regulatory standards. Individualistic worldviews have no effect.

3.5.4 What are the determinants of option choice?

We seek to study the determinants of choosing a specific option in the game. In this subsection, statistics will be based on the 15 rounds of option choice of the experiment. However, we do not include 445 observations that correspond to the periods in the regulatory standards treatment when the policy is implemented (five rounds in Part 2 for all the participants in the regulatory standards treatment, and the last 5 rounds in Part 3 for 36 participants for which the regulatory standards are implemented in Part 3).

Table 3.8 displays the results of a multinomial logit regression analysis clustered at the group level, in which options A, B, and C serve as the dependent variable, with option C designated as the reference category. We employ panel data for this analysis, treating each round of the experiment (15 rounds) as a distinct period. We include the dummy variable *tax treatment*, equal to 1 if the choice was taken in the taxation treatment. We find no treatment effect in the probability of choosing options A or B compared to option C. *Option B is advantageous* is a dummy variable equal to 1 when the participant is assigned to player 4, 5, or 6. If the participant is assigned to player 4, 5, or 6, the probability of her choosing option A decreases compared to option C. However, the probability of choosing option B compared to option C increases, which is an expected result since players 4, 5, or 6 are better off choosing option B than option A. We do not find either a temporal effect or a learning effect, being at later rounds in the game does not influence the decision of choosing option A or option B compared to option C. Concerning cultural worldviews, we do not find any impact of individualistic-communitarian or hierarchical-egalitarian worldviews in the option choice.

Table 3.8 – Determinants of option choice

Dependent variable: option choice	<i>Option A</i>	<i>Option B</i>
Tax treatment	0.45 (0.37)	0.04 (0.42)
Policy implemented	1.87*** (0.60)	1.80*** (0.55)
Option B is advantageous	-1.50*** (0.32)	2.72*** (0.47)
Period	-0.04 (0.03)	0.03 (0.02)
Hierarchical-egalitarian	-0.00 (0.40)	-0.61 (0.53)
Individualistic-communitarian	0.43 (0.31)	-0.39 (0.59)
Age	0.03* (0.02)	0.02 (0.02)
Female	0.76** (0.31)	0.90* (0.47)
In activity	-0.27 (0.30)	0.06 (0.51)
Option C in previous round	-1.86*** (0.38)	-1.52*** (0.29)
Others - option C in previous round	-0.22** (0.11)	-0.17 (0.12)
Constant	-0.96 (0.69)	-2.96*** (0.65)

Robust standard errors clustered at the group level are in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Option C is the reference category. Each category and dummy variables have to be compared to the reference. We use a multinomial logit regression. The periods in the regulatory standards when the policy was implemented were not considered. The dependent variable is the option choice (categorical variable), it is equal to 1 if the participant chooses option A, equal to 2 if option B, and equal to 3 if option C. Option B is advantageous, is a dummy variable = 1 when the participant was assigned as player 4, 5, or 6. Policy implemented is a dummy variable = 1 if the policy was implemented in the round. Option C in previous period is a dummy variable = 1 if the participant chose option C in the previous round. # of others - option C in the previous round represents the number of group members (excluding the participant) that chose option C in the previous round. Period is a variable that captures any learning effect of the game.

We include the dummy variable *Policy implemented*, which represents the impact of implementing a policy. Since we include the rounds when the tax policy is implemented (and not those when regulatory standards are implemented), this variable shows only the effect of taxes on option choice. When the tax is implemented, the probability of choosing options A or B increases compared to option C. Taxes create a disincentive for choosing the option that generates negative externalities. Within the environmental framework, this implies that taxes are efficient for decreasing pollution since it is in the interest of the individuals to choose another non-polluting option in order to avoid the tax. In the transportation mode choice framework, we could say that there is an increase in the probability of preferring an electric vehicle (option A) or public transportation (option B) over a conventional vehicle (option C) when taxes are implemented.

We find that if the participant chose option C in the previous round, the more likely is that she will continue choosing option C, compared to option A or B. We also include the variable *Others - option C in the previous round*, representing the number of members within a group who chose option C in the previous round. It shows that the more participants chose option C in the previous round, the lower the probability of choosing option A compared to option C, however, the effect is not significant for option B. This result suggests a social norm effect, where the participants follow the majority's choice. It can also suggest a vindictive effect, where the participants that took a prosocial choice (by not choosing option C) were incentivized to choose the option generating a negative externality in the following rounds since the other participants did the same.

3.6 Discussion and conclusion

We use a laboratory experiment to study different public policies' acceptability to understand why some policies fail after implementation. We compare taxes with equal redistribution and regulatory standards. We also look at the impact of cultural worldviews on acceptability, and finally, we study whether a policy trial increases acceptability.

Our analysis reveals that 57.8% of participants voted in favor of the implementation of the public policy. In practice, rejection rates are often lower, a rejection rate of 40% or more would likely make it difficult to implement such public policies due to the significant level of opposition. The high rejection rate compared to what is seen in practice might be explained by three factors. First, some individuals who expressed opposition to implementing the public policy in our experiment may have been unsure or indifferent towards the policy and were expressing their uncertainty or lack of strong preference by opposing the policy. Second, usually, governments do not ask the population if they wish to implement a specific public policy. A sense of obligation often influences the population's response to government policies to the government's authority. Individuals may feel compelled to comply with policies implemented by the government. Third, an individual's cost of rejecting a public policy, for example, through social movements or strikes, is higher compared to the experiment, which explains why public policies usually receive more support than observed in our experiment, as individuals may be more likely to accept policies they do not strongly oppose. In our experiment, the direct decision-making format allows participants to express their preferences more easily and without the associated costs of opposing a policy in a real-world setting. It is important to note that voting involves a social norms dimension that can influence acceptability since individuals may conform to social norms or expectations. However, in the eventuality that social norms are influential in acceptability, the anonymization in this experiment can mitigate the effect of social norms. Furthermore, the advantage of using a vote for measuring acceptability is that it represents democratic mechanisms and allows to refer to a referendum and situations where the aim is to get the population more involved in government decisions.

The findings of this study indicate that support for public policies is influenced by experience with a given situation and with a policy trial. We find a decrease in support after the participants experienced the game, this may come from the fact that experiencing the game allows the participants to understand that the best option for them is to choose the option subject to a public policy. Furthermore, exposure to a policy trial can increase support for public policies by making the social benefits more evident to individuals. Focusing on the different types of

instruments, we find that this effect is not observed for taxation policies, but it is for regulatory standards, which are generally more accepted than taxes. The difference in the results between instruments might come from the challenge of changing individuals' preferences when there is strong policy aversion towards a specific instrument. The result highlights that even after pedagogical efforts to increase understanding of the benefits of taxation, the participants are still reticent to support it. In contrast, pedagogical efforts do have an impact on the acceptability of regulatory standards since rejection is less important than for taxes.

Furthermore, we see from the cultural worldviews' results that hierarchical-egalitarian worldviews only impact taxes' acceptability. The results indicate, in our framework, that cultural dimensions may play a role in the rejection of taxation policies, suggesting that differences in the acceptability of public policies may stem from cultural differences. For instance, [Cherry et al. \(2012\)](#) finds higher support for taxes than for bans, and [Cherry et al. \(2017\)](#) finds no difference in acceptability between policies. In line with our results, [Douenne and Fabre \(2020, 2022\)](#) evidenced that French people largely reject a carbon tax and dividend policy, even though they appear aware and concerned about climate change. It is necessary to understand precisely which type of policies are more accepted according to the region's culture where they are aimed to avoid large rejection. If we refer to the transportation mode choice framework and the different cases of policy instruments, we can infer that the choice of implementing bans in Paris could be a more useful approach compared to the implementation of a toll, as seen in London. Acceptability differs depending on the cultural context of the region, for instance, [Dechezleprêtre et al. \(2022\)](#) finds that France is among the countries that support the lowest policies; meanwhile, the United Kingdom stands out as having overall higher support.

To minimize widespread opposition to public policies, examining the acceptability of alternative approaches, such as investing in green infrastructure, public education, or promoting awareness campaigns, may prove beneficial. We would argue that policymakers wanting to avoid opposition should consider the cultural characteristics of the region for which the policy is aimed before implementing any public policy. Accepted public policies in one country are not necessarily equally received in another one, and see the efficacy of the policy undermined. In order

to avoid opposition, it might also be interesting to study the impact of the inclusion of people in public decisions in order to increase their involvement, for example, through referendums or alternative mechanisms, such as collective deliberative institutions, which can increase comprehension of public policies, or allowing individuals to propose public policies. Further experimental research may also focus on the level of acceptability of different public instruments according to different countries or cultures. Moreover, the literature focuses essentially on the acceptability of taxes; future research should focus on the acceptability of alternative policy instruments and their determinants.

3.A Theoretical model

3.A.1 The model

We employ a negative externalities theoretical model where N heterogeneous individuals can choose one of three options: A, B, or C. Each option yields a gain and has a cost. Moreover, option C generates a negative externality, and when an individual chooses this option, it imposes an external cost to all the individuals in the economy (including himself).

Let's assume that two strategies (two options) always dominate one strategy (one option). The dominated strategy, according to the preferences of the individual, can be option A or B. This assumption reduces the range of possibilities for the individual to two options. In the following theoretical model, the economy is composed of N individuals. We only consider two different options; we exclude the dominated option. We denote x_i , a variable equal to 1 if the individual chooses option C and equal to 0 if not. w_0 represents the salary, g_{ik} corresponds to the gain of individual $i = 1, \dots, N$, yielded from choosing option $k = A, B$. c_{ik} is the cost of individual $i = 1, \dots, N$, from choosing option $k = A, B$. g_C denotes the gain from choosing option C and c_C is the cost. E denotes the externality produced from choosing option C.

Nash equilibrium

The following maximization program gives the individual's problem with strategic interactions at the Equilibrium. This program does not take into account the supplementary costs of choosing option C:

$$\max_{x_i} U(x_i) = x_i \times (w_0 + g_C - c_C - E) + (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - \sum_{j \neq i}^N x_j E \quad (\text{A.1})$$

The solution to the individual's problem, denoted x_i^* , is defined by:

$$x_i^* = \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq 0 \\ 0 & \text{otherwise.} \end{cases} \quad (\text{A.2})$$

The left side of the above inequality represents the benefit of individual i of choosing option C relative to option k . If this benefit is positive, the individual should choose option C over option k . The Nash Equilibrium is given by the simultaneous solution of the N individual's problem.

Social optimum

We assume a utilitarian central planner that maximizes a social welfare function represented by the sum of utilities:

$$\max_{x_i, \dots, x_N} W = \sum_{i=1}^N x_i \times (w_0 + g_C - c_C - E) + \sum_{i=1}^N (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - N \sum_{j \neq i}^N x_j E \quad (\text{A.3})$$

The simultaneous solutions to the social planner's maximization problem, denoted x_i^{sp} , is defined by:

$$\begin{aligned} x_1^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{1k} + c_{1k} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \\ &\vdots \\ x_i^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \\ &\vdots \\ x_N^{sp} &= \begin{cases} 1 & \text{if } g_C - g_{Nk} + c_{Nk} - c_C - E \geq (N-1)E \\ 0 & \text{otherwise.} \end{cases} \end{aligned} \quad (\text{A.4})$$

The left side of the above inequalities represents the benefit of choosing option C over option k . The right side of the equation represents their impact on the other individuals, it represents the marginal external cost of choosing option C . The condition states that the optimal choice of options is one in which for all individuals having chosen option C , the benefit is higher than the cost imposed on other individuals.

The difference between the individual's choice condition and the social planner's is given by

$(N - 1)E$, the cost imposed on the other individuals of the economy. If one participant chooses option C, then there is an external cost imposed on all the other individuals.

Pigouvian tax

In order to internalize the negative externality produced by choosing option C, we propose a Pigouvian tax, which is a market-based instrument. A Pigouvian tax allows us to completely consider the external costs of the externality imposed on the other individuals if individual i chooses option C. The Pigouvian tax is designed to equal the external marginal cost making the private cost of the good equal to the social cost.

From equations A.2 and A.4, we can deduce the Marginal External Cost (MEC), which is equal to the Pigouvian tax:

$$MEC = (N - 1)E$$

Decentralized solution

Let's demonstrate that when the Pigouvian tax is equal to $t = (N - 1)E$, the decentralized solution yields the socially optimal solution.

$$\begin{aligned} \max_{x_i} U(x_i) &= x_i \times (w_0 + g_C - c_C - E - t) + (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - \sum_{j \neq i}^N x_j E \\ \text{s.t. } t &= (N - 1)E \end{aligned} \quad (\text{A.5})$$

Substituting the condition in the maximization function, we obtain:

$$\max_{x_i} U(x_i) = x_i \times (w_0 + g_C - c_C - E - (N - 1)E) + (1 - x_i) \times (w_0 + g_{ik} - c_{ik}) - \sum_{j \neq i}^N x_j E \quad (\text{A.6})$$

The solution to the decentralized individual's problem, denoted x_i^d , is defined by:

$$x_i^d = \begin{cases} 1 & \text{if } g_C - g_{ik} + c_{ik} - c_C - E \geq (N - 1)E \\ 0 & \text{otherwise.} \end{cases} \quad (\text{A.7})$$

The above condition states that the decentralized solution with the Pigouvian tax is the one where the benefit of choosing option C over option k must be greater than the external cost produced by choosing option C. It yields the same solution as the social optimum.

3.A.2 Experimental application

The experiment uses $N = 6$, $g_A = g_C = 200$, $g_{1B} = 80$, $g_{2B} = 90$, $g_{3B} = 100$, $g_{4B} = 125$, $g_{5B} = 135$, $g_{6B} = 145$, $c_A = 100$, $c_B = 20$, $c_C = 50$, and $E = 15$ as parameters of the negative externalities game.

At the Nash equilibrium, the inequality:

$$g_C - g_{ik} + c_{ik} - c_C - E \geq 0 \quad (\text{A.8})$$

is verified for any type of player.

Considering players 1, 2, or 3, the dominated strategy is option B. The participant chooses between option A and option C. We substitute in equation A.8 the parameters of the game:

$$200 - 200 + 100 - 50 - 15 > 0$$

The inequality above is verified.

Considering players 4, 5, or 6, the dominated strategy is option A. The participant chooses between options B and C:

$$200 - g_{iB} + c_{iB} - 50 - 15 > 0$$

with $i = 4, 5, 6$.

The above condition is verified for any player 4, 5, or 6. Therefore the equilibrium in our experimental framework is for every participant to choose option C.

At the social optimum, the following inequality is not verified for any of the individuals:

$$g_C - g_{ik} + c_{ik} - c_C - E \geq (N - 1)E$$

Let's consider players 1, 2, or 3, for which the dominated strategy is option B.

$$200 - 200 + 100 - 50 - 15 < 75$$

Let's consider players 4, 5, or 6, for which the dominated strategy is option A.

$$200 - g_{iB} + c_{iB} - 50 - 15 < 75$$

Therefore, the social optimum in our experiment is given by players 1, 2, and 3, choosing option A, and players 4, 5, and 6, choosing option B.

Under our experimental framework, the marginal external cost gives the Pigouvian tax:

$$t = (N - 1)E = 5 \times 15 = 75$$

.

The individual chooses option C with the Pigouvian tax if the following condition is verified following equation A.7:

$$g_C - g_{ik} + c_{ik} - c_C - E \geq (N - 1)E$$

We replace the parameters with their values, and for any type of individual or option, the following is not verified:

$$200 - g_{ik} + c_{ik} - 15 \geq 75$$

3.B Robustness checks

We run robustness checks eliminating 47 participants that answered incorrectly at least one question from the comprehension checks. We run the analysis with 73 participants, 38 in the regulatory standards treatment and 35 in the taxation treatment.

There is a significant difference between vote 1 and vote 2 (Exact McNemar significance probability yields a p-value= 0.02) and between vote 2 and vote 3 (Exact McNemar significance probability yields a p-value= 0.04). Concerning the taxation treatment, there is no significant difference between votes. Focusing on the regulatory standards treatment, there is only a significant difference between vote 2 and vote 3 (Exact McNemar significance probability yields a p-value= 0.06). The difference between treatments disappears, we think that it might be due to the suppression of a large part of the observations.

Table B1 – Robustness checks: Determinants of the acceptability of public policies

Dependent variable: Vote	(1) Global	(2) Regulatory standards	(3) Taxation
Treatment	-0.33 (1.53)		
Period = 1	1.76*** (0.68)	2.27* (1.35)	1.39* (0.76)
Period = 3	1.55** (0.69)	2.27** (1.09)	1.01 (0.88)
Option B is advantageous	0.47 (1.35)	1.76 (3.62)	-0.52 (1.26)
Age	-0.06 (0.05)	-0.06 (0.10)	-0.09 (0.06)
Female	-0.45 (1.12)	-2.93 (2.46)	0.79 (1.09)
Student	1.72 (1.87)	1.64 (4.39)	2.60 (2.20)
In activity	1.17 (1.02)	-0.12 (1.91)	3.10 (2.54)
# option C: Part 1	-1.11*** (0.43)	-2.08* (1.17)	-0.43 (0.52)
Others - option C: Part 1	0.15 (0.15)	-0.32 (0.73)	0.29 (0.21)
# option C: Part 2			0.69 (0.66)
Others - option C: Part 2			0.09 (0.26)
Constant	2.42 (3.55)	11.34** (5.12)	-2.38 (5.78)
Number of clusters	20	10	10
Observations	219	114	105
Number of subjects	73	38	35

Robust standard errors clustered at the group level are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: We use logit regressions clustered at the group level in a panel data set with three periods, each period corresponds to each part of the experiment. The dependent variable is a binary variable equal to 1 for a yes vote and 0 for a no vote. Regression (1) comprises both treatments, regression (2) only uses observations from the regulatory standards treatment, and regression (3) only uses observations from the tax treatment. *Tax treatment* is a dummy variable = 1 when it is the tax treatment. *Period* is a categorical variable, equal to 1 if it corresponds to vote 1, equal to 2 if vote 2, and equal to 3 if vote 3, the reference category is vote 2. In the controls, we include a dummy variable *Option B is advantageous* = 1 when the participant was assigned to player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. *Female* is a dummy variable = 1 if the participant is a female. *Student* is a dummy variable = 1 if the participant is a student. *In activity* is a dummy variable = 1 if the participant works. We include as controls *# option C: Part 1 and Part 2*, representing the number of times the participant chose option C in Part 1 and Part 2, respectively. We include the control *Others - Option C: Part 1 and Part 2*, representing the sum of the number of participants having chosen option C in each round of the first and second parts of the experiment within each group, respectively.

Table B2 – Robustness checks: determinants of the acceptability of public policies by vote

Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Tax treatment	0.13 (0.52)	0.01 (0.58)	0.18 (0.58)	0.12 (0.63)	-0.00 (0.51)	-0.36 (0.57)
Option B is advantageous		0.20 (0.52)		0.25 (0.54)		-0.34 (0.59)
Age		-0.01 (0.02)		0.00 (0.02)		-0.05* (0.02)
Female		0.65 (0.43)		-0.37 (0.56)		-0.62 (0.50)
Student		0.81 (0.72)		0.66 (0.70)		0.23 (0.94)
In activity		0.81** (0.39)		0.59 (0.41)		-0.49 (0.48)
# option C: Part 1				-0.33** (0.16)		-0.47*** (0.17)
Others - option C: Part 1				0.04 (0.05)		0.06 (0.07)
Constant	0.65** (0.33)	0.03 (1.13)	0.11 (0.38)	0.08 (1.60)	0.65* (0.38)	3.69** (1.85)
Number of clusters	20	20	20	20	20	20
Observations	73	73	73	73	73	73
Pseudo R-squared	0.00	0.07	0.00	0.08	0.00	0.17

Robust standard errors clustered at the group level are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variables are a binary variable equal to 1 for a yes vote and 0 for a no vote. For regressions (1) and (2) is the acceptability of taxes at vote 1; for regressions (3) and (4) is the acceptability at vote 2, and for regressions (5) and (6), is the acceptability at vote 3. We use logit regressions clustered at the group level. *Tax treatment* is a dummy variable = 1 when it is the tax treatment. In the controls, we include a dummy variable *Option B is advantageous* = 1 when the participant was assigned as player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. *Female* is a dummy variable = 1 if the participant is a female. *Student* is a dummy variable = 1 if the participant is a student. *In activity* is a dummy variable = 1 if the participant works. We include as a control *# option C: Part 1* representing the number of times the participant chose option C in Part 1. We include the control *Others - Option C: Part 1*, representing the sum of the number of participants having chosen option C in each round of the first part of the experiment within each group.

Table B3 – Robustness checks: The impact of worldviews on the acceptability of regulatory standards

Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Individualistic-communitarian	0.59 (1.00)	0.38 (1.07)	0.26 (0.44)	0.50 (0.66)	0.10 (0.54)	0.40 (0.90)
Hierarchical-egalitarian	-1.35* (0.80)	-1.39 (1.02)	0.08 (0.75)	0.08 (1.16)	-0.89 (0.92)	-1.26 (1.29)
Option B is advantageous		1.14 (0.75)		0.08 (1.11)		-0.56 (0.91)
Age		0.01 (0.03)		-0.02 (0.03)		-0.04 (0.03)
Female		-0.28 (0.74)		-0.96 (0.76)		-1.84*** (0.68)
Student		0.96 (1.17)		-0.46 (0.99)		-0.20 (1.13)
In activity		0.06 (0.50)		0.04 (0.48)		-0.84* (0.45)
# option C: Part 1				-0.61** (0.24)		-0.69** (0.28)
Others - option C: Part 1				-0.09 (0.14)		-0.15 (0.16)
Constant	1.02 (0.77)	-0.02 (1.58)	-0.04 (0.75)	3.70 (2.63)	0.99 (0.89)	7.51*** (2.45)
Number of clusters	10	10	10	10	10	10
Observations	38	38	38	38	38	38
Pseudo R-squared	0.09	0.14	0.00	0.15	0.04	0.21

Robust standard errors clustered at the group level are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variables are a binary variable equal to 1 for a yes vote and 0 for a no vote. For columns (1) and (2) is the acceptability of taxes at vote 1; for columns (3) and (4) is the acceptability at vote 2, and for columns (5) and (6) is the acceptability at vote 3. We use Logit regressions clustered at the group level. *Individualistic-communitarian* is a dummy variable = 1 if the participant is individualistic, and = 0 if communitarian. *Hierarchical-egalitarian* is a dummy variable = 1 if hierarchical and = 0 if egalitarian. We include the control *Others - Option C: Part 1* in regression (4), representing the mean of participants within the group having chosen option C in the first part of the experiment. We include a dummy variable *Option B is advantageous* = 1 when the participant was assigned to player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. We also include as a control

textit# option C: Part 1, which represents the number of times that the participant chose option C in Part 1.

Table B4 – Robustness checks: The impact of worldviews on the acceptability of taxation policies

Dependent variables:	(1) Vote 1	(2) Vote 1	(3) Vote 2	(4) Vote 2	(5) Vote 3	(6) Vote 3
Individualistic-communitarian	-0.20 (0.84)	-1.11 (1.17)	-1.24* (0.69)	-2.68*** (0.96)	-0.59 (0.57)	-0.12 (0.93)
Hierarchical-egalitarian	-1.88*** (0.64)	-2.31* (1.30)	-1.96** (0.78)	-2.62** (1.06)	-1.56* (0.81)	-0.58 (1.23)
Option B is advantageous		-1.41 (0.94)		-0.18 (0.79)		-0.60 (1.02)
Age		-0.03 (0.04)		0.05* (0.03)		-0.11* (0.06)
Female		1.02 (1.06)		-0.09 (0.94)		-0.28 (0.98)
Student		2.26 (1.96)		3.15* (1.69)		0.59 (1.73)
In activity		3.91** (1.65)		4.12** (1.69)		0.63 (1.77)
# option C: Part 1				0.00 (0.33)		-0.38 (0.33)
# option C: Part 2						0.92 (0.64)
Others - option C: Part 1				0.13 (0.11)		0.23 (0.19)
Others - option C: Part 2						-0.04 (0.19)
Constant	1.81** (0.76)	0.88 (2.00)	1.62** (0.71)	-3.58 (3.20)	1.62** (0.68)	2.59 (3.33)
Number of clusters	10	10	10	10	10	10
Observations	35	35	35	35	35	35
Pseudo R-squared	0.14	0.35	0.18	0.33	0.11	0.32

Robust standard errors clustered at group level are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: Dependent variables are a binary variable equal to 1 for a yes vote and 0 for a no vote. For regressions (1) and (2) is the acceptability of taxes at vote 1; for regressions (3) and (4) is at vote 2, and for regressions (5) and (6) is at vote 3. We use logit regressions clustered at the group level. *Individualistic-communitarian* is a dummy variable = 1 if the participant is individualistic, and = 0 if communitarian. *Hierarchical-egalitarian* is a dummy variable = 1 if hierarchical and = 0 if egalitarian. We include the control *Others - Option C: Part 1* in regression (4), representing the mean of participants within the group having chosen option C in the first part of the experiment. We include *Others - option C: Part 2* in regression (6), representing the mean of participants having chosen option C in Part 2 of the experiment. We include a dummy variable *Option B is advantageous* = 1 when the participant was assigned to player 4, 5, or 6; it is equal to 0 when the participant was assigned to player 1, 2, or 3. We also include as a control two variables *# option C: Part 1 and Part 2*, representing the number of times the participant chose option C in Part 1 and Part 2, respectively.

Table B5 – Robustness checks: determinants of option choice

Dependent variable: option choice	<i>Option A</i>	<i>Option B</i>
Tax treatment	0.106 (0.399)	-0.260 (0.619)
Policy implemented	2.340*** (0.722)	2.817*** (0.744)
Option B is advantageous	-2.097*** (0.397)	4.028*** (0.781)
Period	-0.015 (0.034)	0.008 (0.027)
Hierarchical-egalitarian	-0.194 (0.322)	-0.608 (0.567)
Individualistic-communitarian	-0.073 (0.377)	-0.653 (0.732)
Age	0.010 (0.015)	0.035 (0.024)
Female	0.160 (0.246)	1.202** (0.513)
In activity	0.029 (0.356)	0.106 (0.667)
Option C in previous round	-2.098*** (0.390)	-1.634*** (0.349)
Others - option C in previous round	-0.219* (0.124)	-0.181 (0.195)
Constant	0.443 (0.654)	-4.357*** (1.154)

Robust standard errors clustered at the group level are in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Option C is the reference category. Each category and dummy variables have to be compared to the reference. We use a multinomial logit regression. The periods in the regulatory standards when the policy was implemented are not considered. The dependent variable is the option choice (categorical variable), it is equal to 1 if the participant chooses option A, equal to 2 if option B, and equal to 3 if option C. Option B is advantageous is a dummy variable = 1 when the participant was assigned to player 4, 5, or 6. Policy implemented is a dummy variable = 1 if the tax policy was implemented in the round. Option C in previous period is a dummy variable = 1 if the participant chose option C in the previous round. # of others - option C in the previous round represents the number of group members (excluding the participant) that chose option C in the previous round. Period is a variable that captures any learning effect of the game.

3.C Screenshots of the experiment

Figure C1 – Screenshot of the feedback page of option choice

Résultats

Vous avez choisi l'option Option C. Parmi les six membres de votre groupe 2 ont choisi l'option A; 2 ont choisi l'option B; et 2 ont choisi l'option C, vous perdez donc 30 ECUs.

Votre paiement pour cette période 1 correspond à 220 points ECUS.

$$100 + 200 - 50 - (2 \times 15) = 220 \text{ points ECUs}$$

Détail du calcul:

100 correspond à la dotation initiale.

200 correspond à votre gain lié à votre choix.

50 correspond au coût de l'option.

2×15 correspond au dégât généré par les participants ayant choisi l'option C.

Suivant

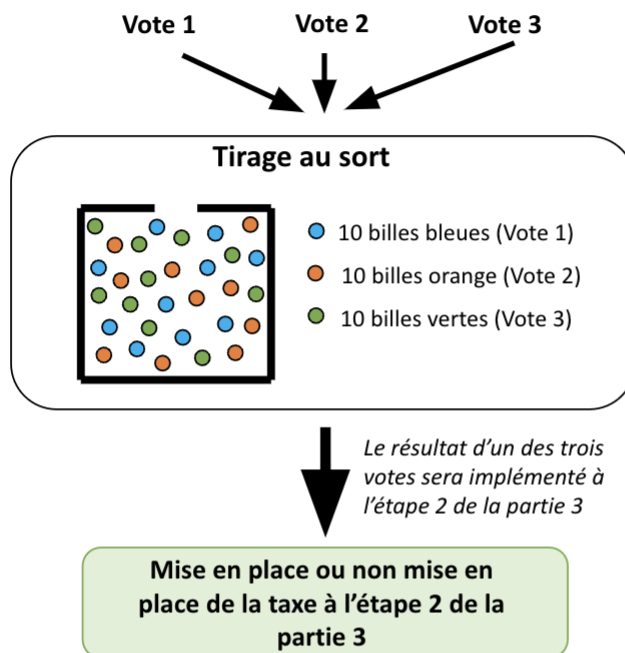
Figure C2 – Screenshot of the vote page

L'expérience commence à partir de maintenant.

Partie 1

Etape 1 (vote)

Rappel : ce vote ne pourra être appliqué qu'à la partie 3.



Vous devez voter pour ou contre la mise en place de la taxe.

Les membres de votre groupe devront aussi voter pour ou contre la mise en place de la taxe.

Rappel : ce vote ne pourrait être appliqué qu'à la partie 3.

En quoi consiste la mise en place de la taxe?

S'il y a mise en place de la taxe les individus qui auront choisi l'**option C** devront payer une taxe de **75 ECUs**.

Les ECUs collectés en tant que taxe seront **redistribués** parmi les six membres du groupe de façon équitable.

Si seulement un membre (vous ou quelqu'un d'autre) de votre groupe a choisi l'option C, vous allez avoir une perte de 15 ECUs, mais vous allez recevoir $75/6 = 12,5$ ECUs supplémentaires.

Si deux membres (vous inclus) de votre groupe ont choisi l'option C, alors vous allez avoir une perte de 30 ECUs. Chaque membre du groupe qui aura choisi l'option C devra payer 75 ECUs de taxe, le total des taxes collectées s'élève à $75 \times 2 = 150$ ECUs. Vous allez donc recevoir grâce à la redistribution de la taxe $150/6 = 25$ ECUs, et ainsi de suite.

Veillez voter pour ou contre la mise en place de la taxe à la Partie 3 :

- ☐ Pour : Oui, je souhaite la mise en place d'une taxe de 75 ECUs qui devra être payée par chaque membre du groupe qui choisit l'option C.
- ☐ Contre : Non, je ne souhaite pas la mise en place d'une taxe de 75 ECUs.

Suivant

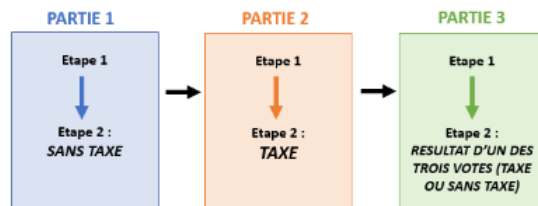
Figure C3 – Screenshot of the option choice page

PARTIE 1

Etape 2

Il n'y a pas de mise en place de la taxe à cette partie !

Rappel :



Cette étape comporte 5 périodes.

A chaque période vous et les autres membres du groupe devez décider de façon individuelle l'option que vous préférez entre l'option A, B et C.

Au début de chaque période, vous, ainsi que les cinq autres membres de votre groupe, disposez chacun d'une dotation de 100 ECUs.

Chaque membre du groupe ayant choisi l'option C imposera une perte de 15 ECUs à chaque membre du groupe. Plus il y a de membres de votre groupe qui choisissent l'option C, plus les pertes sont importantes.

Vous êtes à la période 1. Il reste 4 périodes.

Veuillez vous référer au tableau suivant afin de prendre votre choix:

Joueur 6

	Option A	Option B	Option C
Gain	200 ECUs	145 ECUs	200 ECUs
Coût	100 ECUs	20 ECUs	50 ECUs
Perte	0 ECUs	0 ECUs	15 ECUs

Dotation initiale à chaque tour : 100 ECUs

Nombre de personnes de
votre groupe ayant pris
l'option C :

Vous perdez:

1	15 ECUs
2	30 ECUs
3	45 ECUs
4	60 ECUs
5	75 ECUs
6	90 ECUs

3.D Cultural worldviews survey

The following survey was presented in French. We modified questions 9 and 11 in order to make the questions more relevant to french culture. This survey was taken from [Kahan et al. \(2011\)](#). People in our society often disagree about how far to let individuals go in making decisions for themselves. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

1. The government interferes far too much in our everyday lives.
2. Sometimes government needs to make laws that keep people from hurting themselves.
3. It's not the government's business to try to protect people from themselves.
4. The government should stop telling people how to live their lives.
5. The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.
6. Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

People in our society often disagree about issues of equality and discrimination. How strongly you agree or disagree with each of these statements? [strongly disagree, moderately disagree, slightly disagree, slightly agree, moderately agree, strongly agree]

7. We have gone too far in pushing equal rights in this country.
8. Our society would be better off if the distribution of wealth was more equal.
9. We need to dramatically reduce inequalities between the rich and the poor, and men and women.
10. Discrimination against minorities is still a very serious problem in our society.
11. It seems that minority groups don't want equal rights, they want special rights just for them.
12. Society as a whole has become too soft and feminine.

3.E Tax treatment instructions

The following instructions were originally in french.

Hello and welcome!

Thank you for participating in this experiment!

You are participating in an experiment where you can earn money based on your choices and the choices of other players. Your earnings will also depend on various events. Each participant will make their decisions individually in front of their computer.

We ask you to please read the instructions carefully. These instructions will help you understand the experiment.

Responses to this experiment are important to us and will be completely anonymous and confidential.

During this experiment, you will have to make several decisions. Your earnings will depend on your decisions as well as the decisions of other participants.

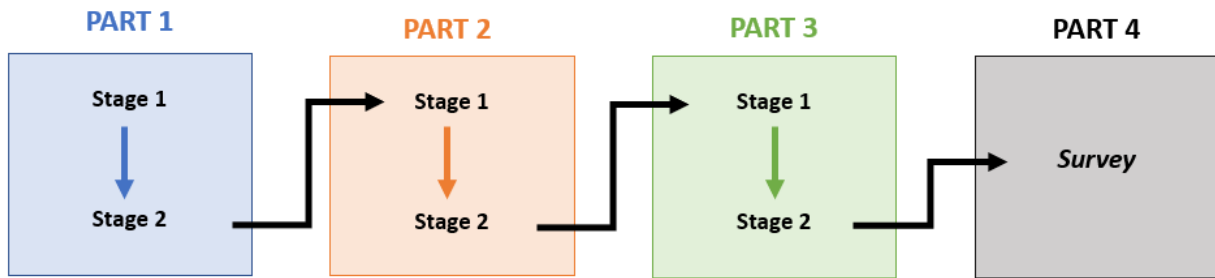
At the end of the experiment, one of your decisions will be randomly selected and will determine your payment. As a thank you for your participation, you will receive 7 euros, in addition to the earnings from the experiment. The total payment of your earnings in euros will be made in cash and privately at the end of the experiment. The earnings are expressed in ECUs.

The conversion rate of ECUs to euros is $1 \text{ ECU} = 0.05 \text{ euros}$.

You can ask questions at any time during the experiment. To do so, raise your hand and an experimenter will come to you to respond privately. During the experiment, all communication between participants is prohibited. Please read the instructions carefully.

The computer will randomly form groups of **6 participants**. The composition of the groups **will remain unchanged** throughout the experiment. You cannot identify the other members of your group and they cannot identify you.

The experiment consists of **four parts**, and you must answer all parts. The first three parts each consist of two stages in which you will have to make decisions. The fourth part of the experiment is a questionnaire.



The composition of the experiment can be summarized with the following image:

For parts 1, 2, and 3:

Stage 1

Stage 1 corresponds to a vote.

The votes are *important*.

You must vote for or against the implementation of a tax. **All members of your group must also vote.**

We will explain later in the instructions what the tax consists of.

Stage 2

In stage 2, you have a choice to make between three options.

Stage 2 consists of 5 rounds.

At the beginning of each round, we will give you an endowment of **100 ECUs** and ask you to choose the option you prefer among options A, B, and C.

Each option will earn you a **different gain** and each option has a **different usage cost**.

How do losses work?

If you choose option C, you incur a **loss of 15 ECUs**, and you **impose a loss of 15 ECUs on each participant** in your group, even if they did not choose option C.

Likewise, if another member of your group chose option C, you also incur a loss of 15 ECUs.

Thus, if two members of your group chose option C, each of you incurs a loss of 30 ECUs.

The more members of your group who choose option C, the greater the losses.

Number of members of your group who chose option C:	You lose:
1	15 ECU
2	30 ECU
3	45 ECU
4	60 ECU
5	75 ECU
6	90 ECU

Example: Suppose you have chosen option A and three members of your group have chosen option C.

Your payment will therefore be:

$$100 + 200 - 100 - (15 \times 3) = 155 \text{ ECU}$$

100 corresponds to your initial endowment, 200 corresponds to your earnings, 100 corresponds to the cost of using the chosen option, and 15×3 corresponds to the loss imposed by the 3 members of your group who chose option C. After each round, your payment will be displayed on your screen for the relevant round.

What does the implementation of the tax consist of?

If the tax is implemented, individuals who have chosen **option C** will have to pay an additional *tax* of **75 ECUs**.

The ECUs collected as tax will be redistributed equitably among the six members of the group.

For each round, if only one member of your group has chosen option C, you will have a loss of 15 ECUs, but you will receive an additional $75/6 = 12.5$ ECUs through tax redistribution.

For each round, if two members of your group have chosen option C, then you will each have a loss of 30 ECUs. Each member of the group who has chosen option C will have to pay 75 ECUs in tax, the total amount of collected taxes will be 150 ECUs. You will therefore receive $150/6 = 25$ ECUs through tax redistribution, and so on.

The following table represents the redistribution of the tax:

Number of members of your group who chose option C:	You lose:	Thanks to the redistribution you earn:	
1	15 ECU	$75/6 = 12.5$ ECU	If you have chosen option C, you will pay 75 ECU
2	30 ECU	$150/6 = 25$ ECU	
3	45 ECU	$225/6 = 37.5$ ECU	
4	60 ECU	$300/6 = 50$ ECU	The amount of the redistribution corresponds to: (tax * Number of members of your group who chose option C) / 6
5	75 ECU	$375/6 = 62.5$ ECU	
6	90 ECU	$450/6 = 75$ ECU	

Attention, regardless of the result of the vote in Part 1, the tax **will not be** implemented.

In **Part 2**, regardless of the result of the vote, the tax **will be** implemented *independently* of the result of the Part 2 vote.

In **Part 3**, the result of the **vote** of one of the three parts will be drawn at random and implemented. **Therefore, it is possible that in Part 3, the tax may or may not be implemented.**

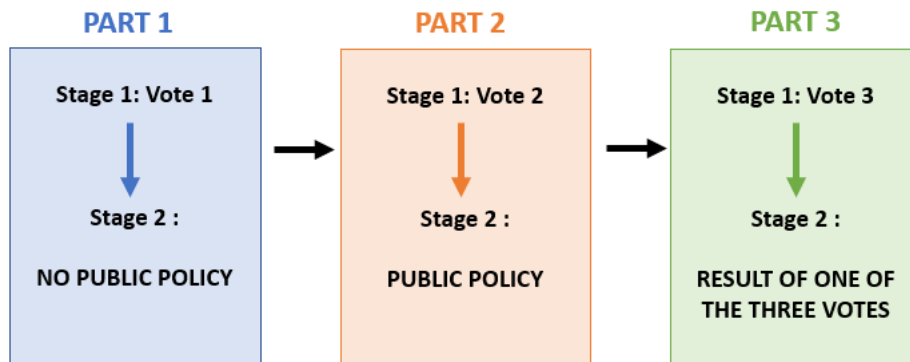
Thus, the votes of the three parts will only have an impact on Part 3.

How will the chosen vote be determined?

The vote will be determined by drawing a **marble** at random.

We will set up an urn in front of you, consisting of 30 marbles:

- 10 green marbles
- 10 orange marbles



— 10 blue marbles

If a **blue marble** is drawn, then the result of the vote in **part 1** will be implemented.

If an **orange marble** is drawn, then the result of the vote in **part 2** will be implemented.

If a **green marble** is drawn, then the result of the vote in **part 3** will be implemented.

Each of the three votes has an **equal probability** of being implemented, which is 1 in 3.

If there is a tie (3 yes and 3 no) in the vote drawn at random, we will roll a die to break the tie.

If the number is even, then the tax will be implemented. If the number is odd, then the tax will not be implemented.

You will know the results of the different votes in your group after the vote in part 3.

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CONCLUSION ET PERSPECTIVES

Cette thèse se focalise sur l'économie publique comportementale, en cherchant à comprendre les différents déterminants et mécanismes relatifs aux défaillances de marché en économie publique tout en se focalisant sur les externalités négatives et les biens publics. Deux thématiques principales sont mises en avant : les comportements pro-environnementaux et l'incertitude, en utilisant deux méthodologies différentes et complémentaires. Une partie est théorique, et provient de la microéconomie comportementale, et l'autre partie est expérimentale, utilisant des expériences en laboratoire. Cette thèse cherche à répondre à différentes questions portant sur la compréhension des déterminants en lien avec la maximisation du bien-être social en présence d'externalités négatives et de biens publics, afin de construire des outils efficaces. Quel est l'impact de la confiance et du pessimisme dans la consommation de biens verts (Chapitre 1) ? Quel est l'impact de différents niveaux d'incertitude et des attitudes face à l'incertitude sur les dons (Chapitre 2) ? Quel instrument est plus accepté entre les taxes et les politiques de régulation ? Est-ce que la mise en place d'un essai de politique publique augmente l'acceptabilité des politiques publiques (Chapitre 3) ?

Le premier chapitre présente un modèle théorique portant sur la consommation de biens verts. Ce type de consommation est sujet à l'incertitude en raison du manque de connaissance de l'impact environnemental associé à ces biens. Cet impact est difficilement mesurable et distant dans le temps. Les connaissances scientifiques actuelles ne permettent pas toujours la comparaison entre un bien conventionnel et un bien vert parfaitement substituable. Dans un premier temps, le premier chapitre propose un modèle de biens publics impurs, dans lequel l'impact des différentes variables telles que le prix, le revenu ou la qualité environnementale sur la consommation de biens verts dans un cadre certain est étudié. Dans un second temps, l'incertitude est

introduite dans le modèle en supposant que l'impact environnemental d'un bien vert, comparé à celui d'un bien conventionnel, est inconnu, et peut même s'avérer négatif. L'introduction de l'incertitude est effectuée grâce à deux paramètres : la confiance dans l'information et le pessimisme. Le modèle suppose qu'il existe une information connue de tous les individus. Cependant, les individus ne font pas toujours confiance à cette information, ou le font de façon partielle. Si les individus font partiellement confiance, ils prennent leurs décisions dans l'ambiguïté en se basant sur leurs croyances probabilistiques, en considérant seulement la réalisation du pire et du meilleur événement. Les résultats de ce modèle indiquent que le pessimisme a un impact négatif sur la consommation de biens verts et que la confiance peut avoir un impact positif ou négatif, selon le niveau de pessimisme de l'individu. La prise en compte des actions des autres individus est aussi étudiée en se focalisant sur l'équilibre et l'optimum de Pareto. Le modèle suggère que la présence d'ambiguïté permettrait, dans certains cas, de réduire ou d'augmenter l'écart entre le niveau optimal de consommation à l'équilibre et à l'optimum. Finalement, le modèle propose différentes fonctions de bien-être social en se basant sur les paramètres introduits.

Dans le deuxième chapitre de cette thèse, une expérience en laboratoire et un modèle théorique sont proposés afin d'étudier l'impact de l'incertitude et des attitudes face à celle-ci sur les dons aux associations. La gestion des fonds des associations n'est pas toujours optimale, ce qui peut être dû à des frais de fonctionnement élevés ou à des détournements de fonds. En raison d'un manque de transparence, les perceptions des donateurs sur la gestion des fonds des associations peuvent influencer leur décision de don. De plus, les effets des dons sont difficilement observables dans certains contextes, tels que les dons destinés à la lutte contre le réchauffement climatique. Ceci implique que la décision d'effectuer un don est souvent prise en situation d'incertitude. L'objectif de ce chapitre est d'étudier comment différents niveaux d'incertitude et des attitudes face à l'incertitude entourant le don reçu par l'association ont un impact sur le montant de don. Grâce à une expérience en laboratoire, dans laquelle le don reçu par l'association est incertain, le niveau d'incertitude est manipulé. Un groupe contrôle, où le montant reçu par l'association est multiplié par 1.2, est comparé à des traitements en environnement risqué et ambigu (ambiguïté élevée ou faible). Les résultats indiquent qu'il n'y a pas de différence entre les montants don-

nés en situation certaine comparé à des situations incertaines. Cependant, l'introduction d'un niveau élevé d'ambiguïté conduit à une diminution des dons par rapport à un environnement risqué et à ambiguïté faible. Les résultats mettent en évidence le rôle négatif de l'aversion à l'ambiguïté et du pessimisme mais seulement en présence d'une ambiguïté élevée. Cela suggère qu'il existe un seuil d'ambiguïté au-delà duquel ces attitudes ont un impact sur les dons, en raison de l'intensification de leur effet dans un environnement fortement ambigu.

Le troisième chapitre présente une expérience en laboratoire visant à étudier l'acceptabilité de la mise en place d'une politique de taxation et de régulation. Les politiques publiques sont conçues pour améliorer le bien-être social de la population en corrigeant les externalités négatives. Cependant, il arrive parfois que ces politiques publiques ne soient pas largement acceptées par la population, ce qui peut créer des contestations sous la forme de mouvements sociaux. Ce rejet peut résulter d'une mauvaise mise en place de la politique, mais également d'une compréhension insuffisante des mécanismes ou des bénéfices de la politique publique, ou encore d'une mauvaise communication de la part des décideurs publics. Par ailleurs, ce rejet peut provenir de préjugés culturels vis-à-vis des différents types de politiques. Par exemple, une taxe non régressive peut être perçue comme une charge financière par la population ou comme un instrument creusant les inégalités. Les politiques de régulation peuvent être perçues par certains comme restrictives des libertés de consommation. En ce sens, afin d'éviter l'échec d'une politique en raison du rejet de la population, il est nécessaire de comprendre les différents déterminants de l'acceptabilité. L'expérience proposée mesure l'acceptabilité de deux politiques publiques grâce à un vote à la majorité. Elle introduit également un essai de politique publique visant à aider les participants à mieux comprendre les bénéfices de la politique publique mise en place. Les résultats suggèrent que les politiques de régulation sont généralement plus acceptées que les politiques de taxation, et que la mise en place d'un essai de politique publique augmente l'acceptabilité d'une politique de régulation.

Les biais psychologiques peuvent atténuer ou intensifier l'ampleur des problèmes créés par la présence d'externalités négatives et de biens publics. Comme vu dans le premier chapitre, la confiance et le pessimisme peuvent aider à atteindre l'optimum social grâce à la fourniture

privée de biens publics. Dans le deuxième chapitre, nous avons vu que le pessimisme diminue la provision privée des biens publics lorsque l'ambiguïté est forte. Les opinions personnelles et culturelles ont un impact sur l'acceptabilité des politiques publiques, comme démontré dans le troisième chapitre. Cette thèse apporte une perspective sur la nécessité de considérer les aspects psychologiques dans la conception et l'évaluation des politiques publiques. Ces aspects psychologiques étant utiles pour la conception et nécessaires afin d'assurer leur efficacité.

Dans une logique d'approfondissement des travaux, cette thèse amène plusieurs interrogations qui restent à étudier. Le premier chapitre étudie la provision privée du bien public que représente la qualité environnementale. Néanmoins, ce modèle considère seulement une façon de contribuer au bien public à travers la consommation de biens verts. Il serait pertinent d'intégrer la possibilité de faire des dons dans le cadre de ce modèle, en regardant comment l'impact de l'incertitude sur les dons et sur les biens verts modifie le comportement des individus. Ensuite, le deuxième chapitre suggère l'existence d'un seuil d'ambiguïté pour lequel les attitudes face à l'ambiguïté ont un impact sur les dons. L'étude de ce seuil pourrait être une perspective de recherche. Finalement, le troisième chapitre propose une meilleure compréhension des bénéfices des politiques publiques grâce à la mise en place d'un essai de politique. D'autres mécanismes permettant d'augmenter l'acceptabilité des politiques publiques pourraient être étudiés, tels que la démocratie délibérative qui permettrait aussi une meilleure compréhension des politiques mises en place. De plus, ce chapitre se focalise exclusivement sur les taxes et les politiques de régulation, l'étude de l'acceptabilité d'autres politiques pourrait aussi être étudiée. De façon plus générale, l'acceptabilité des politiques publiques environnementales considérant la présence d'incertitude mériterait d'être mise en avant, notamment car les questions environnementales soulèvent une multitude de questions liées à l'incertitude.

