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Normes locales et fournitures privées de biens publics environnementaux

Lucie Poinet

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Par

Lucie POINET

Normes locales et fournitures privées de biens publics environnementaux

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Normes locales et fournitures privées de
biens publics environnementaux

Lucie POINET

Sous la direction de Pierre-Alexandre MAHIEU, Lionel RICHEFORT et Benoît SÉVI

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Résumé

L'objectif principal de cette thèse est de mieux comprendre l'impact de la proximité spatiale du groupe de référence sur l'efficacité des normes sociales visant à influencer les comportements pro-environnementaux. Plus précisément, elle cherche à déterminer si un changement de comportement individuel pro-environnemental est plus susceptible d'être adopté en présence d'une norme sociale locale ou d'une norme sociale globale. Les enjeux scientifiques et pratiques de cette thèse sont ancrés dans la littérature sur les incitations comportementales appelées nudges, et les politiques publiques en faveur du développement durable. Les principaux objectifs poursuivis dans la thèse sont les suivants :

- 1) Évaluer l'impact de la proximité spatiale du groupe de référence sur l'efficacité des interventions nudges normes sociales.
- 2) Analyser le rôle de la réciprocité locale dans la contribution aux biens publics.
- 3) Identifier les préférences individuelles pour les normes sociales locales et globales dans le contexte du tri des déchets organiques.

Afin de répondre aux différents objectifs, la thèse est composée en trois chapitres. Le premier chapitre explore l'impact de la proximité spatiale des groupes de référence sur l'efficacité des nudges fondées sur les normes sociales. Dans un premier temps, il définit, à partir de la littérature existante, les concepts de groupe de référence local et global. Une méta-analyse portant sur 65 études expérimentales de terrain, regroupant 71 interventions, a ensuite été menée afin d'évaluer si les

nudges normes locales produisent des effets plus marqués que les nudges normes globales.

Les résultats révèlent que les nudges utilisant des normes sociales ont globalement un effet positif et significatif sur les comportements pro-environnementaux, avec une taille d'effet moyenne. Cependant, aucune différence statistiquement significative n'a été observée entre les normes locales et globales.

Ces conclusions soulignent la nécessité de mener davantage d'expérimentations de terrain afin d'enrichir la base de données de la méta-analyse et de permettre des analyses plus approfondies. Un plus grand nombre d'études permettrait d'identifier plus précisément les contextes dans lesquels la proximité spatiale du groupe de référence pourrait influencer l'efficacité des interventions.

Le second chapitre examine le concept de réciprocité locale sur les plans théorique et expérimental. Il permet de mieux comprendre les dynamiques sous-jacentes des contributions volontaires aux biens publics, où la proximité spatiale entre individus joue un rôle. Ce chapitre permet dans un premier temps d'éclaircir la différenciation du comportement de réciprocité locale par rapport à la réciprocité globale de manière conceptuelle et théorique. Un jeu de bien public a ensuite été mis en place en laboratoire pour corroborer les résultats théoriques et distinguer le comportement de réciprocité locales des autres comportements de contributions volontaires au bien public.

Les résultats expérimentaux révèlent que la réciprocité locale joue un rôle dans les contributions volontaires au bien public : une hausse des contributions des voisins directs entraîne une augmentation moyenne de 0,167 unité des contributions individuelles. Ces dynamiques sont particulièrement marquées dans les réseaux connectés, où un lissage des contributions des groupes connectés peut être observé. Contrairement aux études classiques sur les biens publics, ce chapitre met en évidence un maintien du niveau des contributions dans le temps, suggérant que

la réciprocité locale stabilise la coopération à un niveau plus élevé.

Ces conclusions approfondissent la compréhension des motivations individuelles à contribuer volontairement aux biens publics en mettant en lumière le rôle essentiel des dynamiques de voisinage. En montrant que la réciprocité locale peut favoriser le maintien de la coopération, ce chapitre recommande aux pouvoirs publics de concevoir des incitations efficaces en diffusant des informations ciblées sur les comportements vertueux au sein des communautés locales.

Dans le troisième chapitre, nous analysons les préférences individuelles pour les normes descriptives locales et globales dans le contexte du tri des déchets organiques à Phnom Penh, capitale du Cambodge, où les autorités municipales visent à instaurer un tri à la source pour améliorer la gestion des déchets urbains. L'objectif principal de cette étude est de comparer l'impact des normes sociales locales (à l'échelle du quartier) et globales (à l'échelle de la ville) sur l'adoption d'un comportement pro-environnemental tel que le tri des déchets.

Nous mobilisons la méthode des choix discrets (DCE), une approche quantitative permettant d'évaluer les préférences individuelles pour des biens et services non marchands. Cette méthode, bien qu'amplement utilisée dans l'évaluation des biens environnementaux, reste peu exploitée pour étudier l'influence des normes sociales sur les comportements environnementaux. Nous intégrons directement les normes sociales locales et globales comme attributs dans les scénarios hypothétiques proposés, permettant ainsi de mesurer leur poids relatif dans les décisions des individus.

L'analyse repose sur un échantillon de 390 réponses exploitables, collectées via des entretiens en face-à-face à Phnom Penh. Les résultats des modèles économétriques montrent que la norme sociale locale a un effet statistiquement significatif sur les préférences pour le tri des déchets organiques, tandis que la norme sociale globale n'affiche aucune significativité. Ces résultats révèlent que les individus sont

plus sensibles aux comportements de tri des résidents de leur propre quartier qu'à ceux de l'ensemble de la ville. En outre, une proportion significative de répondants manifeste un sentiment d'appartenance plus fort à leur quartier qu'à leur ville, ce qui pourrait expliquer la préférence pour la norme locale.

Ces résultats confirment que l'efficacité des normes descriptives peut dépendre de la distance spatiale au groupe de référence. En termes d'implications pour les politiques publiques, nous recommandons de focaliser les campagnes de sensibilisation sur les normes sociales locales au travers des nudges sur le tri des déchets organiques. Une telle approche pourrait contribuer significativement à réduire les volumes de déchets dirigés vers les décharges, tout en promouvant des pratiques environnementales durables.

En conclusion, bien que les résultats de cette thèse sur l'influence de la proximité spatiale des groupes de référence sur les comportements pro-environnementaux varient selon les chapitres, ces divergences peuvent s'expliquer par des différences culturelles et méthodologiques. Toutefois, ces résultats offrent des pistes prometteuses pour la conception de politiques publiques visant à encourager les comportements pro-environnementaux. D'une part, les nudges basés sur les normes sociales se révèlent efficaces et peu coûteux à mettre en oeuvre pour les pouvoirs publics. D'autre part, cibler des groupes de référence locaux, comme les quartiers, et renforcer le sentiment d'appartenance par des initiatives communautaires pourrait renforcer l'impact de ces interventions. Ainsi, cette thèse souligne que les normes sociales, lorsqu'elles sont soigneusement conçues et adaptées au contexte, représentent un levier efficace pour promouvoir des comportements pro-environnementaux.

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Introduction générale

Les nudges comme instrument d'incitation

Les défis environnementaux et sociaux de notre époque exigent des stratégies innovantes pour encourager des comportements durables. Une approche prometteuse est celle des nudges, définis par THALER et SUNSTEIN (2008) comme tout aspect de l'architecture des choix qui modifie de manière prévisible le comportement sans interdire des options ou modifier de manière significative les incitations économiques. Cet outil exploite les biais cognitifs et les heuristiques de décision pour orienter les comportements vers des résultats plus bénéfiques pour les individus et la société.

Les nudges sont des outils qui incarnent le principe de *paternalisme libertaire*, un concept central à la théorie des nudges (THALER et SUNSTEIN 2008). Il combine deux idées apparemment opposées : le paternalisme, qui implique que des autorités guident les décisions des individus pour leur bien, et le libetarisme, qui insiste sur la liberté de choix et l'autonomie individuelle. Le paternalisme, ici, consiste à influencer subtilement les décisions des individus pour qu'ils adoptent des comportements qui sont jugés bénéfiques pour eux-mêmes et pour la société. Cette influence repose sur l'idée que les individus ne prennent pas toujours les meilleures décisions pour leur propre bien-être, en raison de biais cognitifs ou d'un manque d'information. Le libetarisme, quant à lui, insiste sur l'importance de la liberté de choix. Si les choix restent ouverts, l'architecture des choix est conçue de manière à encourager certaines décisions sans limiter les options disponibles.

Les avantages des nudges résident dans leur capacité à être à la fois efficaces et peu coûteux. Contrairement aux incitations financières, les nudges peuvent souvent être mis en oeuvre avec un minimum de ressources et facilement intégrés dans les environnements existants (THALER et SUNSTEIN 2008). Afin d'illustrer le faible coût des nudges, BENARTZI et al. (2017) ont calculé les coûts des interventions de type nudges comparés aux outils de politique traditionnels. Ils ont constaté que le rapport coûts/bénéfices des nudges est souvent plus avantageux que celui des interventions traditionnelles. Par exemple, ils montrent que le nudge de l'étude d'ALLCOTT (2011) visant à réduire la consommation d'électricité en permettant aux individus de comparer leur consommation avec celle de foyers voisins coûterait entre 2 à 8 fois moins cher que des instruments financiers conventionnels pour atteindre un résultat similaire.

Un autre avantage des nudges est qu'ils peuvent permettre d'atténuer l'effet d'éviction souvent associé à la mise en place d'un instrument d'incitation. L'effet d'éviction est la diminution de la motivation intrinsèque résultant de la mise en place de mesures d'incitations monétaires, et qui peut engendrer des comportements contraire à l'objet de l'incitation. Les mécanismes de prix peuvent parfois se révéler moins efficaces, voire conduire à une réduction de la fourniture du bien public (BÉNABOU et TIROLE 2006). Afin d'illustrer les conséquences de l'effet d'éviction sur les contributions aux biens publics, l'étude de FREY et OBERHOLZER-GEE (1997) examine l'acceptation de l'installation d'un site de stockage de déchets nucléaires à proximité d'habitations. Sans incitation monétaire, 50,8% des ménages du quartier acceptent la construction de ce centre, tandis qu'avec une incitation monétaire, le taux d'acceptation chute à 24,6%.

Les nudges peuvent toutefois faire débat dans la littérature concernant leurs aspects éthiques. Considérés par certains comme des manipulations, ils suscitent des questions sur leur légitimité et leur acceptabilité. HANSEN et JESPERSEN (2013) proposent une classification des nudges basée sur deux critères : la transparence et

le système cognitif affecté. La transparence se réfère à la capacité des individus à reconnaître qu'ils sont nudgés. Le système cognitif affecté peut être soit le système impulsif (système 1) soit le système réfléchi (système 2) du cerveau. Un nudge qui influence le système 1 affecte directement le comportement de l'individu, modifiant la façon dont il agit sans qu'il en ait pleinement conscience. En revanche, un nudge qui sollicite le système 2 influence le choix de l'individu, permettant une prise de décision plus consciente. Cette distinction est cruciale pour évaluer l'éthique des nudges, car un impact sur le système 1 peut limiter la capacité de choix de l'individu. Une illustration de cette classification est présentée dans le tableau ??.

Pour HANSEN et JESPERSEN (2013), les nudges transparents et basés sur le système 2 sont les plus éthiques, car ils maintiennent la liberté de choix tout en aidant les individus à prendre de meilleures décisions. En ce sens, ils sont particulièrement adaptés pour une mise en oeuvre par les pouvoirs publics, car ils respectent à la fois l'autonomie individuelle dans la prise de décision et l'objectif d'amélioration du bien-être collectif.

	Transparent	Non-transparent
Système 2	Incitation à un choix réfléchi <i>Ex : nudge norme sociale</i>	Manipulation du choix <i>Ex : ajouter des options non pertinentes aux ensembles de choix</i>
Système 1	Influence du comportement <i>Ex : changer les options par défaut</i>	Manipulation du comportement <i>Ex : cadrage "opt-out" des formulaires</i>

Tableau des types d'intervention nudge (adapté de HANSEN et JESPERSEN (2013))

Nudges et politiques publiques

L'intérêt croissant pour les nudges a entraîné une évolution significative dans la conception et la mise en œuvre des politiques publiques. Désormais, ces politiques ne se limitent plus à l'utilisation de mécanismes traditionnels tels que les réglementations normatives ou les incitations financières. Elles cherchent également à influencer les comportements en intégrant des nudges dans leurs dispositifs d'action publique, permettant ainsi de promouvoir des changements comportementaux de manière plus douce et non contraignante.

Par exemple en 2010, sous l'impulsion de David Cameron, le gouvernement britannique a créé sa propre unité dédiée aux nudges, la *Behavioral Insight Team* (BIT). Cette structure avait pour mission d'intégrer les sciences comportementales dans la conception des politiques publiques dans des domaines variés tels que la santé, l'éducation ou le développement durable. Dans le secteur de la santé, l'une des initiatives visait à accroître le don d'organes. Pour ce faire, le gouvernement a expérimenté plusieurs stratégies de communication, notamment en diffusant des messages tels que « Trois personnes meurent chaque jour faute de donneurs d'organes » ou en incorporant des photos et des logos facilement reconnaissables pour renforcer l'impact des campagnes.

Sous la présidence de Barack Obama, la dimension institutionnelle de l'intégration des sciences comportementales dans les politiques publiques s'est renforcée avec la création, en 2015, de la *Social and Behavioral Sciences Team* (SBST). L'approche du nudge a ainsi été utilisée dans divers domaines, tels que l'accès aux bourses pour les étudiants défavorisés et l'incitation des salariés à épargner pour leur retraite.

Par exemple, concernant la promotion de l'épargne retraite, plutôt que d'imposer aux employés de cotiser à un plan d'épargne, un nudge « par défaut » a été mis en place sous la forme de système d'adhésion automatique. Ce mécanisme tire

parti du biais du status quo, un biais comportemental selon lequel les individus ont tendance à rester dans la situation initiale. En inscrivant automatiquement les employés à un plan d'épargne, tout en leur laissant la possibilité de se désinscrire, cette stratégie aurait permis l'augmentation des taux d'adhésion au plan. Cette idée s'appuie sur des études comportementales, telles que celle de MADRIAN et SHEA (2001), qui montrent que dans les entreprises où les employés doivent entreprendre des démarches actives pour souscrire à un plan d'épargne, les taux de participation n'atteignent que 20% après trois mois d'ancienneté. En revanche, avec l'adhésion automatique, ce taux grimpe à 90%, et très peu de salariés se désengagent une fois inscrits au programme.

En France, en 2017, un département dédié aux sciences comportementales a été créé au sein de la *Direction Interministérielle de la Transformation Publique* (DITP). Ce département a pour mission d'identifier et de tester des solutions visant à améliorer l'efficacité et l'impact des politiques publiques. Leurs missions touchent divers domaines, tel que la santé, le développement durable ou l'emploi. Par exemple, dans le domaine de la santé, une intervention vise à réduire la prescription excessive d'antibiotiques afin de limiter le phénomène de résistance bactérienne. L'approche consiste à envoyer par courrier aux médecins des retours personnalisés sur leurs pratiques de prescription, une méthode qui pourrait réduire les prescriptions d'antibiotiques d'environ 5% selon une étude (BRADLEY et al. 2019).

Un exemple récent d'application des nudges s'est déroulé lors des Jeux Olympiques de Paris 2024. Dans le cadre de cet événement, le secrétariat général pour la modernisation de l'action publique a lancé un challenge de création de nudges visant à promouvoir des comportements écoresponsables et citoyens sur les sites olympiques. Parmi les initiatives retenues et mises en place lors des Jeux, nous pouvons observer des affiches encourageant le tri des déchets à travers des slogans tels que "No Benne, no gain" et "One, two, tri", ou à la réduction de l'utilisation de plastique à usage unique, avec des messages comme « Have a gourde day

», pour l’usage de gourdes plutôt que de bouteilles en plastique. Ces interventions illustrent l’utilisation des nudges dans le cadre de politiques publiques pour encourager des comportements à externalités positives.

Homo cooperativus

Dans un monde où les individus seraient des *homo economicus*, les nudges seraient moins pertinents. Le modèle traditionnel de l’*homo economicus*, au cœur de l’économie néoclassique, postule que les agents sont rationnels, dotés de capacités cognitives illimitées, toujours en quête de maximiser leurs utilités personnelles sur la base d’informations complètes et précises. Dans un tel cadre théorique, les décisions optimisées élimineraient les besoins d’intervention externe pour orienter les choix.

Cependant, les avancées en économie comportementale et en psychologie ont largement remis en question cette hypothèse de rationalité parfaite. De nombreux travaux révèlent que les comportements humains sont bien plus complexes et ne se limitent pas à la maximisation rationnelle de l’utilité individuelle. En réalité, les décisions des individus sont également souvent influencées par des facteurs sociaux, les affilant à des *homo cooperativus*. Des phénomènes tels que la réciprocité et le conformisme aux normes sociales en sont des illustrations probantes.

Plusieurs études ont démontré que les individus ajustent leurs contributions en fonction des actions des autres membres du groupe, ce qui les qualifie de coopérateurs conditionnels. SONNEMANS et al. (1999) définissent la **coopération conditionnelle** comme une corrélation positive entre la contribution d’un individu et celles des autres membres du groupe. Les coopérateurs conditionnels sont disposés à augmenter (ou à réduire) leur contribution s’ils anticipent que les autres membres du groupe en feront autant. Dans l’étude expérimentale menée par FISCHBACHER et al. (2001), 55% des participants sont classés comme coopérateurs conditionnels, tandis que 23% se comportent comme des passagers

clandestins, et 22% adoptent un autre type de comportement. De manière similaire, KURZBAN et HOUSER (2005) constatent que 63% des participants agissent en tant que coopérateurs conditionnels.

Il arrive que les individus agissent non seulement pour ajuster leur comportement à celui des autres, mais aussi en raison d'un sentiment de responsabilité morale envers le groupe ou les individus dont les efforts génèrent des bénéfices partagés (SUGDEN 1984). Ainsi, dans le cadre de contributions volontaires à un bien public, le principe de **réciprocité** stipule que si chaque membre d'un groupe contribue à un certain niveau d'effort pour la production d'un bien public, il existe une obligation morale pour chacun d'égaliser au moins cet effort. Des expériences en laboratoire ont été menées pour étudier l'expression de la réciprocité. Dans l'expérimentation de FEHR et GÄCHTER (2000), il a été observé que plus de la moitié des participants adoptaient un comportement de réciprocité.

Le comportement de réciprocité peut être positif ou négatif (FEHR et GÄCHTER 2000). Cela fait intervenir les notions de **complémentarité stratégique** et de **substituabilité stratégique** (BÉNABOU et TIROLE 2006). La complémentarité stratégique se manifeste par une interaction positive entre les décisions de contribution des individus, renforçant ainsi les contributions volontaires des coopérateurs conditionnels. Ce phénomène survient lorsque les individus sont intrinsèquement motivés à contribuer à un bien public. En revanche, la substituabilité stratégique, qui est souvent observée chez des individus moins motivés intrinsèquement, peut entraîner une diminution des contributions globales, car les individus tendent à se reposer sur les efforts des autres.

Lorsque les manquements à la réciprocité sont sanctionnés, cela favorise le maintien d'un niveau de coopération élevé et renforce directement les **normes sociales** (FEHR et GÄCHTER 2000). Les normes sociales se divisent en deux catégories : les normes injonctives, qui indiquent ce qui est socialement approuvé ou désapprouvé, et les normes descriptives, qui se réfèrent à ce que la majorité des individus fait ef-

fectivement (CIALDINI et al. 1991). L'étude expérimentale de terrain de CIALDINI et al. (1991) illustre l'influence de ces deux types de normes sur les comportements, notamment en ce qui concerne les dépôts sauvages de déchets. Ce phénomène a également été confirmé par des expériences en laboratoire, où il a été observé que les normes sociales influencent les contributions individuelles aux biens publics, en raison de la conformité aux normes et de la désutilité ressentie lorsqu'on s'en écarte (FEHR et SCHURTENBERGER 2018).

Enfin, il a été démontré que l'influence des normes sociales est étroitement liée à l'**identité** des individus au sein des groupes sociaux auxquels ils appartiennent. Ce sentiment d'appartenance constitue la base de ce que l'on appelle l'identité sociale. AKERLOF et KRANTON (2000) intègrent cette notion d'identité dans leur modèle économique, montrant que les comportements adoptés sont intrinsèquement influencés par le groupe social d'appartenance de l'individu. Les recherches expérimentales menées par CHEN et LI (2009) confirment ces résultats. Leur étude en laboratoire mesure les effets de l'identité de groupe induite sur les préférences sociales, révélant une augmentation de 47% des contributions à un bien public lorsque les participants sont associés à des individus de leur propre groupe. Ainsi, l'identité sociale peut renforcer la coopération au sein du groupe pour le maintien des biens publics (CHEN et LI 2009).

Les dynamiques sociales explorées dans cette partie jouent un rôle déterminant dans l'adoption des comportements au sein des groupes. La manière dont les individus ajustent leurs comportements en réponse aux actions des autres membres met en lumière l'importance des interactions sociales dans la prise de décision. Cette compréhension des mécanismes sociaux ouvre des perspectives prometteuses pour la conception d'instruments non-monétaires d'incitation de type nudge, en particulier ceux qui reposent sur l'utilisation des normes sociales.

Nudge norme sociale

Le nudge norme sociale influence les choix d'adoption de comportement en exploitant les perceptions des comportements des autres. BICCHIERI et DIMANT (2022) le définissent comme "un nudge dont le mécanisme d'action repose sur l'évocation des attentes sociales dans le but d'inciter à un comportement souhaitable, en supposant que les préférences individuelles pour adopter le comportement cible dépendent des attentes sociales". Ainsi, ces nudges reposent sur l'hypothèse que les préférences pour les comportements pro-sociaux peuvent être influencées par l'attente que la plupart des individus se comportent de cette manière.

Les nudges normes sociales appartiennent à la catégorie des nudges transparents et basés sur le système 2, c'est-à-dire qu'ils sont considérés comme des nudges éthiques (HANSEN et JESPERSEN 2013). Ils sont transparents car leur mécanisme est visible, et ils sollicitent le système réflexif du cerveau, encourageant ainsi une réflexion consciente sur l'adoption des comportements. De plus, les interventions basées sur les normes sociales sont généralement bien acceptées. Dans l'étude de HAGMAN et al. (2015), 66% des individus interrogés les trouvent acceptables. Au regard de ces caractéristiques, il semble pertinent de promouvoir davantage ce type d'instrument incitatif.

Les nudges basés sur les normes sociales peuvent s'appuyer à la fois sur les normes sociales descriptives et injonctives. Les normes sociales descriptives informent sur ce que la plupart des gens font, avec pour objectif de modifier les attentes empiriques concernant le comportement des autres. Un individu peut se conformer à ces normes s'il cherche à prendre des décisions perçues comme les plus efficaces. En revanche, les normes sociales injonctives informent sur ce que la majorité des gens approuvent ou désapprouvent, avec pour but de susciter des attentes normatives sur ce que les autres considèrent comme la bonne conduite à adopter. Se conformer à une norme injonctive signifie rechercher l'approbation sociale ou éviter les sanctions sociales (JACOBSON et al. 2011).

Lorsqu'il y a une incohérence entre les informations normatives et descriptives, les individus tendent souvent à accorder plus de poids aux informations descriptives (BICCHIERI et XIAO 2009). En effet, comme certains individus respectent les normes sociales par crainte des sanctions sociales, observer des comportements déviants peut affaiblir leurs attentes normatives. Par exemple, une pancarte au-dessus d'une poubelle indiquant de jeter les déchets à l'intérieur peut être inefficace s'il y a beaucoup de déchets par terre à proximité.

De nombreuses études de terrain ont évalué l'efficacité des nudges basés sur les normes sociales. Par exemple, ALLCOTT (2011) a étudié l'impact des nudges dans la promotion de la réduction de la consommation d'énergie. En utilisant des lettres personnalisées comparant la consommation d'énergie du destinataire à celle de ses voisins, les chercheurs ont observé une réduction moyenne de 2% de la consommation d'énergie chez les ménages. Egalement, FERRARO et PRICE (2013) ont envoyé des lettres à plus de 100 000 foyers pour encourager la réduction de la consommation d'eau, en utilisant une comparaison sociale pour le groupe traité. Ils ont observé une réduction de 5,28% chez les ménages qui consomment plus que la moyenne, avec un effet qui s'est atténué dès le mois suivant. Toutefois, bien que dans leur méta-analyse CIALDINI et JACOBSON (2021) montrent que les nudges basés sur les normes sociales sont généralement efficaces pour encourager les comportements pro-environnementaux, une part non négligeable des interventions présente des résultats soit nuls, soit mitigés. Il est possible que la composition et la pertinence du groupe de référence utilisé pour construire ces nudges influence les résultats.

Normes sociales et groupe de référence

Le groupe de référence se réfère à tout groupe influençant le comportement d'un individu (BICCHIERI 2016). Cette influence peut découler de l'observation des comportements des personnes dans l'environnement physique immédiat de l'indi-

vidu. Le groupe de référence peut être composé de pairs, de voisins, de collègues de travail, de consommateurs, et sert de point de comparaison pour réajuster les comportements, attitudes et croyances individuels.

Une norme est qualifiée de locale ou globale en fonction de la proximité spatiale de son groupe de référence. Comme l'expliquent MERTENS et SCHULTZ (2021), le groupe de référence d'une norme locale se compose d'individus partageant une plus grande proximité spatiale et un environnement spatio-physique commun. Cet environnement spatio-physique est défini comme un lieu spécifique, marqué par des caractéristiques physiques où les individus interagissent et adoptent des comportements (FORNARA et al. 2011). Plus cet environnement est restreint, plus l'influence des comportements des autres devient importante (FORNARA et al. 2011). Une plus grande proximité avec les individus intensifie le sentiment de réciprocité (GOLDSTEIN et al. 2008) ou la crainte de sanctions sociales (CZAJKOWSKI et al. 2019), entraînant ainsi un conformisme accru vis-à-vis des comportements des personnes spatialement proches.

Sur le plan théorique, plusieurs modèles mettent en évidence l'impact de la proximité spatiale du groupe de référence. Par exemple, le modèle de conformité d'AKERLOF (1997) intègre la notion de proximité spatiale, suggérant que les individus ont plus tendance à se conformer à ceux qui sont spatialement plus proches. En manipulant les réseaux dans lesquels les individus sont imbriqués, les groupes de référence varient. BRAMOULLÉ et KRANTON (2007) démontrent que les contributions individuelles varient en fonction de la structure du réseau, qui peut soit favoriser la coopération et la contribution aux biens publics, soit la décourager. La position de l'individu au sein du réseau semble avoir une influence sur sa contribution. Lorsqu'un individu occupe une position centrale, c'est-à-dire qu'il est plus densément connecté et que son groupe de référence est plus large, son comportement peut différer de celui d'un individu en position périphérique (BALLESTER et al. 2006, BRAMOULLÉ et al. 2014).

Des expériences en laboratoire viennent corroborer ces observations en démontrant que la variation du groupe de référence influe sur les contributions aux biens publics. FATAS et al. (2010) ont testé différentes formes de réseaux. Ils ont observé que la contribution globale au bien public dépend de la forme du réseau. À l'échelle des contributions individuelles, ROSENKRANZ et WEITZEL (2012) explorent les effets des facteurs locaux et constatent que la contribution individuelle diminue avec l'augmentation du nombre de voisins directs que l'individu a dans le réseau. BOOSEY (2017) démontre que la composition du groupe de référence influence les contributions individuelles. Ils ont observé qu'avoir un passager clandestin dans son groupe de référence tend à accélérer la réduction des contributions au bien public, tandis qu'avoir un contributeur inconditionnel dans son groupe de référence tend à maintenir les contributions au bien public.

Quelques études de terrain ont examiné la variabilité spatiale du groupe de référence dans le cadre de l'implémentation des interventions basées sur les normes sociales. L'étude emblématique de GOLDSTEIN et al. (2008) a démontré que, pour encourager la réutilisation des serviettes dans les chambres d'hôtel, une norme sociale locale, définie à l'échelle de la chambre, s'avère bien plus efficace qu'une norme globale, appliquée à l'échelle de l'hôtel. Toutefois, les résultats d'autres recherches, comme celles menées par CZAJKOWSKI et al. (2019) et MERTENS et SCHULTZ (2021), offrent des résultats plus nuancés. Des études supplémentaires sont cruciales pour éclairer les conditions optimales d'efficacité des normes sociales, notamment pour guider la conception et la mise en œuvre de nudges normes sociales destinés à relever les défis environnementaux actuels.

Objectifs de la thèse et méthodologies

L'objectif de cette thèse est de mieux comprendre l'impact de la proximité spatiale du groupe de référence sur l'efficacité des normes sociales pour influencer les comportements pro-environnementaux. Plus précisément, elle cherche à déterminer si le changement de comportement individuel pro-environnemental est plus à

même d'être adopté en présence d'une norme sociale locale ou d'une norme sociale globale. Les objectifs principaux de ce travail sont les suivants :

1) Évaluer l'impact de la proximité spatiale du groupe de référence sur l'efficacité des interventions normes sociales d'expérimentations terrain issues de la littérature existante

Il s'agit de déterminer si l'effet de l'implémentation d'un nudge norme sociale change lorsque la norme sociale de l'intervention est locale ou globale. Cela implique une analyse des études antérieures pour voir si la proximité spatiale a un impact significatif.

2) Comprendre le rôle de la réciprocité locale dans la contribution aux biens publics

Cette partie explore si la réciprocité locale peut soutenir les contributions privées aux biens publics et si la position des individus dans un réseau influence leurs comportements. L'objectif est de mieux comprendre les dynamiques de coopération entre individus dans le cadre de contributions aux biens publics.

3) Déterminer les préférences individuelles pour les normes sociales locales et globales dans le cadre du tri des déchets organiques

Nous cherchons à déterminer si la proximité spatiale du groupe de référence est un facteur d'influence pour l'adoption de comportement de tri et de valorisation des déchets organiques. L'objectif est de conseiller les pouvoirs publics sur le choix du groupe de référence pour maximiser l'efficacité des interventions basées sur les normes sociales.

Pour répondre à ces objectifs, trois études ont été menées en utilisant des méthodes variées. Nous avons tout d'abord réalisé une méta-analyse en nous basant sur les résultats d'études antérieures (MULLER 1988). Cette analyse a permis de dresser un état des lieux des connaissances existantes et de déterminer l'impact du choix du groupe de référence sur l'efficacité des interventions normes sociales

visant à encourager les comportements pro-environnementaux.

Ensuite, nous avons instauré un cadre théorique relatif à la réciprocité locale. Ce cadre théorique nous a permis de formuler des prédictions théoriques sur les équilibres en présence de comportements de réciprocité, en variant la structure du réseau. Ces prédictions ont été testées à l'aide d'une expérimentation en laboratoire, par le biais d'un jeu de bien public (LEDYARD et al. 1994).

Enfin, une expérience de choix discret a été menée pour examiner les préférences individuelles pour les normes sociales locales et globales, considérées comme des attributs dans le choix de trier les déchets organiques alimentaires (MCFADDEN 1972, TRAIN 2009).

Ces différentes études permettent de mieux comprendre l'impact de la proximité spatiale du groupe de référence sur l'efficacité des normes sociales, et d'offrir des pistes concrètes pour concevoir des interventions efficaces, notamment en matière de tri des déchets organiques. Les objectifs, méthodes et résultats de chaque chapitre sont illustrés dans la figure ci-dessous.

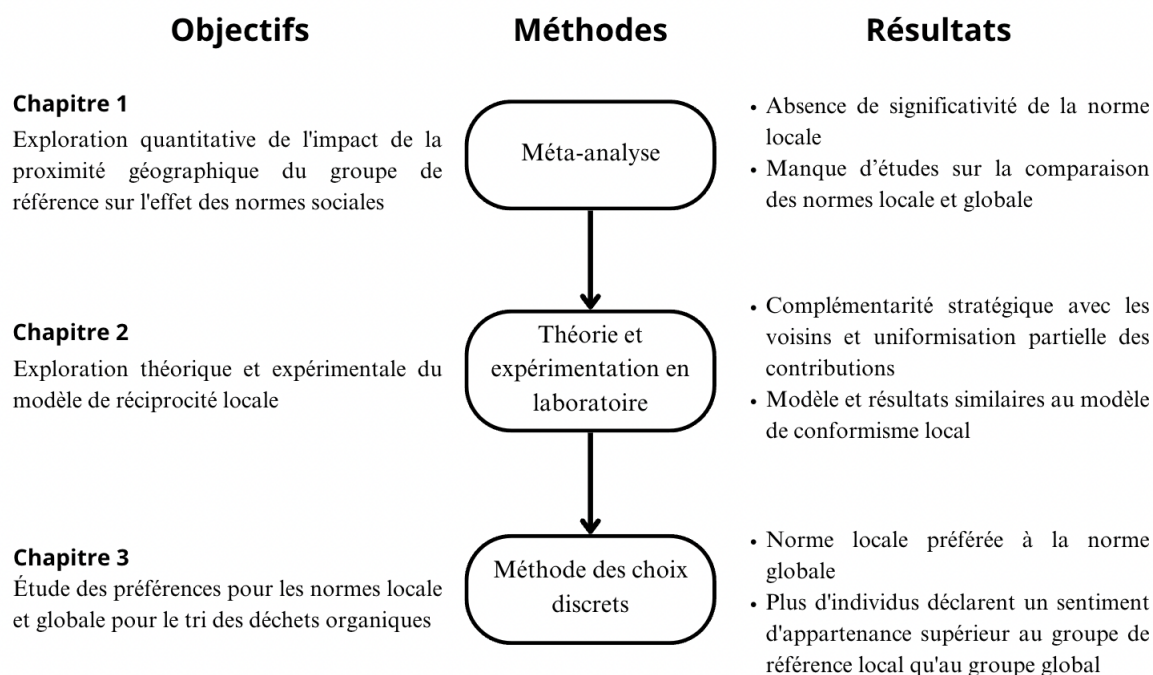


Figure présentant les objectifs, méthodes et résultats de chaque chapitre

Chapitre 1

Dans le chapitre 1, nous cherchons à évaluer l'impact de la proximité spatiale des groupes de référence sur la taille de l'effet des interventions en normes sociales, à un niveau agrégé. Pour ce faire, nous avons réalisé une méta-analyse incluant des expériences de terrain portant sur des interventions normes sociales.

Certaines études démontrent l'efficacité des interventions basées sur les normes sociales, tandis que d'autres révèlent une efficacité limitée (KURZ et al. 2005, SCHULTZ et al. 2008), voire un effet rebond (AMIOT et al. 2018, REESE et al. 2014). Les effets varient donc considérablement d'une étude à l'autre. La proximité spatiale du groupe de référence pourrait expliquer en partie cette variabilité.

Selon BICCHIERI (2016), le groupe de référence est défini comme "tout groupe exerçant une influence sur le comportement d'un individu". Des théories en psychologie et des modèles en économie suggèrent qu'une plus forte proximité spatiale du groupe de référence augmente son influence sur l'individu par rapport à un

groupe plus distant (LATANÉ 1981, AKERLOF 1997). L'étude empirique pionnière de GOLDSTEIN et al. (2008) confirme ces résultats en montrant que la proximité spatiale du groupe de référence influence le comportement de réutilisation des serviettes par les clients d'hôtel.

En nous basant sur la méta-analyse de BERGQUIST et al. (2019), nous avons établi des critères d'inclusion qui ont permis de sélectionner 65 études pour notre propre méta-analyse, couvrant 71 interventions nudges norme sociale et associées à autant de groupes de référence. Pour chaque groupe de référence dans notre base de données, nous avons calculé le d de Cohen, offrant une mesure standardisée de la taille de l'effet de chaque intervention. Par ailleurs, en nous appuyant sur des études en psychologie et en économie (BOHNER et SCHLÜTER 2014, MERTENS et SCHULTZ 2021, FORNARA et al. 2011, CZAJKOWSKI et al. 2019), nous avons défini les concepts de normes sociales locales et globales. Cela nous a permis de classer les groupes de référence de notre échantillon comme locaux et globaux.

Les résultats de notre méta-régression suggèrent que les interventions normes sociales influent sur le changement de comportement. La taille de l'effet de ces interventions est relativement faible mais hautement significative. Cependant, nous n'avons pas trouvé de preuves suggérant que la proximité spatiale des normes locales par rapport aux normes globales ait un impact significatif sur l'efficacité des interventions en normes sociales. Les tests de robustesse montrent que ces résultats sont indépendants du codage de la variable de norme locale.

Nous pensons que la taille insuffisante de notre échantillon n'a pas permis à la variable d'être significative. Des expériences de terrain supplémentaires sont nécessaires pour consolider ces résultats et contribuer aux futures méta-analyses. De plus, avec un échantillon plus grand, nous pourrions croiser plus facilement les variables pour affiner notre compréhension des contextes dans lesquels les normes locales produisent des résultats supérieurs à ceux des normes globales.

Chapitre 2

Dans le second chapitre de cette thèse, nous explorons l'influence de la réciprocité locale sur les contributions volontaires aux biens publics, en la distinguant d'autres modèles de comportement de contribution. Tout d'abord, nous proposons un cadre théorique qui précise le concept de réciprocité locale. Nous montrons que la réciprocité peut être envisagée non seulement à l'échelle globale, en tenant compte des contributions de tous les individus du réseau, mais aussi à l'échelle locale, en mettant l'accent sur les contributions du voisinage direct des individus. Ensuite, nous concevons un cadre expérimental qui permet d'analyser spécifiquement la réciprocité locale.

La littérature existante sur les mécanismes de contribution volontaire aux biens publics n'a que rarement examiné les implications de la réciprocité sous l'angle local. Par exemple, CROSON (2007) utilise un jeu linéaire de biens publics pour observer la coopération conditionnelle, montrant que les participants tendent à aligner leurs contributions sur celles des autres membres de leur groupe. De même, KURZBAN et DESCIOLI (2008) explorent la réciprocité dans un modèle de bien public circulaire, soulignant son rôle central dans l'ajustement des comportements après l'observation des contributions des pairs. Toutefois, aucune de ces études ne différencie la réciprocité locale de la réciprocité globale.

Pour étudier empiriquement la réciprocité locale, nous avons mené une expérience de jeu de bien public linéaire en laboratoire. Selon les différents traitements expérimentaux, les participants reçoivent soit des informations sur les contributions de leurs voisins directs (sous forme de moyenne ou de distribution des contributions), représentant ainsi un groupe de référence local, soit des informations sur les contributions de l'ensemble du groupe, représentant un groupe de référence global. En fonction de ces informations, les participants prennent des décisions, telles que coopérer ou adopter une stratégie de free-riding.

Nos résultats empiriques fournissent des éléments en faveur de l'adoption de com-

portement de réciprocité locale, démontrant ainsi sa pertinence, bien que nous ne soyons pas parfaitement en mesure d'éliminer la possibilité qu'une telle réciprocité locale soit également un conformisme à la norme sociale, étant donné que les deux modèles théoriques ont des implications similaires. De plus, nous montrons que l'accès à des informations détaillées sur les contributions individuelles (distribution) encourage davantage la participation comparé aux informations agrégées (moyenne). Cette constatation apporte un éclairage utile pour les politiques publiques qui cherchent à stimuler les contributions aux biens publics en tirant parti des dynamiques locales de réciprocité.

Chapitre 3

Dans le troisième chapitre de cette thèse, nous nous concentrons sur l'évaluation des préférences individuelles concernant les normes descriptives locales et globales dans le contexte du tri des déchets organiques. Plus précisément, notre objectif est de comparer les préférences et de déterminer si l'une des normes est plus influente que l'autre pour faire émerger ce comportement pro-environnemental. L'étude a été menée à Phnom Penh, la capitale du Cambodge, où les autorités municipales cherchent à élaborer une politique de collecte des déchets organiques impliquant un tri à la source (SENG et al. 2018).

La méthode des choix discrets est largement utilisée pour évaluer les biens et services non marchands, tels que les biens publics environnementaux (MARIEL et al. 2021). Cependant, peu d'études examinent l'influence des normes sociales sur l'adoption de comportements pro-environnementaux à travers cette méthode. Nous avons constaté que les effets des normes sociales peuvent être étudiés de différentes manières : avant (CZAJKOWSKI et al. 2019), pendant (VILLAMAYOR-TOMAS et al. 2019) et après (FRANCESCHINIS et al. 2022) la tâche de choix. Il est possible d'inclure les normes sociales comme attributs pendant la tâche de choix lorsqu'elles sont un critère d'adoption du comportement étudié. PASSAFARO et al. (2019) et FORNARA et al. (2011) montrent que les normes sociales influencent les comportements de tri des déchets. Nous avons alors intégré les normes sociales

locales et globales en tant qu'attributs dans la tâche de choix afin de mettre en avant les préférences déclarées pour ces deux normes.

Au total, 390 réponses à l'enquête ont été prises en compte pour l'analyse. Les résultats économétriques indiquent que la variable norme sociale locale est statistiquement significative à un niveau de 1% avec le signe attendu, tandis que la variable de norme sociale globale n'est pas significative. De plus, nous mettons en évidence qu'une proportion plus élevée des personnes interrogées ressentent un sentiment d'appartenance plus fort à leur quartier qu'à leur ville, par rapport à la proportion d'individus qui se sent davantage liée à leur ville qu'à leur quartier. Cette observation pourrait être à la source des résultats obtenus.

Nos résultats suggèrent que la norme sociale descriptive a un impact positif sur la prise de décision de trier ses déchets organiques, qui dépend de la proximité spatiale du groupe de référence. Nous recommandons aux autorités publiques, dans le cadre de la mise en place de mesures incitatives visant à accroître le taux de tri des déchets organiques, de communiquer sur la norme sociale locale associée à ce comportement.

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Chapter 1

A local versus global descriptive social norm: a meta-analysis of field experiments on pro-environmental behavior

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Abstract: The literature has extensively explored the influence of social norms on pro-environmental behavior. While social norm nudge have shown highly variable effects in the literature, little attention has been paid to the spatial distance of an individual to the reference group used, which may impact norm nudge effectiveness. Through a meta-analysis of 65 field experiments, we examine how the spatial distance of the 71 reference groups affects the effect size of social norm nudge. Our findings reveal a significant effect of social norm nudge on behavior change. However, we do not find significant evidence that the spatial distance to the reference group impacts the effectiveness of the social norm nudges. The implications of these findings for public policy are discussed.

Keywords: Social Norm Nudge; Local Social Norm; Meta-analysis; Publication bias

JEL: C20; C50; Q40; Q51; Q53

1.1 Introduction

The promotion of pro-environmental behavior is a critical area of research, particularly in the context of addressing environmental challenges and fostering sustainable practices. For this purpose, the exploration of social norms and their impact on behavior change in environmental contexts is an area that has stood out in recent decades. Notably, studies like those by Allcott (2011) and Schultz et al. (2007) shed light on the effectiveness of utilizing social norms to reduce household energy consumption. This avenue of research extends beyond energy conservation to encompass waste management, water conservation or sustainable food consumption.

Cialdini et al. (1991) distinguish between two types of norms: *descriptive* and *injunctive norms*. As posited by the authors, the descriptive norm can be defined as the perception of how the majority of individuals behave in a given situation. To illustrate, an individual may increase its recycling efforts after observing that its neighbors are engaging in the same behavior. In contrast, the injunctive norm concerns the perception of what is socially approved or disapproved by the reference group. In this instance, an individual may engage in recycling as a means of gaining social approval, given that recycling is considered socially approved behavior by others.

The processes involved in conforming to each norm are distinct. An individual may adhere to the descriptive norm if they seek to make decisions that save effort, which is associated with the concept of informational influence. Informational influence refers to the phenomenon whereby individuals rely on the behavior or opinions of others to inform their own actions, particularly in situations where they feel uncertain or lack sufficient information (Delouvé 2018). In such instances, individuals assume that others possess superior knowledge or insight, and by imitating their behavior, they can make decisions more efficiently without investing additional cognitive or physical effort. In contrast, conforming to the

injunctive norm is concerned with seeking social approval or avoiding social sanctions (Jacobson et al. 2011). This is referred to as normative influence, whereby individuals conform by adopting the majority's opinion in the presence of others, seeking to be positively regarded by other group members (Delouvé 2018).

Social norms are increasingly employed to encourage the adoption of pro-environmental behaviors through social norm nudges (Cialdini and Jacobson 2021). The social norm nudges trigger behavioral change by informing people about the behavior of others, called the reference group (Richter et al. 2018). They can lead to changes, such as a 2% reduction in electricity consumption as shown in the paper by Allcott (2011).

While some empirical studies demonstrate the effectiveness of social norm nudges, others papers show limited efficiency of the incentive tool (Kurz et al. 2005, Schultz et al. 2008), or even a boomerang effect¹ on pro-environmental behaviors illustrated by a negative impact of the nudge (Schultz et al. 2007, Richter et al. 2018). We then observe that the effects of social norm nudges vary greatly from one study to another. Although some studies have already explored factors influencing the effectiveness of the social norm information (Schultz et al. 2007, Croson et al. 2010, Carrus et al. 2009), certain aspects still require further investigation.

It is possible that the spatial distance to the reference group of the social norm has a role to play in the variability of the effects of social norm nudges. The reference group is any group that exerts influence on an individual's behavior (Bicchieri 2016). Social impact theory (Latané 1981) states that when the reference group is spatially close to the individual, the latter is more heavily influenced by the reference group than when the reference group is physically distant. For example, customers who shop in the same store as an individual may have a more direct in-

1. The boomerang effect is a situation where a policy or action intended to reduce environmental damage instead leads to an increase in negative externalities.

fluence on that individual's behavior than customers who shop in different stores. This influence can stem from observing the actions of others within the individual's physical environment. The greater impact of the local norm compared to the global norm is aligned with other theories in psychology (Fresque-Baxter and Armitage 2012) and economics (Akerlof 1997).

Some previous empirical researches have focused on the influence of local norms compared to the global norm on the effect of social norm nudge. For example, the most cited study is Goldstein et al. (2008), who conducted a study on pro-environmental behavior specifically regarding towel reuse in hotels. They found that local norms at the room level had a more significant impact compared to global norms at the hotel level. Mertens and Schultz (2021) also investigated the effects of different spatial levels of reference groups. However, their results did not show significantly different effects between local and global norms. These studies highlight the importance of understanding the role of spatial proximity in shaping the effectiveness of social norm nudges.

Our study aims to examine, at a larger scale, the impact of social norm nudges using a local reference group compared to a global reference group on the adoption of pro-environmental behaviors. To achieve this, we conduct a meta-analysis that comprises field experiments examining social norm nudges. Meta-analysis is "a generic term referring to a number of methods for statistically analyzing quantitative summaries of previous studies in the same field" (Muller 1988). We have included a set of 65 studies, corresponding to 71 reference groups analyzed. For each reference group studied, we calculate Cohen's d , which correspond to a standardized mean effect size. The findings from our meta-regression suggest that the effect of interventions based on social norms is significant, with an overall effect size of 0.160 Cohen's d , indicating a relatively small yet highly significant effect. However, we did not find any evidence suggesting that the spatial distance between local and global norm reference groups has a significant impact on the effectiveness of social norm nudges.

We have identified two meta-analyses focusing on field interventions aimed at promoting environmental behaviors. The first study, conducted by Nemati and Penn (2020), examines the effects of various information-based nudges on changes in behavior related to water, electricity, and gas consumption. Several non-monetary incentives are examined, such as usage feedback or comparative feedback, the latter being equivalent to the social norm nudges studied in our paper. Like our research, their meta-analysis exclusively includes papers conducting field experiments. The authors utilize a meta-regression to evaluate the impact of different independent variables on the effectiveness of nudges across various domains. The selected independent variables and methodology are thus inspiring for our study. The second study, conducted by Bergquist et al. (2019), focuses specifically on the influence of social norms on pro-environmental behavior. Their dataset comprises studies investigating both implicit and explicit norms². They define three independent variables and evaluate their impact by comparing means of the effect size between two populations. The papers included in their meta-analysis are particularly relevant to our study as they closely align with our research scope.

To our knowledge, no meta-analysis examining the impact of social norms on pro-environmental behavior has investigated whether the reference group used in social norm nudges affects the effectiveness of the intervention. In this study, we aim to address this gap by conducting a meta-regression to explore whether local social norms have a more significant impact on the effect size of social norm nudges compared to global social norms. Answer to this question would help refine social norm nudges to make them more effective in encouraging pro-environmental behaviors.

The rest of our paper is structured as follows. Section 1.2 outlines the methodology employed for data collection and describes the various variables included in

2. Implicit norms communicate social norms through subtle cues in the environment, while explicit norms are written information that are explicitly communicated.

the meta-regression. Section 1.3 elucidates the econometric treatment applied to address publication bias and conduct the meta-regression. Section 2.4.2 presents the findings, while Section 3.6 interprets the results and provides concluding remarks.

1.2 Method

The meta-analysis allows researchers for synthesizing the results of empirical studies. The general principle of the method is based on the assumption that effect size is constant and any differences observed between individual studies are attributed to sampling fluctuations. Therefore, meta-analysis aims to obtain the best possible estimate of the common effect size. The meta-analytic approach relies on three main principles: exhaustive search for existing studies, rigorous and reasoned selection of studies, and estimation of the common effect size. By synthesizing results from multiple studies, we can provide a comprehensive assessment of the overall impact of social norm nudges, and the effect of the reference group chosen to the effect size of the social norm nudge.

1.2.1 Data collection

Ensuring the robustness of data collection is imperative in conducting a meta-analysis, necessitating a well-defined protocol. In our study, we draw upon the methodology of data collection outlined in the meta-analysis of Bergquist et al. (2019). Their work offers a complete survey of articles concerning field experiments utilizing social norms to promote pro-environmental behaviors up to 2018. Their article is thus aligned with the thematic focus of our research. Building upon their data collection method, we aim to extend their review by conducting a systematic literature search of articles in English across Scopus and Web of Science, up to February 2024. We have chosen these two platforms because they offer several advantages. They cover a wide range of disciplines, providing access to articles from fields such as economics, psychology and sociology, which can conduct field experiments using social norm nudges. In addition, their temporal and

geographical coverage is extensive, allowing us to access older publications as well as articles from different countries. Finally, these platforms are very convenient for conducting a meta-analysis due to their robust filtering options and simplified data export processes. We employ specific keywords outlined in Appendix 1.1 to guide our search strategy.

The criterias of inclusion in our meta-analysis are the following:

- Studies must constitute field experiments
- They must use explicit social norms to encourage pro-environmental behaviors
- The social norm nudge must consider an explicit reference group
- Comparisons between treatment and control groups must be provided
- Data must provide information to calculate the standardized mean difference effect size Cohen's d

Field-experiment

Generally, field experiments in economics involve controlled experiments conducted outside of a traditional laboratory setting to address economic questions (Levitt and List 2009). Consequently, studies conducted in laboratory settings were excluded. Participants in these experiments may be aware that they are part of a study. In that case, this field experiment is defined as an artefactual field experiment (Harrison and List 2004). An example of artefactual field experiment is the study of Bergquist et al. (2019), where participants were offered the opportunity to participate in the experiment. Alternatively, participants may be observed without being aware that they are part of an experiment, which is referred to as a natural field experiment. An example is the experiment of Bernedo et al. (2014) where household were randomly selected and not informed being in the sample of participants.

Explicit social norm and pro-environmental behavior

Studies involving implicit norms, where participants might infer the norm from context, were excluded because in these cases, no explicit social norm nudge is

applied. For example, in a study by Cialdini et al. (1991), the researchers tested the salience of social norms related to littering by varying the amount of litter on the ground. Here, the norm is considered implicit because it is based on observing the behavior (littering) rather than disseminating explicit information about social norms. Additionally, within studies employing multiple treatments, only the "social norm only" condition was considered. Our focus here is on pro-environmental behaviors – those related to waste reduction, water conservation, electricity savings, sustainable food choices, or any other domain with clear ecological benefits. Studies examining health-related actions, such as choosing organic food (which may not always translate to environmental sustainability), were not included.

Explicit reference group

To ensure a clear understanding of the reference group's influence, we implemented a specific inclusion criterion for social norms. Studies where the social norm nudge lacked a clearly defined reference group were excluded. This is particularly important for our analysis, which focuses on the impact of reference group selection relative to its spatial proximity. For instance, in the study by Reiter and Samuel (1980), the explicit message "Pitch In!" aimed at emphasizing cooperation does not define a reference group. Additionally, studies employing multiple reference groups within a single experiment were included, with the condition that each social norm effect were compared to the control group. Therefore, in the coding table, we have included a row for each reference group, such as for the study by Schultz et al. (2008) which examines the reference groups "hotel guest" and "guest in the room" within a single study.

Control group conditions

Only studies where the social norm treatment were compared with a control condition were included into the pool of studies. This approach allows for a direct comparison of the treatment's effect with no treatment. When only comparisons between two different treatments are available, it is not possible to determine the net effect of the intervention relative to no treatment. Some studies only compare

different treatments together (study 1 of Bohner and Schlüter 2014, study 2 of Goldstein et al. 2008). Unfortunately, we could not incorporate them into our meta-analysis.

Cohen’s d

The selected articles must provide sufficient information to allow for the calculation of the effect size using the standardized mean difference, known as Cohen’s d (Cohen 1988). Cohen’s d is a useful measure of effect size that describes the difference between the means standardized by the standard deviation of the two groups. It is an important tool in meta-analyses as it offers a standardized method to compare results from different studies with similar designs (Maher et al. 2013). Details related to this subject can be found in the next section, which covers the dependent variable.

1.2.2 Dependent variable

To define our dependent variable, we considered a measure that could evaluate the effect of social norm nudges on behavior change. Cohen’s d is a measure of effect size that quantifies the difference between two means, typically used when comparing two groups in a study. We selected this measure because it is the most relevant measure for comparing the studies in our dataset, as it provides a universal scale for interpreting effect sizes (small, medium, large), regardless of the variables’ units. It is widely used in social sciences and can be applied in various contexts where the data are continuous and two groups are being compared, making it highly flexible.

Given that in our study we are primarily interested in studying the effects of local norms compared to global norms, we defined a measure for each social norm, taking into account the different reference groups. Thus, if a study considers several reference groups, we have calculated for each reference group its effect in comparison with the control group. One study can therefore include several outcomes.

Depending on the reporting results in each study, we calculated Cohen's d using available data. The appropriate data to calculate Cohen's d were for example means and standard deviations of the control and treatment group samples, chi-square, ANOVA or regression results. The formulas for calculation are presented in the Appendix 1.2. To perform the calculation, we used a tool developed by Wilson (2013).

We have standardized the outcome to ensure comparability between the Cohen's d resulting from the studies. Thus, a positive Cohen's d indicates a positive impact of the intervention using social norms on pro-environmental behaviors (e.g., reduced electricity or water consumption, increased purchase of sustainable foods), while a negative Cohen's d means a negative impact of the intervention on the behavior studied.

1.2.3 Independent variables

Independent variables can help explain heterogeneity in effect sizes across studies. To identify independent variables, we could draw inspiration from the two meta-analysis of Bergquist et al. (2019) and Nemati and Penn (2020). Based on the two meta-analyses combined with our own reflections and the data available in the articles, we have identified five categories of independent variables: i) reference group, corresponding to the study of the impact of local norms versus global norms; ii) studied sector, representing the pro-environmental behavior under examination; iii) surveyed sample; iv) provided social norm information, specifying the type of information provided to the treated groups; v) study characteristics.

Reference group

In order to establish our reference group variables, we first need a clear understanding of how are defined local and global norms. We aim to achieve this goal through a two-stage approach. First, we conduct a review of the literature specifically examining the differing influence of social norms when comparing local and global reference groups. Second, we identify how reference groups are designated

as local or global within the selected studies. By integrating these insights, we can then define our "Local norm" and "Global norm" variables.

The first question to address is how local and global norms are defined in the literature. Our initial observation is that local and global norms are defined relative to each other; a norm is considered local because its reference group is spatially closer than that of a global norm. Bohner and Schlüter (2014) point out that in the context of a local norm, each individual's contribution carries more weight and is more immediate than in the case of a global norm. According to Mertens and Schultz (2021), the reference group of a local norm comprises individuals with greater spatial proximity, creating a significant commonality that strengthens the influence of the norm.

A second factor that distinguishes local norms from global norms is that local norms emerge from individuals who share the same spatial-physical environment (Fornara et al. 2011). The spatial-physical environment is defined as a particular location, characterized by its physical features, where people interact and engage in behaviors. Local norms are thus associated with specific places where interactions occur, and that behaviors are influenced by the individuals who are physically present or are spatially closed. Relatively, the global norm would correspond to a broader spatial-physical environment, or even an environment where the individual's behavior does not take place.

Thirdly, related to the previous point, the influence of the local norm could come from interactions present in this shared space, with known or unknown individuals. This cultivates reciprocity in behavior (Goldstein et al. 2008), or leads individuals to conform out of fear of being sanctioned for violating the norm (Czajkowski et al. 2019). Conversely, in a global norm with a larger group, interactions would be diffuse, reducing the sense of reciprocity and fear of sanctions for norm violations.

Thus, based on the definitions of local and global norms, we identify three criteria

for defining the reference group as local or global: a relative assessment of the reference groups in terms of whether they are physically or spatially closer to the individual, with a stronger proximity for local than global norm; a spatial-physical environment in which the behavior for local norms takes place; and a place where social interactions take place.

Then, we identify which reference groups have been established as local and global in studies that have examined both levels of social norms. Table 1.1 shows the classifications made in the selected papers in the literature. This allows us to define the coding for all the reference groups encountered in studies in the meta-analysis.

Sample	Reference	Behavior	Local norm	Global norm
Hotel guests	Goldstein et al. 2008	Towel Reuse	Guests in the room	Guests in the hotel
	Schultz et al. 2008	Towel Reuse	Guests in the room	Guests in the hotel
	Bohner and Schlüter 2014	Towel Reuse	Guests in the room	Guests in the hotel
	Reese et al. 2014	Towel Reuse	Guests in the room	Guests in the hotel
Customers	Ryoo et al. 2017	Mug usage	Store customers	Store brand customers
Students	Lede et al. 2019	Water	University students	People
Households	Datta et al. 2015	Water	Neighbors	City residents
	Mertens and Schultz 2021	Recycling	Neighbors	State residents
	Czajkowski et al. 2019	Recycling	City residents	Country inhabitants

Table 1.1 – Sources for defining the local and global norms

To begin, we will examine the reference groups that appear to have a consensus, i.e. those involving the samples hotel guests, customers and students. Towel reuse in hotels has been extensively studied in the literature (Goldstein et al. 2008, Schultz et al. 2008, Bohner and Schlüter 2014, Reese et al. 2014). The reference group "Guests in the room" is consistently considered local, while "Guests in the hotel" is always considered global. We maintain these classifications as they are coherent with the criteria of locality defined above.

The customers are also usually studied in the literature by the reference groups

"Store customers" and "Store brand customers". Ryoo et al. (2017) consider the local norm to be the clientele of the store, while the global norm comprises customers of the brand. We have retained this typology in coding the variable, as it aligns with the definitions of the locality of the norms. Customers are more likely to encounter, conform to, and be sanctioned for deviating from the norm by other customers of the store with whom he shares the same spatial-physical environment.

The reference groups "University students" and "People" are studied by Lede et al. (2019) and are usually seen in field experiments that examine the impact of social norms. In Lede et al. (2019), the local reference group comprises university students, while the global norm group consists of "people," a typology that we also retain due to its coherence with the criteria we developed earlier. While the reference group "University students" pertains specifically to student samples, the reference group "People" can apply to various types of samples, including customers, households, or hotel guests.

On the other hand, we observe a lack of consensus regarding the consideration of local and global reference groups in studies involving households. While there is no debate about the local consideration of the neighborhood and the global consideration of the state and the country, the question arises as to whether the reference group "City residents" should be considered local as proposed by Czajkowski et al. (2019) or global as defined by Datta et al. (2015). Given the criteria for defining local and global norms, we might consider that the reference group "City residents" corresponds more to a global norm due to the more diffuse interactions among inhabitants of the area. However, given the lack of studies that compare all of these reference groups, we decide to also test the model considering "City residents" as local for robustness checks.

Finally, in some articles, we encountered other reference groups that are not studied in papers addressing the comparison effects of several reference groups. A

category of sample frequently seen in papers is workers (Handgraaf et al. 2013, Ornaghi et al. 2018, Tetlow et al. 2014). In these cases, the reference groups "Colleagues in the same building" and "Colleagues in another building" are used. Regarding the definitions of local and global norms, we classified the former as local since individuals in the same building are part of the employee's spatial and physical environment, and the behavior is performed in that place. Conversely, we classified "Colleagues in another building" as global because these individuals are much less likely to interact frequently, reducing the probability of this reference group to sanction a deviation or the individual to conform through reciprocity, and the behavior is not performed in that place. Additionally, we encountered the reference group "Similar household". Since this reference group lacks any spatial characteristic, we could not classify it as either local or global. Therefore, it was categorized as another norm.

In conclusion, the reference group categories comprise three control variables: Local norm, Global norm, and Other norm. The Local norm variable includes reference groups such as "Guests in the room", "Store customers", "University students", "Colleagues in the same building" and "Neighbors". The Global norm variable encompasses "Guests in the hotel", "Store brand customers", "Colleagues in another building", "People" and "Country's inhabitants". The reference group "City residents" is considered local, then global to test any differences in the regression. Lastly, the Other norm variable contains only "Similar households". Table 1.2 illustrates the coding of these variables.

Sample	Reference group	Local norm	Global norm	Other
Hotel guests	Guest in the room	x		
	Guest in the hotel		x	
Customers	Store customers	x		
	Store brand customers		x	
Students	University students	x		
Households	Neighbors	x		
	City residents		x	
	Country's inhabitants		x	
	Similar households			x
Workers	Colleagues in the same building	x		
	Colleagues in another building		x	
Any sample	People		x	

Table 1.2 – Reference groups variables coding

Other control variables

We included as control variable the sector under investigation. In the paper by Nemati and Penn (2020), the sector does not appear to be significant in influencing the effect of the types of information provided on adopting pro-environmental behavior. It is possible that by including reference groups in the regression, a particular sector may stand out more than others. Three sectors are particularly examined in the literature: water consumption, energy consumption and waste sorting. Other types of behaviors have been incorporated into the variable "Other sector", which may include behaviors such as the adoption of sustainable transportation (Mundaca et al. 2022) or sustainable food consumption (Richter et al. 2018). Each variable is coded as binary.

Furthermore, we included in our analysis independent variables related to the sample type. Nemati and Penn (2020) demonstrated that the household-level unit has a significantly negative effect on the treatment effect size. Additionally, Bergquist et al. (2019) found a stronger influence of social norm on student sam-

ples. We categorized our samples into four categories: "Household", "Student", "Worker" and "Consumer". Each of these variables is binary.

Then, we included the type of social norm information into our model. As highlighted by Nemati and Penn (2020), the nature of information provided can affect the treatment's impact. Our focus in this study is on social norm information which can be presented in various forms. We identified three common types of social norm information typically examined. Firstly, "Social comparison" involves comparing individuals' consumption with that of a reference group. Secondly, "Mean consumption level" indicates that the information provided to individuals is the average consumption of their reference group, without involving comparison of consumption. Lastly, "Participation rate" information is the percentage of the reference group adopting the pro-environmental behavior. Additionally, there are a few other types of social norm information provided to the sample, which are categorized as "Other information". All variables are binary.

Finally, we incorporated several study characteristics as independent variables into our analysis. Firstly, we examined the cultural context of the surveyed sample, considering its potential impact on the outcome. Bergquist et al. (2019) indicated that individuals from individualistic countries tend to show a higher sensitivity to social norms compared to those from collectivist cultures. Following Berglund (2006), we coded this variable as continuous using the individualism index of each country (Hofstede et al. 2014). The higher is the index, the more the country is individualist. Next, we took into account the visibility of the behavior being studied. Private behaviors such as electricity or water consumption at home were distinguished from publicly visible behaviors like recycling or purchasing sustainable food. Additionally, we included the frequency of exposure to the nudge, represented by the number of reports. This variable reflects how many times individuals accessed the social norm nudge. For one-time intervention, the number is one. For continuous access to information, such as electricity monitoring over several weeks, we recorded the duration of the intervention in days (e.g.,

14 for a two-week period). Nemati and Penn (2020) found that the effectiveness of nudge decreases with an increasing number of reports. Finally, we accounted for demographic controls in our analysis. Nemati and Penn (2020) demonstrated that including demographic characteristics significantly increases the estimated effectiveness of the nudge. We defined a paper as having controlled for demographic characteristics if it included factors such as income or education level of the sample.

The set of independent variables are summarized in the Table 1.3.

Independent variable	Definition
Reference group	
Local norm	The reference group of the social norm is local (yes = 1; otherwise = 0)
Global norm	The reference group of the social norm is global (yes = 1; otherwise = 0)
Other norm	The reference group of the social norm is neither local or global (yes = 1; otherwise = 0)
Sector	
Water	The study concerns the water sector (yes = 1; otherwise = 0)
Energy	The study concerns the energy sector (yes = 1; otherwise = 0)
Waste	The study concerns the waste sector (yes = 1; otherwise = 0)
Other sector	The study concerns other sectors (yes = 1; otherwise = 0)
Sample	
Household	The sample consists of households (yes = 1; otherwise = 0)
Student	The sample consists of students (yes = 1; otherwise = 0)
Worker	The sample consists of workers (yes = 1; otherwise = 0)
Consumer	The sample consists of consumers (yes = 1; otherwise = 0)
Social norm information	
Social comparison	Treatment is a social comparison (yes = 1; otherwise = 0)
Mean consumption level	Treatment is a mean consumption level information, without comparison (yes = 1; otherwise = 0)
Participation rate	Treatment is a participation rate information (yes = 1; otherwise = 0)
Other information	Treatment is another social norm information (yes = 1; otherwise = 0)
Study characteristics	
Culture	Individualism index of the country of the study (continuous)
Publicly visible	The pro-environmental behavior is publicly visible (yes = 1; otherwise = 0)
Number of reports	The number of time the social information is provided (continuous)
Demographic controls	Analysis includes demographic controls such as income and education (yes = 1; otherwise = 0)

Table 1.3 – The independent variables potentially influencing the model

1.3 Econometric method

The initial step regarding econometric in conducting a meta-analysis involves examining publication bias. Publication bias occurs when there is a tendency for studies with statistically significant results to be more likely to be published com-

pared to those with non-significant results. In cases of publication bias, a positive correlation is typically observed between precision, measured by standard error, and effect size. To address this issue, we follow the methodology outlined by Stanley and Doucouliagos (2012). First, we employ the Funnel Asymmetry Test (FAT). The FAT examines the relationship between the estimated effect and its standard error. The test relies on a linear regression where the estimated effect is regressed on the inverse of the standard error across studies. This test is commonly used in meta-analyses (Buckley 2020, Nelson 2013, Yuan et al. 2020). The following steps outline how to perform the FAT.

$$ES_i = \beta_0 + \beta_1(SE_i) + \epsilon_i \quad (1.1)$$

In the Equation (1.1), ES_i represents the effect size and SE_i denotes the standard error in study i . If the coefficient β_1 is statistically significant, it indicates the presence of publication bias. In such instances, studies with larger standard errors are expected to exhibit larger effect sizes. For studies that did not report their standard errors, we can derive this information through calculation. To this end, after estimating the Cohen's d of the study and determine the 95% confidence interval limits, we calculate the standard deviation using the following formula:

$$CI^+ = \bar{x} + 1.96 \cdot \frac{SD}{\sqrt{N}} \iff SD = \frac{(CI^+ - \bar{x}) \cdot \sqrt{N}}{1.96} \quad (1.2)$$

With N being the number of individual both in the treated group and in the control group. Finally, we calculate the SE from the SD and N with the formula:

$$SE = \frac{SD}{\sqrt{N}} \quad (1.3)$$

Next, we addressed the heteroskedasticity of the error terms arising from the varying precisions of the estimated effects. To mitigate this, we weighted the estimation by $\frac{1}{SE}$, which is approximately equivalent to \sqrt{N} but offers greater

precision. This gives rise to the following equation:

$$\frac{ES_i}{SE} = \frac{\beta_0}{SE} + \beta_1 + \frac{\epsilon_i}{SE} \quad (1.4)$$

With the Equation (1.4) we can estimate if β_1 is equal to zero (the null hypothesis). If the null hypothesis is rejected, then the estimation suffers publication bias. This point is known as FAT.

Once publication bias has been addressed, our next step is to determine whether the effect size significantly differs from zero. We employ Precision Effect Tests (PET) to estimate the true effect size, denoted as β_0 (Stanley and Doucouliagos 2012). If the null hypothesis is verified, it suggests no effect size. If the null hypothesis is rejected, indicating a significant effect size, we proceed to evaluate the effect more precisely using another method called PEESE (Stanley and Doucouliagos 2014). PEESE, or Precision Effect Estimate with Standard Error, follows a similar procedure as before. However, instead of regressing by SE as in Equation (1.1) and weighing by SE as in Equation (1.4), we utilize the term SE^2 .

After addressing publication bias and assessing the significance of the effect size, the final step involves considering independent variables. We incorporate these independent variables into Equation (1.4), leading to a multiple meta-regression analysis. These independent variables may explain variations in the reported effect size. Thus, the final equation takes the form:

$$\frac{ES_i}{SE} = \frac{\beta_0}{SE} + \beta_1 + \frac{X'_{ij}}{SE} + \frac{\epsilon_i}{SE} \quad (1.5)$$

With X'_{ij} being the vector of independent variables.

Lastly, we clustered the standard errors for studies that appear multiple times in the database, either due to the production of several studies or considering more than one reference group in their study. This clustering helps to appropri-

ately account for the potential dependence among these repeated observations.

1.4 Results

1.4.1 Sample of studies

Our final sample comprises 65 articles, encompassing a total of 2336 references. In order to establish our set of papers, we first included articles from Bergquist et al. (2019) that explicitly addressed social norms, leading to the identification of 63 eligible articles. Following a comprehensive review of these articles, we excluded 14 due to unavailability of the paper ($N = 5$), absence of a clear reference group in the study ($N = 4$), not enough information available to calculate Cohen's d ($N = 2$) or absence of comparison of the social norm treatment to a control group ($N = 3$).

To supplement this database, we conducted additional article searches using a research strategy similar to Bergquist et al. (2019) (see Appendix 1.1). As the authors ended their literature review in February 2018, we extended our search from this time to January 2024. This search yielded 2257 eligible articles from Scopus and Web of Science. Subsequent screening based on title, abstract, and duplication led to the selection of 48 articles for full review, of which 16 met our inclusion criteria, generating a database comprising 65 studies. Given that some studies analyze multiple reference groups, a total of 71 reference groups are observed in our database. Figure 1.1 illustrates the flowchart of the selection process.

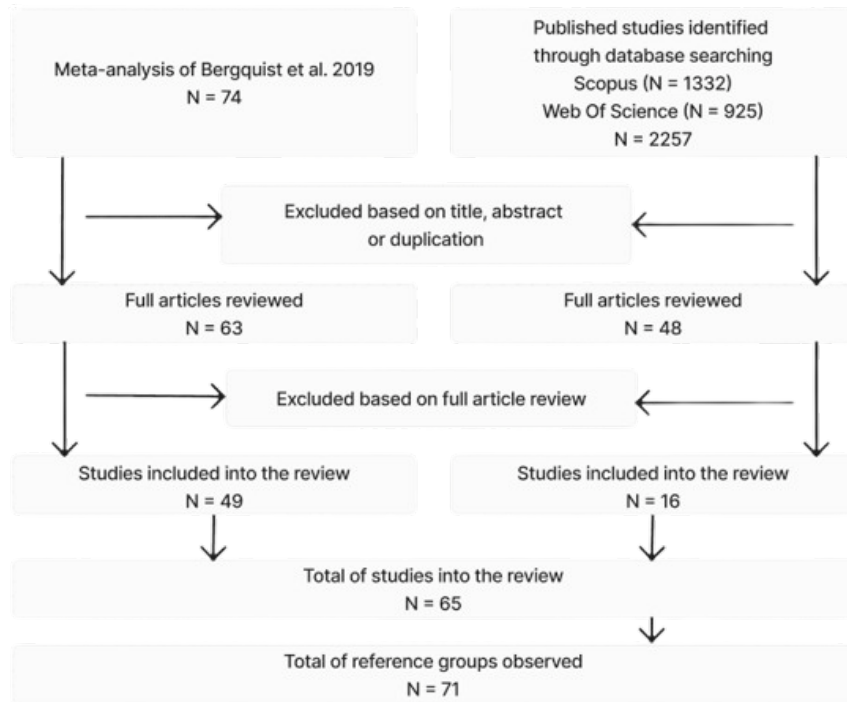


Figure 1.1 – Flow chart for the selection process

Among the studies incorporated in the meta-analysis, we found that 45 reference groups studied are affiliated to local norms, while 20 reference groups are affiliated to global norm groups. Finally, 6 reference groups have no spatial character and are classified as "Other norm". The distribution of reference groups in the article is shown in Table 1.4.

Sample	Reference group	Local norm	Global norm	Other norm
Hotel guests	Guest in the room	5		
	Guest in the hotel		10	
Customers	Store customers	6		
	Store brand customers		0	
Students	University students	6		
Households	Neighbors	22		
	City residents		3	
	Country's inhabitants		2	
	Similar households			6
Workers	Colleagues in the same building	3		
	Colleagues in another building		2	
Any sample	People		6	
Total		42	23	6

Table 1.4 – Reference group distribution

1.4.2 Meta-regression results

Publication bias

To illustrate the presence of publication bias, we utilize a "funnel plot", a graphical tool commonly employed in meta-analysis. A funnel plot is a graphical tool used in meta-analysis, designed to visually assess whether there is publication bias in the collection of studies being analyzed. On the vertical axis is a measure of study size or precision, such as standard error or sample size. Studies with larger samples or greater precision are placed towards the top of the graph, while smaller, less precise studies are at the bottom. For this analysis, we opt to use the square root of the sample size as the vertical axis. On the horizontal axis of the funnel plot lies the estimated effect size for each study, which serves as our dependent variable, specifically Cohen's d calculated for each study.

In an ideal scenario in absence of publication bias, the funnel plot should exhibit an inverted funnel shape. In such a scenario, studies would be symmetrically dis-

tributed around the overall effect estimate. At the bottom of the plot, smaller and less precise studies would disperse more widely due to random error, while larger and more precise studies would cluster more closely around the true effect at the top of the inverted funnel.

When there is a publication bias, the graphic may exhibit asymmetry. This asymmetry manifests a non-uniform distribution of studies across the plot. There may be a gap or clustering of studies on one side of the graph, usually the side representing smaller, less precise studies. Small studies with insignificant results may be absent or under-represented. The funnel plot generated for our study is depicted in Figure 1.2a.

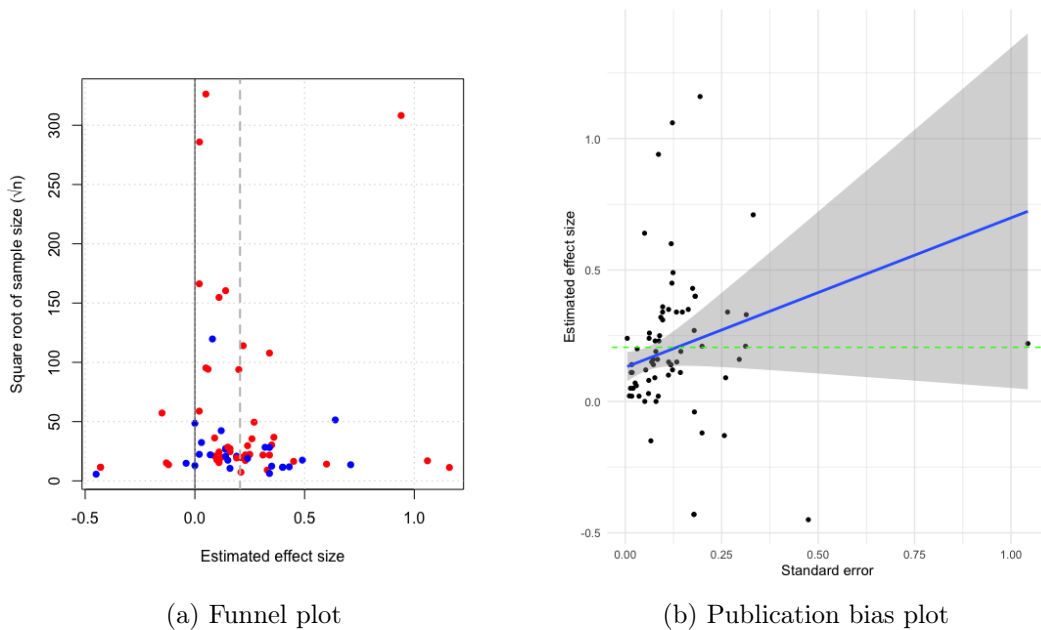


Figure 1.2 – Figures for publication bias tests

In our funnel plot, the mean effect size is 0.205 Cohen’s d , indicated by the dotted vertical line. Upon examination, we observe a slight asymmetry towards studies with larger effect sizes. Specifically, there is a slight asymmetry towards the right of the graph, marked by two studies with high estimated effect sizes but low sample sizes. Another outlier is positioned at the top right corner of the plot, deviating from the ideal inverted funnel shape. Despite these observations, the presence of publication bias is not readily apparent beyond these three points.

Additionally, we aim to compare the effect sizes between local (in red) and global (in blue) norm nudges. Graphically analyzing the data, we find that the points are relatively mixed, and we are unable to discern a notable difference in the effect sizes between the two types of norms.

Figure 1.2b compares gross and net effect sizes after correction for publication bias. The green line represents the mean effect size without correction for publication bias, yielding a value of 0.205. In contrast, the blue line depicts the regression associated with the FAT-PET method described in Section 1.3, which corrects for publication bias. Notably, the effect size appears lower after accounting for publication bias correction.

We then test numerically the statistical significance of the publication bias. The detailed results of the publication bias tests are presented in Table 1.5. The PET, represented by the intercept β_0 , denotes the genuine effect size, while the FAT serves as a control variable capturing publication bias, represented by β_1 . In the first column, we observe that solely considering the mean coefficient indicates the presence of a genuine effect size. Moving to column (2), employing the PEESE method where coefficients are weighted by $1/SE$, yields a lower but still highly significant effect size. Columns (3) and (4) are intended to test for publication bias. In column (3), the variable β_1 is found to be non-significant, indicating failure to reject the null hypothesis of publication bias. On the other hand, the intercept β_0 remains significant, suggesting the presence of a genuine effect size stemming from the social norm nudge. Comparing column (3) to column (2), we observe similar results. The PEESE method, known for its robustness, reinforces our findings. Thus, we conclude that the true effect size when controlling for publication bias is 0.160 and remains highly significant.

	(1)	(2)	(3)	(4)
β_0	0.205***	0.161***	0.129***	0.160***
	(0.032)	(0.042)	(0.034)	(0.044)
$\beta_1(SE_i)$			0.568	1.220
			(0.357)	(1.488)
Method	Mean coef.	PEESE	FAT-PET	PEESE

Notes: Clustered standard errors are in parentheses;

$p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table 1.5 – Test for publication bias

Multiple meta-regression

Having established the presence of a genuine effect size for social norm nudges in field experiments, our focus shifts to examining the role of various independent variables. The results of the linear regression are presented in Table 1.6.

In column (1), we present the results when all independent variables are integrated into the model. Here, we observe that only the water sector exhibits significance at the 10% level, meaning that implementing a social norm nudge would result to an higher effect relative to water consumption reduction.

Subsequently, we conduct stepwise model analyses in both directions to identify the most significant variables explaining the variation in the dependent variable. The results are depicted in column (2). This shows the significance of five independent variables. Notably, regarding the sector of interest, the water sector retains significance at the 10% level, indicating its particular sensitivity to social norm nudges.

Concerning the sample category, the variable "Household" emerges as significant at the 10% conventional level. Provision of social norm information to households significantly diminishes the effect size. This aligns with findings from Nemati and

Penn (2020) who observed a reduction in effect size for interventions targeting gas, electricity, and water sectors at the household level.

Examining the type of information provided to the sample, none of the different methods employed appear to have a significantly greater impact than the others. It seems that the various social norm nudge methods produce rather similar effects.

Considering study characteristics, implementation in individualist countries reduces the effect size relative to collectivist countries. This result aligns with the findings of Bergquist et al. (2019). Additionally, effect size is higher for behaviors that are publicly visible, such as recycling or sustainable food consumption.

Regarding the distinction between local and global norms, we did not observe a statistically significant difference in the effect size of the social norm nudge based on the locality of the reference group. We then sought to determine if the influence of the local norm is dependent on the culture in which the field experiment takes place. We hypothesized that in a collectivist country, the local norm might be more influential than in a country characterized as individualistic. To explore this, we created an interaction variable linking the variable Culture with the variable Local norm. The results of the model are presented in regression (5). It can be seen that the interaction variable is not significant. Moreover, the results of the stepwise analysis are similar to those of model (2). Therefore, our sample does not provide evidence to support the idea that the local norm is stronger in countries with a collectivist culture, nor indicates that the local norm has a more significant effect on the social norm effect size. These points will be discussed in more detail in Section 3.6.

	(1)	(2)	(3)	(4)	(5)
Reference group					
Local norm (vs Global norm)	0.003 (0.093)		0.003 (0.093)		0.089 (0.211)
Other norm (vs Global norm)	-0.019 (0.117)		-0.019 (0.115)		0.028 (0.155)
Local norm * Culture					-0.088 (0.176)
Sector					
Water (vs Other sector)	0.120*** (0.044)	0.062* (0.034)	0.120*** (0.035)	0.062* (0.034)	0.120*** (0.045)
Energy (vs Other sector)	0.092 (0.086)		0.092 (0.074)		0.096 (0.088)
Waste (vs Other sector)	0.056 (0.067)		0.056 (0.061)		0.045 (0.096)
Sample					
Household (vs Consumer)	-0.054 (0.093)	-0.068** (0.033)	-0.054 (0.094)	-0.068* (0.036)	-0.059 (0.097)
Student (vs Consumer)	0.052 (0.092)		0.052 (0.093)		0.045 (0.096)
Worker (vs Consumer)	-0.099 (0.142)		-0.099 (0.149)		-0.103 (0.146)
Social norm information					
Social comparison (vs Other information)	-0.028 (0.120)		-0.028 (0.122)		-0.027 (0.121)
Mean consumption level (vs Other information)	-0.056 (0.147)		-0.056 (0.138)		-0.061 (-0.101)
Participation rate (vs Other information)	-0.094 (0.103)		-0.094 (0.104)		
Study characteristics					
Culture	-0.098 (0.066)	-0.102*** (0.034)	-0.098 (0.066)	-0.102** (0.034)	-0.023 (0.153)
Publicly visible	0.136** (0.064)	0.102*** (0.031)	0.136** (0.059)	0.102*** (0.030)	0.139** (0.066)
Number of reports	-0.000 (0.001)		-0.000 (0.001)		-0.000 (0.001)
Demographic controls	-0.022 (0.071)		-0.022 (0.069)		-0.027 (0.073)
Econometrics specifications					
PET: Beta 0	0.148 (0.150)	0.203*** (0.042)	0.148 (0.144)	0.203*** (0.044)	0.079 (0.199)
FAT : 1/SE	0.119 (0.092)	0.113 (0.080)	0.119 (0.095)	0.113* (0.080)	0.113 (0.090)
Standard errors clustered by	Study	Study	Author	Author	Study
Notes: Clustered standard errors are in parentheses; $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$					

Table 1.6 – Results of the meta-regression

Robustness checks

As a robustness check, we conduct the same meta-regression analysis as in columns (1) and (2), but with the standard errors clustered not only by studies but also by authors. This clustering accounts for potential correlations within studies authored by the same individual, which may arise from similarities in methodology, data sources, or researcher's expertise.

The results of this analysis are presented in columns (3) and (4). Notably, we find consistent results with our main findings; each significant variable remains significant at the same level. This indicates that our results are insensitive to the standard error clustering approach. Standard errors were also clustered by country. As the results were similar to those in the Table 1.6, we have not displayed them separately. It reaffirms the robustness of our main findings.

Also, considering the variability of consideration regarding the locality of the reference group the "City resident", we examine whether coding this reference group as local changes the results. The results of the regressions with all control variables, as well as those after conducting a stepwise analysis, are presented in the Table 1.3 of the Appendix. It is observed that the results are identical to the main findings of our study.

To delve deeper into the impact of coding on the results, we automated the evaluation of all possible combinations of the binary variables composing Local norm in a linear regression. This was done to identify if there are configurations where the Local norm variable shows statistical significance in the model. Given the existence of ten reference groups, it follows that there are 10^2 possible combinations, resulting in a total of 1,024 combinations. By automating the coding and testing of these 1,024 combinations, it is possible to assess whether the absence of significance of the Local norm variable is a consequence of the categorisation of reference groups. We found that, regardless of how the Local norm variable is coded, it is never significant at conventional thresholds. Therefore, the results

should be robust to the way the Local norm variable is coded.

1.5 Discussion and conclusion

In this study, our aim was to conduct a meta-analysis to elucidate the significant impact of local and global social norms on the adoption of pro-environmental behaviors within the use of social norm nudges. We initiated our analysis by differentiating between local and global norms through a focused review of the relevant literature. This process permitted the classification of reference groups as either local or global norms. Subsequently, we assembled a dataset for meta-analysis, which includes 65 articles and encompasses 71 reference groups categorized into three types: local, global, and other.

We then proceeded with econometric analyses and tests for publication bias, which we found to be non-significant. Including a set of control variables, meta-regression revealed the significance of certain variables. We observed that applying the intervention to households and in more individualistic cultures, as well as presenting information in the form of a participation rate, reduced the effect of normative nudges, whereas applying the nudge to the water sector and on observable behavior increased this effect.

Regarding the effect of local norms compared to global norms, we found that presenting information on the social norm relative to a local reference group does not allow normative nudges to have a significantly greater effect than when a global norm is implemented. This contradicts the results obtained by the reference paper Goldstein et al. (2008), widely cited in the literature, as well as theories in psychology such as the social impact theory (Latané 1981) and the place identity (Fresque-Baxter and Armitage 2012).

This observation leads to two hypotheses. The first is that the local norm might be significantly more influential in specific contexts. According to Schultz (2014),

communicated social norms effectively promote pro-environmental behavior, but only "in some contexts, for some behaviors, and for some individuals". We attempted to cross the local norm variable with the culture variable, hypothesizing that the local norm might be perceived as stronger in collectivist countries where individuals spend more time in communal settings than in individualistic countries where behaviors are more private. We constructed an interaction variable between the two, which turned out to be non-significant and thus it was not possible to draw conclusions about any differences in local norm nudge impact based on the type of culture. With a larger sample, it would be interesting to cross-reference the local norm variable with other variables to determine in which contexts it has a greater effect than the global norm.

This leads to our second hypothesis regarding the lack of significance of the local norm variable. We believe that our too small sample size did not allow the variable to be significant, which is the main limitation of our study. Indeed, with a sample of 71 reference groups, we cannot demonstrate the significance of a variable when its effect is relatively small.

Additional field trials are needed to consolidate the results and contribute to future meta-analyses. Having a larger database would allow for the exploration of different interaction variables to determine whether local and global norms exhibit significantly different effects. Additionally, with a larger sample size, we could more easily cross-reference variables to refine our understanding of the contexts in which local norms yield greater results than global norms.

To further enhance this study, alternative methodologies could be employed to gain deeper insights into the presence of publication bias and to refine the effect size estimates. For example, the Trim-and-Fill method can be used to estimate the number of missing studies due to publication bias and adjust the effect size results accordingly (Duval and Tweedie 2000). By estimating the number of missing studies with both local and global reference groups and incorporating the effect

sizes of these missing studies, we could partially address the limitation of our small sample size. Applying this method in a future analysis would help to complete and refine the results of our paper.

In terms of implications for public policy, our study suggests that the implementation of social norm nudges is beneficial, as they lead to changes in behavior. This is evidenced by the significant effect size of the social norm nudge intervention. This is particularly the case in the water sector and with regard to observable behaviors, such as those carried out in public places (e.g. water consumption in dormitories, use of recyclable cups in coffee shop, etc). With regard to the reference group to be used, our meta-analysis indicates that both local and global reference groups can be used for social norms to produce positive effects.

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Appendices

1.1 Searching strategy

Date: from 2018

("Social norm*" OR "Descriptive norm*" OR "Dynamic norm*" OR "Social Comparison*" OR norm)

AND

("Pro-environmental behavio*" OR "Pro-environmental decision*" OR "Environmental decision*" OR sustainab* OR "Environmental concern" OR "Consumer behavio*" OR consumption OR conservation OR transportation OR littering OR "Pro environmental behavio*" OR "Pro environmental decision*" OR "Home water report" OR "Home energy report" OR "Consumer behavior" OR "Pro environmental behavior" OR "Pro-environmental behavior")

AND

("Field experiment" OR "Field study" OR intervention*)

Document type: article

Subject area: Social science, environmental science, psychology, energy, economics and econometrics

Database	Date	Hits
Scopus	From 2018	1332
Web of Science	From 2018	925
Total hits		2257

Table 1.7 – Searching strategy results

1.2 Formulas for calculating Cohen's d

With means and standard deviations: $d = \frac{M_1 - M_2}{SD_{pooled}}$

With chi-square: $d = 2\sqrt{\frac{\chi^2}{N - \chi^2}}$

With independent t-test: $d = t\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$

With one way ANOVA: $d = 2\sqrt{\frac{F}{N}}$

With logistic regression: $d = \frac{\beta}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$

1.3 Additional robustness checks

	(1)	(2)
Reference group		
Local norm (vs Global norm)	0.020 (0.100)	
Other norm (vs Global norm)	-0.003 (0.118)	
Sector		
Water (vs Other sector)	0.123** (0.048)	0.062* (0.034)
Energy (vs Other sector)	0.099 (0.091)	
Waste (vs Other sector)	0.059 (0.069)	
Sample		
Household (vs Consumer)	-0.056 (0.091)	-0.068** (0.033)
Student (vs Consumer)	0.054 (0.089)	
Worker (vs Consumer)	-0.106 (0.141)	
Social norm information		
Social comparison (vs Other information)	-0.323 (0.121)	
Mean consumption level (vs Other information)	-0.062 (0.150)	
Participation rate (vs Other information)	-0.098 (0.067)	
Study characteristics		
Culture	-0.098 (0.067)	-0.102** (0.034)
Publicly visible	0.138** (0.064)	0.102*** (0.031)
Number of reports	-0.000 (0.001)	
Demographic controls	-0.026 (0.072)	
Econometrics specifications		
PET: Beta 0	0.134 (0.155)	0.203*** (0.042)
FAT : 1/SE	0.121 (0.092)	0.113 (0.080)
Standard errors clustered by	Study	Study

Notes: Clustered standard errors are in parentheses; $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Chapter 2

Local reciprocity in linear public goods games: Theory and experiment

Authors: Lucie POINET, Lionel RICHEFORT, Benoît SÉVI

Abstract: This paper investigates the concept of local reciprocity as a driver of voluntary contributions to public goods. We develop a theoretical framework to differentiate local reciprocity from global reciprocity, where individuals respond primarily to the contributions of their immediate neighbors rather than the entire group. Using a linear public goods game experiment, we explore how varying levels of information — local (neighbor contributions) versus global (total group contributions) — affect cooperative behaviors. Our analysis tests several behavioral models, including altruism, conformity, and reciprocity, revealing a strong preference for local reciprocity. Participants were more likely to align with the contributions of their direct neighbors, and specific information about individual contributions tends to increase participation compared to aggregated data. These insights underscore the importance of leveraging local social dynamics to encourage public good contributions, offering valuable implications for the design of public policies.

Keywords: Local Reciprocity; Theoretical Models; Laboratory Experiment

JEL: C71; C73; C92; H41

2.1 Introduction

The provision of essential services, such as clean water, air quality, and support for non-governmental organizations, relies heavily on public engagement. In order to ensure the continuity and effectiveness of these essential services, it is crucial to understand and encourage the mechanisms that motivate individuals to contribute to the public good.

Studies in behavioral theories have revealed that individuals make voluntary contributions to public goods driven by both external incentives, such as personal gain, and intrinsic internal motivations, such as altruism, conformity, or reciprocity (Bénabou and Tirole 2006, Andreoni 1988, Bergstrom et al. 1986). These different motivations influence individuals' contribution behaviors and play a crucial role in explaining their commitment to the public good.

Our paper aims to enhance our understanding of the various motivations underlying voluntary contributions to the public good. In short, we provide both a theoretical framework and an experimental analysis of the potential motivations behind individual giving for the public good and show the central role of the concept of *local reciprocity* which has not, to the best of our knowledge, attracted much attention so far.

According to Sugden (1984), reciprocity is based on unconditional commitment. Individuals adhere to a form of morality not based on altruism, but rather on cooperation. In this way, individuals feel some kind of obligation to contribute at least the minimum level of the known members benefiting from the public good.

Importantly for our study, traditional economic models do not discriminate between local and global reciprocity. Indeed, economic literature predominantly examines reciprocity from a global perspective, i.e. individuals tend to reciprocate contributions regardless of spatial proximity. An exception is Sugden (1984)

who distinguishes agents that are within and outside a group, which is a first step to consider to the possibility of a localized form of reciprocity.

In this paper, we go further into the concept of *local reciprocity*.¹ Quite often, in cases where there is a single public good, individuals may not know the contributions of all the members benefiting from it. Instead, they have knowledge of a limited number of agents who contribute to this public good, forming the basis for their reciprocity. Understanding the underlying mechanisms and implications of such behavior is of importance to better understand both the individual motivations and the social dynamics influencing voluntary contributions to the public good. It also has policy implications as the public decision maker might use these results to adjust information releases to influence individuals and convince them to contribute more to the public good.

As is now well-known, experimental economics does provide a valuable method for studying economic behaviors, particularly in the context of voluntary contributions to the public good (Jacquemet and L'Haridon 2018). Therefore, we rely on a laboratory experiment to observe individual voluntary contributions to the public good in a simple public good game where participants are grouped in two small communities of four. In the first step of the game, the two communities are separated while they are tied in the second step. As such, we can observe the diffusion of information through the link between communities. Then we investigate how the observations from the experiment are likely to be in line with local reciprocity.

We adopt the standard linear public goods game, where agents have an incentive to free-ride. At each stage of the game, participants are provided with the same information as in Fischbacher et al. (2010) in the C-experiment which is the sum of contributions in their group. We also test with alternative kind of information to conclude whether the sum of contributions is the best way to encourage people

1. This has not to be confounded with local and global public goods (see Blackwell and McKee 2003).

to contribute. These alternatives are the mean contribution for the group² and the explicit individual contributions for the group's individuals. These specific information vary across different treatments. Based on the provided information, participants can then form beliefs and make decisions, including whether to continue cooperating, continue free-riding, or switch to free-riding as a punishment mechanism.

An important feature of our experimental design is that it allows to distinguish between various behavioral models such as commitment, altruism (pure or impure), and reciprocity (local vs. global), whose some of them have been explored in Croson (2007). Moreover, we go one step further about the concept of reciprocity and show how reciprocity should be viewed not only from a global perspective, i.e. considering all individuals' contributions in the game, but also with a focus on contributions in the proximity of the participant under scrutiny. As an illustration, we find evidence of the implication of this model thanks to the higher correlation of individual contributions with the contributions of neighbors, rather than the sum of all players' contributions with, in some sessions, a decrease in the variance of contributions.

Only a few studies have been conducted in the literature so far to investigate the implications of reciprocity in voluntary contribution mechanisms. For instance, Croson (2007) makes use of a simple linear public goods game to analyze reciprocity from an experimental viewpoint. In her study, the author provides evidence of the conditional cooperation of most of the participants, where the latter attempt to match contributions of others in their group. Another related paper is Kurzban and DeScioli (2008) who show the central role of reciprocity for the level of contributions in a circular public good model, where participants can adjust their giving behaviors after observing those of others. But none of these studies that deal with reciprocity in public good games does discriminate between

2. It should be noted that the sum of contributions of others as in Fischbacher et al. (2010) is different from the mean contribution in the group as the group only is half the number of people in the game. See below for more information on the experiment.

local and global reciprocity.

Our contribution is threefold. First, we provide a theoretical framework to differentiate between various behavioral models as these models conduct to different contribution behaviors. Second, we design an experimental setting rendering possible the analysis of the specific concept of local reciprocity. Such a setting is a novelty in the public good literature which only considers reciprocity as global. Our empirical results provide some evidence in favor of local reciprocity, further demonstrating its relevancy, despite we are not perfectly able to remove the possibility that such local reciprocity also is a conformism to the social norm, as both theoretical models have similar implications. Third, we show what kind of information is most important to players. As in Croson (2007) and Kurzban and DeScioli (2008), we deliver different types of information to participants, including the sum, the mean, or the individual contributions of others and provide evidence that knowing others' explicit contributions helps increase participation, in contrast to more aggregate information. This last contribution is helpful for public policies aiming at stimulating giving to the public good.

The remainder of the paper is structured as follows. Section 2 introduces the behavioral principles of voluntary contribution in a theoretical framework. This framework delivers various facts that will help to differentiate between the models at stake. Section 3 provides details about the experimental design. Section 4 first explains the econometric approach of our experimental data and then presents the results. Finally, Section 5 concludes.

2.2 Model

2.2.1 A model of local reciprocity in networks

We consider a public good game with n individuals and one public good. Let $N = \{1, \dots, n\}$ be the set of individuals. Each individual has to choose a contribution $g_i \in [0, w_i]$ to the public good. Let G denote the total contribution of all

individuals and G_{-i} the total contribution of all individuals except i . We consider the following utility function

$$U_i = U_i(w_i - g_i, G)$$

where U_i is supposed to be increasing and concave. We assume that the marginal per capita return of i 's contribution to the public good $\partial U_i / \partial G$ is between $1/n$ and 1, so contributing to the public good is always socially optimal but never individually optimal. This problem is therefore a pure public good problem (Isaac and Walker 1988).

Individuals are embedded in a social network. Let N_i be the set of i 's neighbors. Given G_{-i} and $\{g_j\}_{j \in N_i}$, the problem of individual i is

$$\begin{aligned} \max_{g_i \in [0, w_i]} & U_i(w_i - g_i, g_i + G_{-i}) \\ \text{s.t. } & g_i \geq \min(g_i^c, g_j \text{ for all } j \in N_i) \end{aligned}$$

where g_i^c is the contribution i would most prefer that every other individual chooses, irrespective of whether other individuals actually choose this contribution. Sugden (1984) calls such behavior the principle of unconditional commitment. This suggests a Kantian reasoning on the part of individuals (Laffont 1975; Harsanyi 1982). Each individual chooses the contribution that maximizes his utility subject to the fact that his contribution must be greater than or equal to the minimum between g_i^c and the least any of his neighbors is contributing. We derive theoretical predictions of the model under a specific parameterization.

2.2.2 Theoretical predictions

Let $n = 8$ and suppose that each individual belongs to one cycle of four individuals. Hence, the network is composed of two disconnected cycles of size four, as shown below.

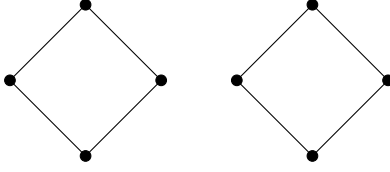


Figure 2.1 – Non-tied community network

We assume that $U_i = 20 - g_i + 0.2G$ for all i . Moreover, individuals choose g_i^c as the contribution that maximizes their utility function subject to their belief that other individuals will choose the same contribution.³ The unique solution to this problem is $g_i^c = 20$. Then, the problem of individual i becomes

$$\begin{aligned} \max_{g_i \in [0,20]} \quad & 20 - g_i + 0.2(g_i + G_{-i}) \\ \text{s.t.} \quad & g_i \geq \min(20, g_j \text{ for all } j \in N_i). \end{aligned}$$

The first order conditions lead to

$$g_i = \min(g_j \text{ for all } j \in N_i).$$

Thus, we obtain the following result.

Every contribution profile such that

$$g_1 = \dots = g_4 \in [0, 20] \quad \text{and} \quad g_5 = \dots = g_8 \in [0, 20]$$

is an equilibrium.

In equilibrium, individual contributions must be equal within each component, but not necessarily between the components. Moreover, due to peer effects, contributions are local strategic complements. Let G_{N_i} denotes the total contribution of i 's neighbors.

3. Precisely, the problem of individual i is

$$\begin{aligned} \max_{g_i \in [0,20]} \quad & 20 - g_i + 0.2(g_i + G_{-i}) \\ \text{s.t.} \quad & g_i = g_j \text{ for all } j \in N. \end{aligned}$$

In equilibrium, it holds that

$$\frac{\partial g_i}{\partial g_j} \geq 0 \text{ for all } j \in N_i \quad \text{and} \quad \frac{\partial g_i}{\partial g_j} = 0 \text{ for all } j \notin N_i.$$

It follows that

$$\frac{\partial g_i}{\partial G_{-i}} = \frac{\partial g_i}{\partial G_{N_i}} \geq 0.$$

To proceed with the comparative statics analysis of the model, we examine the impact of connecting the two cycles. We add a link between individual 4 and individual 5, as shown below, and we study the robustness of Fact 1.

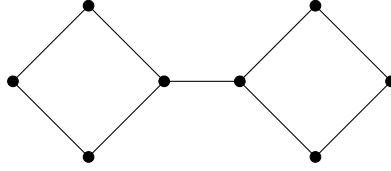


Figure 2.2 – Tied community network

Such change in network structure transforms the network into one unique connected component. Every individual is now path-connected to every other individual. We obtain the following result.

Every contribution profile such that

$$g_1 = \dots = g_8 \in [0, 20]$$

is an equilibrium.

In equilibrium, individual contributions must now all be equal. Thus, the addition of a link generally reduces the variance of all eight contributions.

2.3 Experimental design

2.3.1 General features

The experiment is structured as a repeated sequential game. The design was chosen in order to study the reaction system of individuals to the feedback relative to the social information. The sequence of game periods leads individuals

to contribute towards a stable equilibrium, which may be identified as the Nash equilibrium. Subjects were asked to decide on their contribution to the public good over 60 periods. Each individual is granted 20 Experimental Currency Unit (ECU) per period, according to the following conversion rate: 1 ECU = 0.10 €. Individuals were informed that one period would be randomly selected from the 60 to define their income from the experiment. The payoff function is identical to that of the Section 2.2.

The experiment consists of the evaluation of the effects of two informational feedback which are applied in two separate community networks and subsequently linked. The two informational feedback treatments are compared to a control treatment, resulting in a total of three informational feedback treatments comprising 20 periods : *control treatment*, *mean treatment* and *distribution treatment*. The treatments are described in greater detail in part 2.3.2. Within each of these treatments, the network shape changes from non-tied communities to tied communities after the 10th period. This results in 6 distinct treatments being applied to individuals (3 informational feedback treatments x 2 network shapes). These treatments are illustrated in the Table 2.1 and the Figure 2.3.

Descriptive norm	Non-tied communities	Tied communities
No informational feedback	T1	T2
Informational feedback : mean	T3	T4
Informational feedback : descriptive	T5	T6

Table 2.1 – Treatment classification

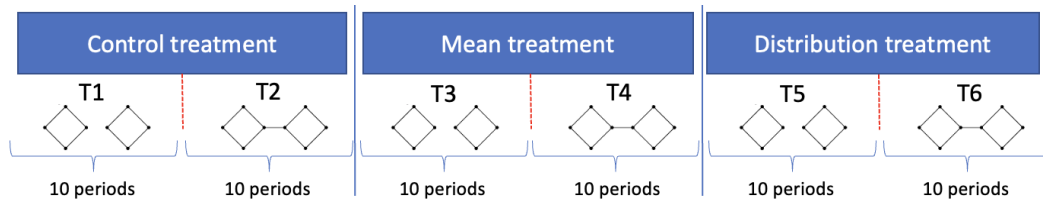


Figure 2.3 – Illustration of the different treatments

2.3.2 Feedback treatments

There are three different feedback treatments. These are relative to the provision of information regarding the individual contributions of others and are played during 20 periods. We chose to administer 20 periods per feedback treatment to allow for coordination of strategies and also to ensure a sufficient number of independent observations within each treatment (Rosenkranz and Weitzel 2012). The number of periods is stated in the experimental instructions. In the *control treatment*, following the completion of each period, individuals are provided with a standard feedback comprising their individual contribution g_i , the gain received π_i and the total contribution of other contributors G_{-i} (T1 and T2). In the *mean treatment*, the information of the mean contribution of the players' neighbors \bar{g}_{N_i} is added to the standard feedback (T3 and T4). In the *distribution treatment*, the feedback is composed by the standard feedback and the distribution of contributions of the individuals' neighbors g_j with $j \in N_i$ (T5 and T6).

2.3.3 Network treatments

In order to stimulate conformism behavior, the participants were grouped according to their level of environmental sensitivity, which was taken to be an identifying characteristic. As evidenced in the literature, behaviors disseminate more rapidly when groups are homophilic (Jackson and López-Pintado 2013). The decision was taken to place the individuals in groups according to their score on the New Ecological Paradigm test (Dunlap et al. 2000). Following completion of the questionnaire, the participants were informed about its use. They were not aware of the result of their test nor whether they were placed in the high or low environmental sensitivity group. However, they were aware that their group comprised individuals with similar environmental sensitivity.

As in the Section 2.2, these groups are undirected cycles⁴. During the first 10 periods of each feedback treatments, the cycles are untied. For the following 10

4. An undirected cycle refers to a structure where each individual (or node) is connected to two other individuals in a closed loop, with no direction assigned to the connections.

periods of each feedback treatment, the cycles are tied, i.e. one individual in each group is connected by a link and thus becomes neighbors. These elements are indicated in the instructions. Individuals are aware of the shape of the network in which they are placed during the game. They are aware of the number of neighbours they have, but are unaware of their placement within the network. The shapes of the networks are illustrated in the Figure 2.4.

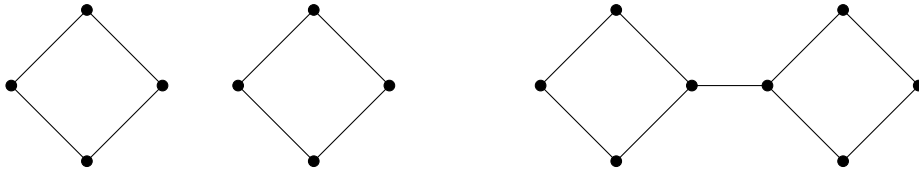


Figure 2.4 – Non-tied community network (left side) and tied community network (right side)

2.3.4 Participants matching and design choices

In this section, we provide some details about how participants are grouped and some design choices.

Firstly, it should be noted that each participant remains within the same group throughout the entirety of the experiment. However, between each feedback treatment of 20 periods, individuals are rematched in order to ensure that they are potentially paired with different neighbors. This methodology ensures that the reputation effect at the beginning of each feedback treatment is no longer operational.

Second, the experiment has a within-subject design, meaning that all treatments are applied to every players. In comparison to a between-subject design, a within-subject design reduces the impact of individual differences, as each participant faces all treatments. This increases the statistical power of the analysis, allowing for more precise comparisons between treatments with fewer participants, and minimizes potential biases that could arise from differences between groups. Recall, that the order of treatments is randomly assigned across sessions.

Thirdly, the experimental design is intentionally neutral, with the public good in question not explicitly identified. Consequently, the results are not influenced by individual preferences, but rather by social information. This approach is adopted to facilitate comparison with previous findings from the literature, where the public good is not precisely defined. However, the concept of public good and some examples have been given within the instructions.⁵

2.4 Empirical analysis

2.4.1 Econometric model

Our econometric analysis is based on the Manski (1993) framework that is a tool for modelling the interaction pattern between agents. The Manski's model provides three hypothesis to explain the interaction of individuals in the same group and their tendency to behave similarly:

1. *The endogenous effects*: individuals behave according to the behavior of others in the group. In our study, individuals have information about the contributions of their neighbors through the informational feedback given. This enables them to influence each other, resulting in an endogenous effect that will be addressed in the econometric models.

2. *The exogenous effects*: individuals behave according to the exogenous characteristics of the group. An exogenous effect may be observed when the outcome exhibits a tendency to vary in accordance with the socio-economic composition of the reference group. In this context, individuals are unaware of the individual characteristics of their neighbors and of all other players. The only information available to them is the proximity of environmental sensitivity of the other play-

5. Instructions and screenshots about the experiment can be found in the Appendix, Figures 2.6 and 2.7. Before the experiment began, the players answered a comprehension questionnaire to ensure that they understood the game.

ers in relation to their own (that is, close to in-group members and distant from out-group members). As the experiment is a repeated sequential game, this implies that the data collected is panel data. As in a panel data model, the focus is on temporal variations, and the individual environmental sensitivity remains unchanged throughout the experiment, the exogenous effect is not present here.

3. *The correlated effects:* The group members exhibit common characteristics or are situated within a similar institutional environment, which influences their behavior in a similar manner. This may occur if the unobservable variables of the neighbors are correlated with those of the individual. The fixed effects model enables the consideration of the effects of omitted variables. As will be explained in the following section, we will utilise fixed effects models, thus there should be no correlation effect in our study.

Prior undertaking the analysis, we need to address the sources of endogeneity of the variables. One potential cause of endogeneity is omitted variable bias, which arises when unobserved individual characteristics are correlated with their responses to the information being examined. To illustrate, consider the impact of a social norm nudge on recycling behaviors. Individuals with high environmental consciousness may naturally recycle more, which could create a correlation between their predispositions and responses to the nudge, leading to similar behaviors that stem from their intrinsic traits rather than the effects of the treatments. To mitigate omitted variable bias, we performed the Hausman test, which confirmed the presence of fixed effects within the models. Accordingly, all regressions incorporate fixed effects models to account for unobserved characteristics.

Another factor contributing to endogeneity can be caused by the simultaneous nature of individuals' contributions. Despite contributing at the same time, individuals possess knowledge of social information from the preceding period. This information from the previous period has the potential to impact an individual's decision in the current period. We investigated which specific preceding period

individuals referred to when making their contribution choices in period t . Beyond a lag of one period, no statistically significant variables with a time lag were identified. Consequently, our estimation accounts for a lag of one period, considering that in period t , an individual's decision is influenced by the social information of $t-1$. Therefore, in our empirical analysis, we temporally lagged the explanatory variables *sum of non-neighbors' contributions* and *sum of neighbors' contributions* by one period.

To estimate our model, the data gathered from the experiment are shaped in a data panel. The Hausman test was performed, indicating that a fixed-effect model should be used (p-value < 2.2e-16). In the experiment, subjects could choose any contribution between 0 and 20. However, individuals may wish to contribute an amount less than 0 or more than 20. In these cases, only bounded values can be chosen. Consequently, we employ the parametric test two-limit tobit model for the estimation (Nelson 1974). It should be noted that if the individual wishes to contribute a value between 0 and the endowment, then the actual contribution is observed. Therefore, we utilize the following censored dynamic panel model to explain individual contributions:

$$\begin{aligned}
 g_{i;t} &= 0 \text{ if } g_{i;t}^* \leq 0 \\
 g_{i;t} &= g_{i;t}^* \text{ if } 0 < Y_{i;t}^* < 10 \\
 g_{i;t}^* &= 20 \text{ if } g_{i;t}^* \geq 20
 \end{aligned}$$

Based on the results of the theoretical models, the aim of our experiment is to assess the reaction of individuals to the behavior of neighbors and non-neighbors. The econometric model for any treatment can be written as follow:

$$g_{i;t} = \beta_0 + \beta_1 \text{Sum_Noneigh}_{t-1} + \beta_2 \text{Sum_Neigh}_{t-1} + \beta_3 \text{time} + \alpha_i + \epsilon_{it} \quad (2.1)$$

The dependant variable $g_{i;t}$ is defined as the individual contribution at period t in line with the theoretical framework developed above. For the ease of comprehen-

sion, $G_{N_i^c t-1}$ in the Table 2.7 has been renamed $Sum_Noneigh_{t-1}$ and corresponds to the sum of non-neighbors' contributions at the previous period. With the same purpose, $G_{N_i t-1}$ is coined Sum_Neigh and is the sum of neighbors' contributions at the previous period. The time variable representing the periods is included as a control variable to ascertain whether the contributions decline over the course of the experiment, as is frequently observed in classic public goods games (Andreoni 1988). α_i contains the fixed effect of individuals and ϵ_{it} is the error term.

Finally, we address the issue of correlation by clustering the standard errors per session. The experiment involved individuals being matched during session, resulting in observations that are likely to exhibit higher correlation within session compared to the correlation across sessions. This violates the assumption of independence, which is crucial for standard statistical inference. By clustering the standard errors by session, we provide a solution to this issue and obtain more accurate estimates of the standard errors.

2.4.2 Results

The experiment was programmed using the Z-Tree software (Fischbacher 2007). This software is frequently used for public good experiments. We conducted 17 sessions with a total of 136 participants. The experiment was conducted in the Laboratory of Economics and Management of Nantes Atlantiques (LEMNA) in Nantes. Each session included 8 participants and last for around an hour and half. The average earning was 22,62€ .

Descriptive Statistics

In the Appendix, the Tables 3.3 give a view of the descriptive statistics and the Figure 2.5 recalls the aggregated data. As a reminder, each informational feedback treatment consists of 20 periods. During periods 1 to 10, the groups are non-tied. Then, they are tied in periods 11 to 20.

The experimental design is a within-subject design, and the protocol has been

constructed in a manner that prevents the order effect from influencing the results. The mean response time was calculated for the initial, intermediate, and concluding stages of the experiment. The mean response time for the initial round was 31 seconds, for the intermediate stage, 25 seconds, and for the concluding round, 20 seconds. This reduction in time can be attributed to the learning effect. The reduction in time was only 11 seconds between the beginning and the end of the experiment, yet the responses remained relatively serious throughout the experiment.

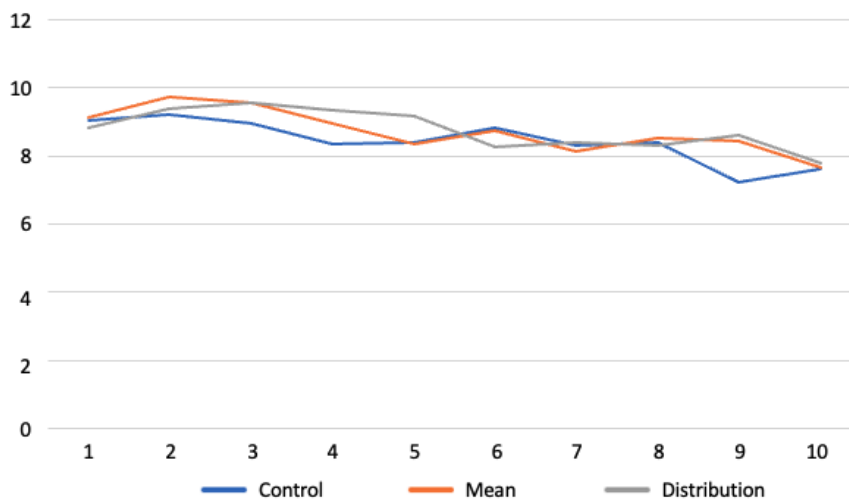


Figure 2.5 – Average contribution per treatment

We start by comparing T1, T3 and T5, i.e. the feedback treatments at the first 10 periods. The *mean treatment* increases contributions by 3.8% compared to the *control treatment* and the *distribution treatment* by 4.7% compared to the *control treatment*.

The Mann-Whitney U test is a non-parametric statistical test used to determine whether there are differences between two independent groups. Table 2.2 presents the results of the Mann-Whitney U test, which was conducted to assess the differences between the various treatments. There was a significant difference between the observations of the *control treatment* and the *mean treatment*, as well as between the *control treatment* and the *distribution treatment* (at 5% and 10% respectively). However, the test revealed no significant difference between the *mean*

and *distribution* treatments.

Treatment	Mean	Distribution
Control	0.0319	0.0090
Mean		0.563

Table 2.2 – Results of Mann-Whitney U test between the different treatments (p-value)

Regressions analysis

The econometric results presented in Table 2.3 are derived from the models described in Eq. 2.1. We observe that the more detailed⁶ the information on the contributions of other individuals is, the more individuals are influenced by the information provided.

The analysis of the control variable, for each treatment, reveals a significant decrease in the variable *time*. This indicates that contributions decline over time, a phenomenon that has been previously observed in public good experiments (Andreoni (1988)) and can be attributed to a failure of the individuals to establish a norm. However, in contrast to the findings of numerous previous public good experiments, our results indicate a relatively low rate of decay in contributions over time. Andreoni (1988) refers to social norms as a reason why some agents may free ride. Ambrus and Pathak (2011) show theoretically and experimentally how reciprocity can explain decreases in contributions, as well as the restart effect. Conversely, Villeval (2020) notes that "the norm will tend to support a particular level of contributions" (p. 189), thereby providing some explanation for the limited decay observed in our experiment.

In the *control treatment*, individuals are slightly influenced by *Sum_Noneigh*, representing the sum of non-neighbors' contributions, with the variable being significant at 1%. All things being equal, the provision of an additional ECU by non-neighbours results in an average increase of 0.054 ECU in the contribution made

6. Level of details : sum of other's players contribution < mean of neighbors' contributions < distribution of neighbors' contributions

by i . Strategic complementarities are observed exclusively with non-neighbors for the control treatment, given that the variable representing the sum of neighbors' contributions is not significant

In the *mean treatment*, the variable *Sum_Neigh* is statistically significant at 5%. This indicates that individuals consider the contributions of their neighbours from the previous period when making their own contributions. All things being equal, an increase of one ECU in the sum contribution of neighbors results in an increase of 0.088 ECU in the contribution of the individual in question. Therefore, in the *mean treatment*, individual's contributions appears to be a strategic complement to that of his neighbors. The variable *Sum_Noneigh* does not appear to be significant, indicating that individuals are quite indifferent to the contributions of their non-neighbors when making their contribution decisions.

In regard to the distribution treatment, individuals make their current contribution decisions based on the sum of contributions from their neighbors, with a significance level of 1%. A one point increase in the *Sum_Neigh* variable is associated with an increase in contribution of 0.167 ECU. There is a strong complementarity between their contributions. As for the *mean treatment*, the variable *Sum_Noneigh* is not significant. When individuals possess knowledge of the direct contributions of their neighbors, they appear to be indifferent to the contributions of non-neighbors when making decisions.

Variables	Control	Mean	Distribution
N	1224	1224	1224
Intercept	5.739***	6.284***	3.590***
(s.e.)	(0.901)	(1.219)	(1.295)
<i>Time</i>	-0.142*	-0.226***	-0.192***
(s.e.)	(0.079)	(0.071)	(0.071)
<i>Sum_Noneigh</i>	0.054***	0.020	0.006
(s.e.)	(0.015)	(0.017)	(0.021)
<i>Sum_Neigh</i>	0.041	0.088**	0.167***
(s.e.)	(0.030)	(0.037)	(0.030)

Note: $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table 2.3 – Results of the models for the first 10 periods of the experiment

Identification of the behavior adopted in the experiment

The aim of this section is to identify the behavioral patterns exhibited by participants during the public goods game experiment. To do this, we will compare the regression results with the theoretical predictions associated with local reciprocity, as well as with various models that could involve voluntary contributions and that have been extensively studied in the literature. We consider self-interest, commitment, pure and impure altruism, pure warmth, global reciprocity and norm conformism. The theoretical expectations for each type of behavior are summarised in Table 2.7 in the Appendix.

Firstly, it is observed that across all treatments, individuals base their contribution on that of their neighbors. However, in the *self-interest* and *commitment* models, individuals are indifferent to their neighbors' contributions when making their own contribution choices. Therefore, the behaviors observed in the experiment do not align with these models.

The results from the *Pure Altruism* and *Impure Altruism* models demonstrate

strategic substitutability between neighboring contributions and individual contributions. In these models, an increase in neighboring contributions is associated with a decrease in individual contributions. The regression coefficient should be negative. However, contrary to expectations, we find a strategic complementarity between individual contributions and neighboring contributions, as indicated by the positive coefficients of *Sum_Neigh*, *Mean_Neigh*, and *Distri_Neigh*. Thus, the *Pure Altruism* and *Impure Altruism* models do not accurately predict the players' behaviors in this experiment.

The empirical results of the experiment indicate that individuals exhibit indifference towards the contributions of non-neighbors. This is evident from the non-significant coefficient of *Sum_Noneigh*. In the *Pure Warm-Glow* and *Global Reciprocity* models, it is expected that individuals exhibit strategic complementarity with non-neighbors equivalent to that with neighbors. However, since this is not what we observe, we can conclude that individuals did not adopt these behaviors during the experiment.

At this stage of the analysis, it is not possible to distinguish between the *Local Reciprocity* and *Norm Conformism* models. Both models demonstrate strategic complementarity with neighbouring entities and a lack of potential complementarity with non-neighbouring entities, which aligns with the empirical results observed.

2.4.3 Distinction between Local Reciprocity and Norm Conformism

The *Local Reciprocity* and *Norm Conformism* models cannot be distinguished on the basis of the observed strategic complementarities with neighbors and non-neighbors. In order to differentiate between these behavior models in the context of the experiment, it is necessary to establish an additional neighboring link.

As discussed in the experimental design, creating an additional neighboring link between the two social networks implies that individuals involved in this new link have three neighbors instead of two. In the case of the *mean* and *distribution* treatments, this individuals can observe the contributions of their two previous neighbors from its group plus the new neighbor from the other group.

The introduction of an additional neighboring link influences the equilibrium dynamics of individual contributions and the public good in the *Norm Conformism* model, as described in the model written in the Appendix and the results summarised in Table 2.7. If the individuals exhibit heterogeneity, which is a highly plausible scenario in the context of our experiment, the establishment of the additional link should result in a modification of the profile of contributions and the total sum of contributions, called G . If the average total contributions G before and after the link are significantly different, it is possible that the individuals have adopted some conformism to the local norm.

Table 2.4 presents a comparison of the G values before and after the establishment of a new neighborhood link in the network. The results indicate significant differences in contribution for both the *control* and *mean* treatments. This suggests that individuals may have adopted norm conformism behavior during these treatments. Conversely, the *distribution* treatment shows no significant disparity in the public good provision before and after the neighborhood linkage. This outcome can imply that when individuals have access to information regarding direct contributions from their neighbors, they tend to adopt a behavior based on *Local Reciprocity*.

T-test	Control	Mean	Distribution
P-value	9.101e-05	3.204e-08	0.6515
Analysis	Different	Different	Similar

Table 2.4 – Comparison of total contributions to the public good before and after the creation of the link

Furthermore, the introduction of an additional link has a notable and quantifiable

impact in accordance with the *Local Reciprocity* model. Under this model, the formation of an additional neighboring link between groups is expected to result in a reduction in the overall variance of contributions.

Thus, an additional method for distinguishing between the two models is to examine the evolution of variance. Table 2.5 displays the number of sessions in which a reduction of variance was observed. The results are relatively consistent across the various treatments, with 6 or 7 sessions experiencing a decrease in variances after the establishment of the neighborhood link, in comparison to the pre-link period. To assess the significance of the variance reduction in these sessions, a t-test can be conducted. The obtained low p-values for all three treatments indicate strong evidence of a substantial difference between the means of the two groups. This finding suggests that the observed difference is unlikely to be attributed to random chance alone. Thus, the reduction in variance is deemed significant, providing further support for the notion that individuals in these sessions adopted a behavior based on *Local Reciprocity*.

Treatment	Control	Mean	Distribution
Decrease of Variance (nb session)	7/17	7/17	6/17
T-test	0.0180	0.0143	0.0212
Analysis	Different	Different	Different

Table 2.5 – Study of the significance of the decrease in session variance

To conclude, the impact of the new link on contributions to the public good is not significant across all treatments. Additionally, the decrease in variance after the establishment of the neighborhood link is not observed in all sessions. Therefore the findings of our study do not clearly differentiate between the adopted behaviors of *Local Reciprocity* and *Norm Conformism*. The implications of these results are discussed in the conclusion section.

2.5 Concluding remarks

In conclusion, our study examines local reciprocity in the context of voluntary contributions to public goods. By distinguishing between local and global reciprocity, as well as identifying the behavior adopted through different behavioral models, this paper contributes to a deeper understanding of the motivations that drive individuals to contribute to public goods.

Through our laboratory experiment, we aimed to empirically determine the behavior of individuals in a public goods game and to study the impact whether this behaviour is likely to be in line with the concept of local reciprocity as a mechanism of voluntary contribution to the public good. The different treatments and the evolution of the network aimed to discriminate the behavioral model adopted by the players.

Individuals responded to the different treatments and to the network change induced by the introduction of a neighboring link between the two groups. The results suggest that individuals adopted either a conformity behavior similar to a model indicating some conformism to a norm or a reciprocity behaviour based on the model of *Local Reciprocity*.

Thus, our experiment identifies two main types of behavior in the mechanism of voluntary contribution observed: *Local reciprocity* and *Conformity*. The two models are theoretically similar, as they are both based on conditional cooperation through a moral mechanism. However, they differ in terms of the reason for behavior change. *Local Reciprocity* is a model of constraint (the agent contributes the minimum between what he wants to give and the minimum contribution of others), while the conformity model is determined as a preference to conform to a social norm (represented as the average contribution of other agents).

The introduction of the neighboring link had an impact on the results, but it

did not clearly identify which type of behavior was adopted by the individuals. It is possible that the theoretical models do not adequately account for the network change, so further investigation of the theoretical models and their empirical implications is needed.

Furthermore, our study highlights that the dissemination of different information leads to different results. We show that information about direct contributions from neighbors significantly increases contributions compared to information about the average of neighbors' contributions or just the sum of all agents' contributions.

From the perspective of public authorities, it is crucial to understand the behavior adopted by agents when contributing to public goods as well as the necessary information to be disseminated to encourage contribution to public goods. Indeed, anticipating their behavior can lead to better predictions of proposed programs and the implementation of effective incentive systems.

As a future research, it may be interesting to further explore the model of *Local Reciprocity* in contrast with the widely-studied reciprocity behaviour that is often viewed as global. To the best of our knowledge, the concept of *Local Reciprocity* has not yet been extensively studied in the literature. The results of our study highlight the importance of exploring at the theoretical and empirical implications of this behavioral model.

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Appendices

2.1 Experiment

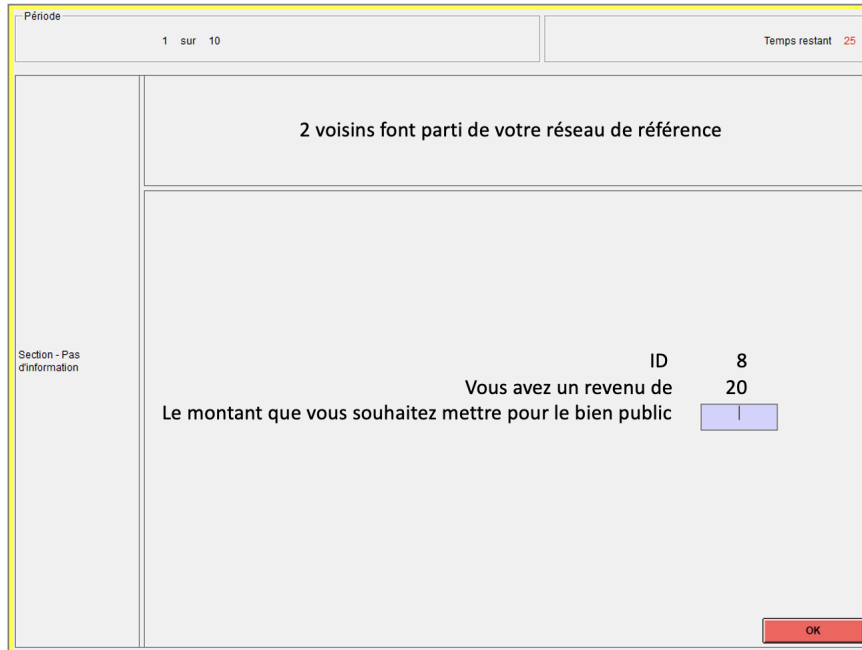


Figure 2.6 – Screen for choosing contribution

Vous avez contribué	4	Les autres joueurs ont contribué au total	48
Votre gain final sur ce tour est de	26	En moyenne, vos voisins ont contribué	9
Votre gain comprend			
- Votre bénéfice privé qui est de	16		
- Et le bénéfice collectif, qui est de	10		

Période suivante

Figure 2.7 – Screen of social information feedback

Treatments (min-max contribution)	Mean	Standard Deviation
Control treatment (0-20)	8.26	5.63
- T1 (0-20)	8.36	5.68
- T2 (0-20)	8.00	5.64
Mean treatment (0-20)	8.47	5.70
- T3 (0-20)	8.70	5.70
- T4 (0-20)	8.08	5.73
Distribution treatment (0-20)	8.74	6.20
- T5 (0-20)	8.75	6.02
- T6 (0-20)	8.70	6.51
	Observations	
Session	17	
Participants per session	8	
Sex (Female = 1)	55%	
Age	Range : 15-29 (83%)	
Variables (min-max Likert Range)	Mean	Standard Deviation
Perception of self-cooperation (1-7)	3.044	0.957
The information is perceived as a threat (1-5)	2.162	1.302
The information is perceived as a manipulation (1-5)	2.316	1.300
Feeling of pressure from the information (1-5)	2.581	1.422
The information was felt to be useful (1-5)	3.735	1.250
The information was appreciated (1-5)	3.794	1.261

Table 2.6 – Descriptive statistics

2.2 Theory

In this appendix, we present alternative theories of giving. We use the same parametrization of the model as the one used in Section 2.

1. Self-interest

Individuals only care about their own payoff. Given G_{-i} , the problem of agent i is

$$\max_{g_i \in [0,20]} 20 - g_i + 0.2(g_i + G_{-i}).$$

The objective function is strictly decreasing with respect to g_i . Hence, the equilibrium is:

$$g_i^* = 0 \text{ for all } i \in N.$$

Moreover, g_i^* does not depend on neither the contribution of others nor the network structure.

2. Pure altruism

Individuals care about both their own payoff and the benefit generated to other individuals from the public good (Becker, 1974). For simplicity, we present the quadratic case when individuals are equally altruistic. Let $\Pi_i = 20 - g_i + 0.2G$ for all i . Given G_{-i} , the problem of individual i is

$$\max_{g_i \in [0,20]} \Pi_i - \frac{\alpha}{2} (\Pi_i)^2 + nG - \frac{\beta}{2} (nG)^2$$

$$\text{s.t. } G = g_i + G_{-i}$$

where α and β are positive parameters. The first order conditions lead to the following best response function

$$g_i = \min(\max(0, a - bG_{-i}), 20)$$

where $a > 0$, and $b > 0$ if and only if $\alpha < 16\beta$. Then, if α is sufficiently small, the equilibrium is interior. Otherwise, the equilibrium is $g_i^* = 20$ for all i . Moreover, g_i^*

is negatively related to G_{-i} and does not depend on the network structure.

3. Pure warm-glow

Individuals care about both their own payoff and their own contribution to the public good (Andreoni, 1989; 1990). For simplicity, we present the quadratic case when individuals are equally egoistic. Given G_{-i} , the problem of individual i is

$$\begin{aligned} \max_{g_i \in [0,20]} \quad & \Pi_i - \frac{\alpha}{2} (\Pi_i)^2 + g_i - \frac{\gamma}{2} (g_i)^2 \\ \text{s.t.} \quad & G = g_i + G_{-i} \end{aligned}$$

where γ is a positive parameter. The first order conditions lead to the following best response function

$$g_i = \min(\max(0, a + bG_{-i}), 20)$$

where $a > 0$ and $b > 0$. Then, if α is sufficiently small, the equilibrium is interior. Otherwise, the equilibrium is $g_i^* = 20$ for all i . Moreover, g_i^* is positively related to G_{-i} and does not depend on the network structure.

4. Impure altruism

Individuals care about both their own payoff, the benefit generated to a group of agents from the public good (including themselves), and their own contribution (Andreoni, 1989; 1990). For simplicity, we present the quadratic case when individuals are both equally altruistic and equally egoistic. Given G_{-i} , the problem of individual i is

$$\begin{aligned} \max_{g_i \in [0,20]} \quad & \Pi_i - \frac{\alpha}{2} (\Pi_i)^2 + nG - \frac{\beta}{2} (nG)^2 + g_i - \frac{\gamma}{2} (g_i)^2 \\ \text{s.t.} \quad & G = g_i + G_{-i} \end{aligned}$$

where α , β and γ are positive parameters. The first order conditions lead to the

following best response function

$$g_i = \min(\max(0, a - bG_{-i}), 20).$$

where $a > 0$, and $b > 0$ if and only if $\alpha < 16\beta$. Then, if α is sufficiently small, the equilibrium is interior. Otherwise, the equilibrium is $g_i^* = 20$ for all $i \in N$. Moreover, g_i^* is negatively related to G_{-i} and does not depend on the network structure.

5. Global reciprocity

Individuals choose the contribution that maximizes their payoff subject to the fact that their contribution must be greater than or equal to the minimum between the contribution they would make under commitment theories and the least any other individual is contributing (Sugden, 1984). Given G_{-i} and $\{g_j\}_{j \neq i \in N}$, the problem of individual i is:

$$\begin{aligned} \max_{g_i \in [0, 20]} \quad & 20 - g_i + 0.2(g_i + G_{-i}) \\ \text{s.t.} \quad & g_i \geq \min(g_i^c, g_j \text{ for all } j \neq i \in N). \end{aligned}$$

The first order conditions lead to

$$g_i = \min(g_i^c, g_j \text{ for all } j \neq i \in N).$$

Since $g_i^c = 20$ for all i , every contribution profile given by

$$g_1^* = \dots = g_8^*$$

is an equilibrium. Moreover, g_i^* is positively related to g_j for all j , and does not depend on the network structure.

6. Norm conformism

Individuals care about both their own payoff and the distance between their contribution and a social norm. For simplicity, we present the quadratic case when

individuals are equally sensitive to social norms. Given G_{-i} and \bar{g}_i , the problem of individual i is

$$\max_{g_i \in [0,20]} 20 - g_i + 0.2G - \frac{\delta}{2} (g_i - \bar{g}_i)^2$$

where δ is a positive parameter. The first order conditions lead to the following best response function

$$g_i = \min \left(\max \left(0, -\frac{0.8}{\delta} + \bar{g}_i \right), 20 \right).$$

Let \bar{g}_i be the average contribution of i 's neighbors. Hence, the equilibrium is:

$$g_i^* = 0 \text{ for all } i \in N.$$

Moreover, g_i^* is positively related to the contribution of i 's neighbors and does not depend on the network structure. Note that the same result is obtained if \bar{g}_i is defined as the least contribution of i 's neighbors.

7. Reputation

This mechanism is similar to the norm conformism case except that δ is negative. Let \bar{g}_i be the average contribution of i 's neighbors. Hence, the equilibrium is:

$$g_i^* = 20 \text{ for all } i \in N.$$

Moreover, g_i^* is positively related to the contribution of i 's neighbors and does not depend on the network structure. Note that the same result is obtained if \bar{g}_i is defined as the least contribution of i 's neighbors.

8. Summary

Let \mathbf{g}^* denote the equilibrium profile, \mathbf{g}_{-i} the contribution profile of all agents except i , \mathbf{g}_{N_i} the contribution profile of i 's neighbors, G_{N_i} the total contribution of i 's neighbors, and $G_{N_i^c}$ the total contribution of i 's non-neighbors. The following table summarizes our findings.

Behavior	Anticipation	Equilibrium	$\frac{dg_i^*}{dG_{N_i}}$	$\frac{dg_i^*}{dG_{N_i^c}}$	Link
Self-interest	G_{-i}	$g_i^* = 0$	$= 0$	$= 0$	no effect
Pure altruism (quadratic)	G_{-i}	$g_i^* > 0$ (unique)	≤ 0	$= \frac{dg_i^*}{dG_{N_i}}$	no effect
Pure warm-glow (quadratic)	G_{-i}	$g_i^* > 0$ (unique)	≥ 0	$= \frac{dg_i^*}{dG_{N_i}}$	no effect
Impure altruism (quadratic)	G_{-i}	$g_i^* > 0$ (unique)	≤ 0	$= \frac{dg_i^*}{dG_{N_i}}$	no effect
Global reciprocity (average or min)	G_{-i} and $(\bar{G}_{-i}$ or $\mathbf{g}_{-i})$	$g_1^* = \dots = g_8^*$	≥ 0	$= \frac{dg_i^*}{dG_{N_i}}$	no effect
Local reciprocity (average or min)	G_{-i} and $(\bar{G}_{N_i}$ or $\mathbf{g}_{N_i})$	$g_1^* = \dots = g_4^*$ and $g_5^* = \dots = g_8^*$	≥ 0	$= 0$	$\text{Var}(g_1^*, \dots, g_8^*)$ decreases
Norm conformism (quadratic & average or min)	G_{-i} and $(\bar{G}_{-i}$ or \bar{G}_{N_i} or \mathbf{g}_{-i} or $\mathbf{g}_{N_i})$	$g_i^* = 0$	≥ 0	$= 0$	no effect
Reputation (quadratic & average or min)	G_{-i} and $(\bar{G}_{-i}$ or \bar{G}_{N_i} or \mathbf{g}_{-i} or $\mathbf{g}_{N_i})$	$g_i^* = 20$	≥ 0	$= 0$	no effect

Table 2.7 – The linear public good game with 8 individuals embedded in two disconnected cycles of size four

Chapter 3

Local versus global descriptive social norm: A DCE applied to the waste sorting behavior in Phnom Penh, Cambodia

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Abstract: Cambodia is facing severe waste management problems due to a growing population and waste emissions, which are accelerating the depletion of landfill capacity. One solution is to involve residents in separating organic waste at source. Previous literature has widely explored the influence of descriptive social norms on individuals' pro-environmental behavior. However, despite a growing interest in the subject, the role of spatial distance of an individual to the reference group remains unclear. Our study seeks to fill this gap by investigating the impact of a descriptive social norm at two scales: local (neighborhood) and global (city). In this aim, we incorporate descriptive norms as attributes in a discrete choice survey. Our findings reveal that only the local social norm exerts a significant influence on organic waste sorting behavior, while the global social norm does not show a significant effect at conventional statistical levels. These results highlight the importance of considering the spatial distance to the reference group when studying descriptive social norms. The policy implications of these findings are discussed.

Keywords: Descriptive Social Norm; Local Social Norm; Discrete Choice Experiment
JEL: C99; D91; Q51; Q53

3.1 Introduction

There is a considerable waste management problem in Cambodia, including Phnom Penh, where it is observed that rubbish is present on the streets and in natural areas. Moreover, with a large increase in population as well as an increase in per capita waste emission, landfills have reached their capacity twice as fast as initially estimated (Seng et al. 2018). As perpetual landfill expansion would contribute to soil, water and air pollution, it is of great importance to reduce the input flow. One solution is to involve residents in waste separation at source. The average Phnom Penh resident's waste bin consists of 50% organic waste (Seng 2015). Introducing source separation of organic waste therefore represents a large potential for reducing inputs to landfills.

The literature indicates that social norms, reflecting the majority's behaviors, can motivate waste sorting and serve as an effective incentive mechanism. Traditional economic tools, such as taxes or subsidies, may not be suitable in developing countries with limited government financial resources. An increasingly effective alternative is the use of non-monetary incentives, known as nudges, which promote behavior change. Social norms can thus be leveraged as an incentive mechanism, referred to as a social norm nudge.

A growing body of research has sought to understand the relationship between descriptive social norms and pro-environmental behavior. For example, previous studies have demonstrated that descriptive social norms exert a significant influence on individuals' commitment in favor of various pro-environmental behaviors, including water and electricity consumption, as well as waste sorting practices (Farrow et al. 2017).

According to Cialdini et al. (1991), a descriptive social norm is based on a perception of what most people would do in a given situation. This conformity can be driven by a desire for social approval, fear of social disapproval or belief that the behavior is effective and beneficial. More recently, Bicchieri (2016) specifies the concept as "*a pattern of behavior such that individuals prefer to conform to it on condition that they believe that most people in their reference network conform to it*" (page 19).

The reference group is thus central to the definition of a descriptive social norm. This influence can stem from observing the actions of others within the individual's physical environment. Social impact theory (Latané 1981) states that when the reference group is spatially close to the individual, the latter is more heavily influenced by the reference group than when the reference group is physically distant. For example, a neighbor may have more immediate impact than a citizen living in another part of the city. Although reference group spatial distance may play a role in the effects of descriptive social norms, the literature reveals mixed results. Empirically, while Goldstein et al. (2008) found a major distinction between local and global social norms, Mertens and Schultz (2021) observed no significant difference and Czajkowski et al. (2019) even concluded that under certain conditions the effect of local social norms may be lower.

Our study aims to fill this gap by assessing the impact of descriptive social norms at two spatial scales: the local social norm at the neighborhood scale, and the global social norm at the city scale. This study focuses on preferences for organic waste separation within Phnom Penh, the capital city of Cambodia. In order to investigate this subject in depth, we make use of the Discrete Choice Experiment method (hereinafter referred to as DCE).

A DCE is a survey-based research method commonly applied to explore the preferences of individuals for different attributes of a product, service or policy. In a DCE, respondents are presented with several hypothetical scenarios and a status

quo. Each scenario describes a set of options with different levels of attributes, while the status quo represents the current state or serves as a baseline against which the other options are compared. According to the method, individuals are asked to choose their preferred option between the scenarios and the status quo.

The DCE is widely employed for non-market goods and services valuation, such as environmental public goods (Mariel et al. 2021). For example, it is useful to determine individuals' preferences for programs in the areas of nature conservation (Valasiuk et al. 2018), energy (Achtnicht 2011) and recycling (Almazán-Casali et al. 2019). Moreover, it can capture the degree of influence of descriptive social norms on individuals' decision-making processes (Villamayor-Tomas et al. 2019, Chen et al. 2009).

To the best of our knowledge, there are only a few studies that have actually investigated descriptive social norms using the DCE in the environmental domain. Methodologically, we include the descriptive social norm directly as an attribute in the DCE. Individuals choose whether or not to purchase waste sorting bags under hypothetical scenarios that include both classical attributes in the recycling field and hypothetical descriptive social norms. Results from the conditional logit model and mixed logit model indicate that the local social norm variable is statistically significant at a 1% level at the expected sign, while the global social norm variable is not significant at any conventional statistical levels. This outcome suggests that the descriptive social norm has a positive impact on decision-making with a dependence on the chosen reference group.

The remainder of this paper is organized as follows. Section 3.2 presents the literature review, while Section 3.3 describes the DCE method and Section 3.4 outlines the survey design. The final two sections of the paper are devoted to a discussion of the study's results and concluding remarks.

3.2 Literature review

3.2.1 Reference group and pro-environmental behavior

The effectiveness of descriptive social norms in changing human behavior may vary depending on the reference group, a term that refers to a group of people who exert influence over an individual's behavior (Bicchieri 2016). A reference group serves as a point of reference for individuals to determine what is considered acceptable or desirable behavior within a particular social context. The reference group can be diverse and may include family members, friends, neighbors or any group with which an individual affiliates; it may also differ depending on the specific behavior being evaluated.

The spatial distance to the reference group is an important factor to consider when studying the influence of descriptive social norms on individual behavior. Indeed, social impact theory, as proposed by Latané (1981), states that the impact of social influence depends on the strength, immediacy and number of sources of influence. Immediacy relates to how close in time and space the reference group is to the particular individual. Based on this theory, influence is stronger when the reference group is spatially closer, since more interactions are occurring with its members. This concept is also reflected in the field of economics, such as in Akerlof's model of conformity, where the author integrates the notion of social proximity (Akerlof 1997). Moreover, Akerlof suggests that individuals are more likely to conform to those with lower spatial distance, thus aligning with the findings of social impact theory.

The pioneering study by Goldstein et al. (2008) empirically illustrated the influence of the reference group's spatial distance. These authors conducted a field experiment to investigate the effectiveness of different normative social influences in promoting conservation behavior among hotel guests. The target intervention involved guests receiving a message highlighting the social descriptive norm related to the reuse of towels by previous hotel guests. Results showed that the

reference group "room guests" (called provincial norm) had a stronger impact on promoting conservation behavior compared to the reference group "hotel guests" (named global norm).

More recently, Passafaro et al. (2019), in relying on the theory of planned behavior, specifically investigated the impact of social norms on recycling behavior at different levels of spatial distance (household, neighbors, residential district and city). Their findings reveal that the closer a local social norm is spatially to a participant's place of residence, the stronger its predictive power in influencing the intention to recycle waste. Similar findings were reported by Fornara et al. (2011) in their study on household waste recycling that distinguished reference groups.

On the other hand, some empirical studies have shown mixed results regarding the impact of reference group spatial distance. Czajkowski et al. (2019) examined whether a descriptive social norm had an effect on household preferences for waste collection contracts that require a greater recycling effort. Using a descriptive social norm as a nudge before the DCE, these authors varied the reference group's spatial distance (city vs. country) as well as the level of the descriptive social norm (low vs. high). The impact of reference group spatial distance depends on the level of descriptive social norms and may be insignificant or even negatively impact recycling preferences with respect to city-scale social norms under certain conditions. Moreover, Mertens and Schultz (2021) compared the effectiveness of various reference groups in promoting waste sorting, including nearby neighbors and citizens of the same state. These authors used a randomized controlled trial to provide social normative feedback at the household level. They failed to find any significant differences between the distinctive treatments of descriptive social norms.

Since reference group spatial distance has been relatively understudied in the field of environmental economics, questions remain regarding its impact on this

area of investigation. Our study therefore aims to assess, through a methodology different from those previously used, whether the geographic scale of the reference group influences waste sorting behavior.

3.2.2 Social norms and DCE

The integration of social norms into DCE has only recently emerged (see Table 3.1). The effects of social norms in the application of DCE can be studied in at least three different ways, i.e.: before, during and after the choice task.

Method	(a) Before the choice task	(b) During the choice task	(c) After the choice task
Nature	Information	Attribute	Follow-up questions
Examples of references			
Recycling	Czajkowski et al. 2019	-	Czajkowski et al. 2017
Other environmental services	Carlsson et al. 2010	Villamayor-Tomas et al. 2019	Franceschinis et al. 2022
	Raux et al. 2015	Chen et al. 2009	Sottile et al. 2017
	Han et al. 2022	Cherchi 2017	Gołębiowska et al. 2020
	Araghi et al. 2014	Tan et al. 2022	Mu et al. 2023

Table 3.1 – Three possible methods for studying social norms with a DCE survey

(a) The social norm can be presented as information subject to variation before the valuation task. This method allows determining the effect of the social norm information on the stated preferences for attributes in the DCE questionnaire. This first method requires a large sample size since each social norm variation corresponds to a treatment. Many studies in the field of environmental economics that investigate social norm effects using DCE employ this methodology (see the non-exhaustive list in Table 3.1). However, in the context of recycling, we only found the paper by Czajkowski et al. (2019), who examined the impact of descriptive social norm nudges on household preferences for waste collection contracts that require an added recycling effort, as explained in Section 3.2.1.

(b) The social norm is directly included as an attribute within the choice set. This approach acknowledges that individuals' behavior and choices are not solely driven by practical considerations but also influenced by the norms and behaviors exhibited by others in their social environment. Thanks to this method, it is possible to investigate how individuals trade off attributes from a program and social norms when making choices, thereby capturing some real-life decision-making processes.

c) The social norm can also be studied once the valuation task has been completed by examining follow-up responses to attitudinal questions. According to this approach, the social norm is treated as a latent variable, and its indirect effect on DCE results can indeed be measured. This method may help explain part of the unobserved preferences for attributes. Only a few studies in the field of environmental economics have applied such an approach, e.g. Gołębiowska et al. (2020) and Franceschinis et al. In the context of waste separation, we identified just one study, by Czajkowski et al. (2017), who investigated the role of social norms, morals and self-interest in promoting household recycling behavior. Their findings suggest that social norms and moral considerations constitute the main determinants of recycling behavior.

Few studies have employed the second method (b) in the field of environmental economics. For instance, Villamayor-Tomas et al. (2019) found that farmers' preferences for participating in an agri-environmental program were influenced by the percentage of participant neighboring farmers. Also providing information on descriptive social norms in percentage terms, Chen et al. (2009) assessed the impacts of neighbors' behavior on household program re-enrollment within the scope of forest maintenance. The approach is more common in the area of market goods such as transport (Rasouli and Timmermans 2013), mobile telecommunications (Confraria et al. 2017, Czajkowski and Sobolewski 2016) or fertilizer use (Wang and Yue 2021).

The prominence of social dilemmas arises in the context of contributions to the environmental public good, e.g. waste sorting, whereby the influence of social norms is crucial in raising awareness. Hence, considering descriptive social norms as a criterion for decision-making proves herein to be particularly relevant. Moreover, studying descriptive social norms as an attribute of the DCE questionnaire offers two main advantages, as compared to standard practices. First, this perspective enables isolating the effects by directly studying individuals' preferences for social coordination when adopting pro-environmental behavior, thereby improving the understanding of this parameter's influence. Second, it serves to identify descriptive social norm effects without the need for a large sample of DCE questionnaire respondents, in turn making it a cost-effective method.

Despite the potential advantages of using descriptive social norms as an attribute in DCE, to the best of our knowledge, no study has yet to be conducted on the subject of waste sorting via this approach. Our aim is to fill this gap by investigating the impact of descriptive social norms on organic waste sorting behavior. This study includes two descriptive social norm attributes in the DCE questionnaire: the waste-sorting rate at the neighborhood scale (called the local social norm), and this rate at the city-wide scale (known as the global social norm).

3.3 Discrete choice experiment method

This paper employs a DCE approach to estimate individuals' preferences for household organic waste sorting. A DCE is a quantitative technique that yields individual preferences (Mangham et al. 2009). By presenting individuals with hypothetical alternatives of products, services or policies and then observing their choices, this method enables determining individual preferences for the attributes of the object under study.

The theoretical foundation of the DCE method is based on Lancaster's model of consumer choice (Lancaster 1966), while its econometric basis relies on random

utility theory maximization (McFadden et al. 1973). Lancaster’s proposition suggests that consumers derive satisfaction not directly from goods, but rather from the attributes they provide. To illustrate this theoretical basis in the context of our case study, which focuses on preferences for setting up an organic waste collection service, let’s consider a respondent’s selection of a waste collection service. Assuming that utility depends on the options selected from a choice set that includes all possible alternatives for waste collection services, the respondent is presumed to have a utility function represented as follows:

$$U_{nj} = \beta x_{nj} + e_{nj}, \quad (3.1)$$

For each respondent n , any alternative of waste collection service j is associated with a specific level of utility U_{nj} . This utility level is influenced by the attributes of the service (x_{nj}), such as collection frequency, monthly cost and the descriptive social norms.

The term β is a vector of preference parameters associated with the observed attributes of an alternative. The error component e_{nj} is composed of the unobserved characteristics that influence the decision-making of individual n , meaning that predictions cannot be output with certainty. Choices made between alternatives depend on the probability that the utility associated with a particular option (j) is greater than that of the other alternatives. It is implicitly assumed that the relationship between utility and characteristics is linear with respect to the parameters and variables function and moreover that the error terms follow an identically and independently distributed type I extreme value distribution. This assumption states that the probability of any particular alternative j being chosen can be expressed in terms of a logistic distribution. The conditional logit model (McFadden et al. 1973) can be used to estimate Equation (3.1), displaying the following general form:

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{ij}}} \quad (3.2)$$

where V_{nj} denotes the "representative" utility function for individual n making the decision to choose alternative j .

$$V_{nj} = \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k \quad (3.3)$$

This model includes k attributes of the waste collection service. Attribute vector (x) is associated with the coefficient vector β_1 to β_k . The k attributes comprise the traditional parameters of a waste collection service program, along with the descriptive social norms attributes at both the local and global scales.

In contrast to the conditional logit model, the mixed logit model allows for heterogeneity in preferences by assuming that individuals have a distribution of preferences that can vary across different decision-making contexts. This assumption means that individuals may have different tastes for the attributes of the particular good or service, and moreover their preferences may be influenced by a variety of factors, including income, demographics or past experiences. The utility function in the mixed logit model becomes:

$$U_{nj} = \beta_n x_{nj} + e_{nj}, \quad (3.4)$$

The mixed logit model assumes that the probability of an individual choosing a particular alternative from a given choice set can be represented as a weighted average of the logit probability of choice for a set of choices. These utility functions are assumed to be drawn from a distribution that allows for heterogeneity in preferences. The probabilities of choice then become a probability integral of the logistic choice weighted by the density of coefficients across the population, expressed as follows:

$$P_{ni} = \int L_{ni}(\beta) f(\beta|\theta) d\beta \quad (3.5)$$

where the first part of the integral is the logit probability of choice for a set of choices, and the second part the coefficient density across the population.

3.4 Survey

Let's begin by introducing the context of our study. In Phnom Penh (Cambodia), a waste collection service has been operational since 2002. Today, it is managed by three different entities, with each entity serving a specific area of the capital city and offering its own collection frequencies. Payment for this service is made directly through residents' electricity bill and ranges from \$0.80 to \$3 per month. The municipality has recently introduced the practice of source separation of organic waste, which involves the use of two types of waste bags: a black bag for non-organic waste, and a white bag for organic waste. Residents have the option to voluntarily sort their waste at the source. While this method of waste separation has been endorsed at the municipal level, no system has yet to be implemented for the collection and reuse of organic waste (Seng et al. 2018).

Phnom Penh features a three-level administrative organization. The largest jurisdiction is called "Khan", which can be likened to districts, with a total of 14 Khans throughout the city. These Khans are further divided into "Sangkat", with a total of 105 Sangkats within Phnom Penh. The Sangkat jurisdiction is responsible for: maintaining and regulating public safety, organizing local elections, and managing administrative procedures such as issuing birth certificates. Each Sangkat is made up of "Phums", with a total of 953 Phums encompassing the capital. While the Phums are spatially closer to individuals, not everyone is aware of the specific Phum assigned to them and therefore may not identify with it. The Sangkat level, on the other hand, is worth considering as a descriptive social norm attribute since it embodies both spatial distance and affiliation aspects.

The attributes for the hypothetical scenarios in the DCE were identified through a combination of a literature review and focus group sessions. Focus groups are a qualitative research method used to study the responses and attitudes of a specific cultural, societal or ideological group towards a particular service, concept or topic (Rabiee 2004). We conducted a focus group both to gain deeper insights into the barriers to sorting organic waste and to discuss relevant attributes; it took place at the Royal University of Law and Economics in Phnom Penh.

Typically, a maximum of ten participants are involved in the group sessions. Our focus group comprised seven individuals. We aimed for a diverse representation, including both experts from the sector and citizens utilizing waste collection services, with varying levels of expertise. In terms of language, we facilitated communication in English to ensure inclusivity. The presence of sector specialists provided valuable insights into the feasibility of proposed options outlined in our survey. Four specialists agreed to join the focus group, including two entrepreneurs - one specializing in zero waste and the other in composting solutions — alongside a representative from a think tank focused on sustainable development projects and waste management. Additionally, we called on an expert in strategic waste management planning from the Phnom Penh Ministry of the Environment. Furthermore, we recruited three Phnom Penh residents who were unfamiliar with the subject matter, whose testimonies were precious in elucidating concrete barriers to organic waste sorting from a citizen's perspective.

In correlating the focus group results with the literature review, we defined the set of attributes presented in Table 3.2.

Attributes	Descriptions	Levels	Variable coding
Frequency	Frequency of the organic waste collection service	Once a week Three times a week Every day	<i>Continuous</i>
Time certainty	Certainty of the schedule for the passage of the waste truck	Certain Uncertain	<i>Categorical</i>
Local social norm	Percentage of neighborhood residents who separate their organic waste	25% 50% 75%	<i>Continuous*</i>
Global social norm	Percentage of city residents who separate their organic waste	25% 50% 75%	<i>Continuous*</i>
Expenses	Monthly household expenses for purchasing sorting bags	\$0.50 (2,000 riels) \$1 (4,000 riels) \$2 (8,000 riels) \$4 (16,000 riels)	<i>Continuous</i>

*Note: For linearity assessment, we also treated these variables as categorical in some regressions

Table 3.2 – Attributes and levels of attributes of the DCE

The frequency of waste collection is an important factor in adopting a waste sorting behavior. Kuo and Perrings (2010) showed that a higher waste collection frequency increases the preference for recycling. This finding has been corroborated by several empirical studies employing the DCE method, including the one by Tarfasa and Brouwer (2018). The Frequency attribute has been divided into three levels: once a week, three times a week, and daily.

The sorting of organic waste can raise sanitary issues due to the potential infestation of animals and insects like rodents, flies and ants in the garbage bags, particularly in developing countries where sanitation problems are more prevalent. The fear of attracting pests can significantly impact sorting behavior for organic waste (Oehman et al. 2022). To address this concern, one potential solution consists of placing garbage bags on the street only at the collection truck's

scheduled time. This approach aligns with Conke's (2018) findings, which indicate that cities with regular collection schedules exhibit a recycling rate twice that of cities with irregular schedules. This result is in line with theories of aversion to uncertainty, as proposed by Kahneman (2011). Therefore, being aware of the garbage truck's collection schedule can positively impact the preferences for sorting organic waste. In this context, we have defined two attribute levels for the time certainty associated with the truck's schedule: Certain and Uncertain.

The local (global) social norm attribute is the proportion of neighbors in the Sangkat (in Phnom Penh) who would sort their organic waste. The motivation for studying these attributes was developed in Section 3.2. The levels of the descriptive social norm attributes were determined based on the approach applied in the study by Chen et al. (2009) and assume the values 25%, 50% and 75%. This choice was implemented for several reasons. First, it enables capturing a spectrum of descriptive social norm intensities, ranging from weak to strong. Second, these levels were selected to ensure easy comprehension by the participants, thus minimizing the risk of misunderstanding or misinterpretation. Third and last, such an approach ensures realism, as the extreme values of 100% and 0% were excluded from the attribute levels, like in Chen et al. (2009). During the interviews, we made sure that participants understood these various percentages.

The expenses for waste sorting play a significant role in the intentions to adopt a pro-environmental behavior (Karousakis and Birol 2008, Benyam et al. 2020). The expenses attribute was designed to align with an opt-in/opt-out system, as intended by the Phnom Penh municipality. This initiative contrasts with the traditional literature on DCE applied to recycling, wherein the financial attribute typically designates a mandatory additional cost per month. In our case, individuals are required to purchase separate recycling bags for sorting organic waste, since it was announced that the bags were biodegradable. The purchase of these bags represents a fixed monthly expense per household, with the level of said expense being adjusted for consistency with the local income and economy since

the values were set at \$0.50, \$1, \$2 and \$4. By matching the cost system of the survey with the municipality's actual projections, we will be able to issue appropriate recommendations for public authorities.

The questionnaire was constructed as follows:

1. Participants were initially informed that results would be communicated to public authorities and moreover were assured of the survey anonymity. The subject was then introduced by presenting the definition of organic waste, accompanied by illustrative examples. Participants were notified that the municipality had planned to implement source separation of organic waste. The benefits of this separation step were then presented, in emphasizing that the collected organic waste would be reused as natural fertilizer in agricultural fields, replacing chemical fertilizers. This effort would contribute to the reduction of soil, air and water pollution. Additionally, sorting organic waste would prolong the lifespan of landfills, thus sparing the population the large expense of building new landfills. A simple explanatory sheet was included, visually depicting the behavior expected in sorting organic waste (see Figure 3.3 in the Appendix). The constraints associated with the process were also highlighted; specifically, it was explained that storing organic waste in bags at home or in the street for extended periods increased the risk of attracting pests.
2. Participants were informed that they would need to choose their preferred hypothetical scenarios relative to the explained program. It was emphasized that individuals had the option to either opt-in or opt-out of sorting their organic waste by virtue of Option 3, which proposed the following: "I prefer not to buy organic waste bags." The implication therein was that if an individual were to choose A, then A would be preferred to B and sorting bags would be purchased to sort organic waste should Scenario A exist. If C were chosen, then even if A or B existed, a sorting bag would not be bought and therefore organic waste would not be sorted.
3. Next, individuals completed the valuation task. The choice cards were in-

tentionally laid out to ensure accessibility to all adult residents of Phnom Penh, irrespective of nationality or educational background. To facilitate comprehension, illustrative attribute levels were incorporated, thus enhancing clarity and comprehensibility of the choice set. Additionally, the DCE was designed in English and Khmer to enable individuals to engage with the choice cards in the language they found easier to understand. Lastly, we adopted a dual currency approach by presenting the monetary values in riels and dollars. This decision was motivated by the widespread usage of both currencies among the Cambodian population. The exchange rate was set constant since the riel is pegged to the dollar.

4. After completion of the DCE survey, participants answered follow-up questions to collect sociodemographic data. We assessed respondents' sense of belonging to their neighborhood and city using a Likert scale (1 = "Strongly disagree", 5 = "Strongly agree"). The questions "I feel like I belong to this neighborhood?" and "I feel like I belong to this city?" were included as indicators of social attachment and identification with the neighborhood and city.

The interviewer was available to ensure comprehension of the questionnaire contents. An example of a choice card is shown in Figure 3.1.











	Option 1 ឥឡូវនេះ:	Option 2 ឥឡូវនេះ:	Option 3 ឥឡូវនេះ:
Frequency of collection of organic waste ចំនួនដងនៃការប្រមូលកាកសំណល់សរីរាង្គ	 Every day រាល់ថ្ងៃ	 Three times a week ៣ដងក្នុងមួយសប្តាហ៍	
Time of the truck's passage ពេលវេលាដែលឡានប្រមូលសំរាមឆ្លងកាត់	 Certain ច្បាស់លាស់	 Uncertain មិនច្បាស់លាស់	
Proportion of your sankgat' neighbours who sort organic waste សមាមាត្រនៃអ្នកជិតខាងក្នុងសង្កាត់របស់អ្នក ដែលប្រែកាកសំណល់សរីរាង្គរបស់ពួកគេ	 75%	 25%	I prefer to not buy organic waste bags ខ្ញុំមិនចង់ទិញថង់កាកសំណល់សរីរាង្គ
Proportion of the city's inhabitants who sort organic waste សមាមាត្រនៃអ្នករស់នៅទីក្រុងដែលប្រែកាកសំណល់សរីរាង្គរបស់គេ	 75%	 25%	
The organic waste bags cost per month ចំណាយរបស់ថង់សម្រាប់ប្រមូលសំរាមសរីរាង្គក្នុងមួយខែ	 ៨០០០+ 8000 Riels 2\$	 ៤០០០+ 4000 Riels 1\$	

Figure 3.1 – Example of choice card

We constructed a D-efficient design using Ngene software (ChoiceMetrics). To manage the cognitive burden placed on participants, these 16 choices were divided into two blocks of choice sets, with each block containing 8 successive choices. Each choice set included three options: two hypothetical scenarios and one option for opting-out.

The questionnaire was administered by ten undergraduate economics students at the Royal University of Phnom Penh, who had been trained to conduct the interviews. Prior to deployment, a dozen pilot interviews were held to refine the questionnaire. This step allowed us to adjust the expense levels so as to better differentiate the attribute. The face-to-face interviews took place from December 20, 2022 through January 13, 2023. A total of 401 completed surveys were collected, of which 390 were usable for analysis. Data on neighborhoods were not collected because the number of neighborhoods was too large (105), while the sample of respondents accessed was insufficient to process this data; furthermore, we sought to minimize the intrusiveness of the follow-up questions. Individuals were randomly selected within areas served by a waste collection service. We set out to interview individuals who were representative of the population in terms of visible characteristics, including gender and age. Only adults (18 and older) were

interviewed.

3.5 Results

3.5.1 Socio-demographic characteristics

Results of the surveyed socio-demographic characteristics are presented in Table 3.3. Our sample was nearly representative in terms of age and gender since the ratios lie close to the actual data in Phnom Penh (59% female in our sample vs. 52% city-wide, and an average age of 31.68 years vs. 28.40 in Phnom Penh). However, our sample was not fully representative of the population as regards certain non-visible characteristics. The sample's average income was \$881.53, significantly higher than that reported across Phnom Penh (\$297.21). Moreover, the sample underrepresents individuals who had not pursued education beyond high school: only 32% of our sample fell into this category, whereas the percentage reported for all of Phnom Penh is much higher, at 82%. The mean sampled household is composed of 4.00 people (vs. 4.60 in reality), and 92.05% of survey respondents declared having lived in Phnom Penh for at least two years.

Variable	Surveyed figures	Actual figures
Women	0.59	0.52
Age	31.68	28.40
Income (in \$)	881.53	297.21
Household size	4.00	4.60
Phnom Penh resident for more than 2 years	0.92	NA
No education beyond high school	0.31	0.82

Table 3.3 – Mean values of socio-demographic characteristics

3.5.2 Choice models

The frequency of waste collection was represented by values of 1, 3 and 7 for "Once a week", "Three times a week" and "Every day", respectively. The cer-

tainty of the waste collection schedule was coded as either 0 for "Certain" or 1 for "Uncertain." We utilized continuous coding for the local social norm and global social norm variables, with values of 0.25, 0.50 and 0.75. To explore the linearity or non-linearity of local and global social norms, another regression incorporated categorical modeling by creating dummy variables for values of 0.50 and 0.75 for each norm. The expenses variable was measured in dollars and took on values of 0.5, 1, 2 and 4. The time certainty variable was treated as categorical, while collection frequency and expenses were considered as continuous. Moreover, we included an Alternative-Specific Constant (ASC) for the status quo and another one for Alternative B. Notably, the ASC for Alternative B did not yield any significant changes in the results, hence it was removed from the table.

The models were estimated using the Apollo package (Hess and Palma 2019) in the R software. The results of the mixed logit models, where the descriptive social norm variables have been set as continuous and categorical, are presented in Table 3.4.

To ensure the robustness of our findings, we ran two different models, both yielding results consistent with the main study outcomes. We first conducted conditional logit regressions using identical models employed in the mixed logit approach. These findings are displayed in Table 3.5 in the Appendix. Next, we tested the model using the correlated randomized parameter method, as recommended by Mariel and Meyerhoff (2018); this method introduces a correlation between parameters, thereby relaxing the assumption of independence among observable variables. The level of significance of the variables is similar to that in the main model. Finally, we employed the Walker method (Walker 2002) to establish reference levels for categorical variables in the mixed logit model. According to this method, the reference level for categorical variables should be the level with the smallest absolute sigma value in the overspecified mixed logit model where means and standard deviations are estimated for all the categorical attribute levels, rather than all but one. Specifically, in our study, the local social norm at

level 0.25 and the global social norm at level 0.75 should be the reference levels. However, setting the reference level of the global norm at 0.25 or 0.75 has no effect on the sign and significance level of the estimated coefficients.

Variable	Descriptive social norms		Descriptive social norms	
	Treated continuous		Treated categorical	
	Mean (s.e.)	Std. Dev.	Mean (s.e.)	Std. Dev.
Local social norm	0.455*** (0.158)	-0.654* (0.339)		
Global social norm	0.121 (0.156)	-0.041 (0.524)		
Local social norm 50 (vs 25)			0.077 (0.151)	0.006 (0.333)
Local social norm 75 (vs 25)			0.274*** (0.087)	0.537*** (0.170)
Global social norm 50 (vs 25)			0.259 (0.198)	0.368 (0.403)
Global social norm 75 (vs 25)			0.060 (0.085)	0.100 (0.310)
Frequency	0.233*** (0.030)	-0.431*** (0.037)	0.233*** (0.031)	-0.453*** (0.041)
Time certainty (vs certain)	-0.655*** (0.089)	1.015*** (0.113)	-0.656*** (0.096)	1.065*** (0.122)
Expenses	-2.320*** (0.257)	2.403*** (0.137)	-2.612*** (0.349)	-3.627*** (0.265)
ASC opt-out	-19.346*** (2.330)	-15.829*** (1.790)	-14.638*** (2.142)	10.514*** (1.422)
LL(final)		-1965.21		-1926.86
AIC		3954.41		3889.72
BIC		4026.96		3998.54

Note: $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table 3.4 – Results of the mixed logit models

Let's start by examining the two descriptive social norm variables, i.e. the local social norm and the global social norm. When these variables are configured as

continuous, interestingly, only one of the two was found to be statistically significant. More specifically, the local social norm variable was significant at the 1% level, indicating that the higher the proportion of neighbors within the neighborhood sorting their organic waste the greater the likelihood of the alternative being chosen. Since individuals do not take into consideration the percentage of city residents who separate their organic waste, it can be inferred that the spatial distance to the reference group, i.e. neighbors, does influence the choice of sorting organic waste. This finding supports theories from psychology suggesting that reference group spatial distance can impact individual behavior. Since this effect is present with both the conditional logit model (Table 3.5, Appendix) and the mixed logit model, we have found consistency in the effects of descriptive social norms on individuals' choices.

To examine the linearity of the descriptive social norms, these variables have also been represented as categorical variables (Table 3.4). The global social norm does not exhibit significance for any of its values at conventional statistical levels. Regarding the local social norm, its significance is not observed at the 50% level compared to the 25% level; however, it does become significant at the 75% threshold when compared to 25%. This result suggests a nonlinear relationship for the variable, hence indicating the presence of a threshold effect beyond the 50% level.

We acknowledge the existence of a form of endogeneity between local social norms and global social norms, given that local social norms are intertwined with global social norms. We then investigated whether individuals tended to select the alternative that aligns with the optimal combination of these social norms. To address this, we introduced an interaction variable, denoted as "Local social norm * Global social norm", into our model, which represents the multiplication of the two social norm variables. Our analysis revealed that this interaction variable did not yield statistically significant results (refer to Table 3.6 in the Appendix). This implies that individuals have mostly perceived the two social norms variables as independent of each other, and only the local social norm influenced their decision-making

regarding organic waste sorting.

Let's now examine the different levels of attachment to the neighborhood and city. By means of the attitudinal questionnaire, it can be assessed whether individuals have a stronger sense of belonging to their neighborhood. Figure 3.2 shows the disparity between individuals' sense of belonging to their neighborhood and their city. Among respondents, 47% reported similar levels of belongingness to both their city and neighborhood. While 21% of respondents expressed a diminished sense of belonging to their neighborhood, as compared to their city, conversely 32% indicated a stronger sense of belonging to their neighborhood than to their city.

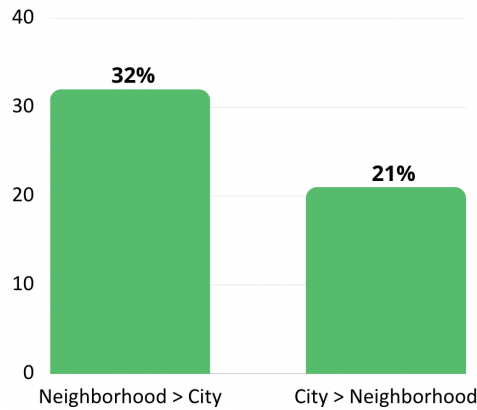


Figure 3.2 – Comparison of a sense of belonging to the reference group's neighborhood and city

To determine whether these variables are significantly different, we conducted a paired samples t-test. The p-value of $4.557e-15$ provides strong evidence against the null hypothesis of equal proportions. More specifically, the average sense of belonging to the neighborhood is 0.146 points higher than for the city. These findings indicate that individuals in the studied population exhibit a stronger sense of belonging to their neighborhood than to their city.

In focusing on program attributes, it is observed that the ASC of the status quo is negative, thus indicating that individuals have a preference for scenarios that involve the process of purchasing organic waste bags. To illustrate this point,

only 8.4% of respondents in the sample simply chose the status quo. This result suggests that individuals are willing to sort their organic waste at home, which reflects a positive inclination towards the source separation of organic waste.

The waste collection frequency variable is of a positive sign. The models reveal that individuals are more likely to choose scenarios with a high waste collection frequency. Certainty in the garbage truck schedule is also found to be preferred over uncertainty, as underscored by the statistical significance at the 1% level. When the time of the garbage truck's passage is uncertain, the alternative has a lower chance of being chosen, emphasizing the importance for residents to be able to dispose of their organic waste at a time close to the scheduled pickup so as to avoid potential sanitary issues caused by pests. The monthly expense of purchasing waste sorting bags also has an impact on preferences. A higher expense reduces the likelihood of choosing this alternative, a finding consistent with the previous literature, as discussed in Section 3.4.

3.6 Discussion and conclusion

Our study has made use of a DCE method to uncover individuals' preferences for an organic waste collection system, by taking into account descriptive social norms related to waste sorting behavior. Consistent with the previous literature on social norms (Goldstein et al. 2008, Passafaro et al. 2019, Fornara et al. 2011), our findings reveal that individuals mainly consider the local social norm in their decision-making process when it comes to sorting organic waste. Results of both the conditional and mixed logit models demonstrate that the local social norm attribute is statistically significant at the 1% level, whereas the global social norm attribute is not statistically significant at any conventional statistical levels.

Our study adds valuable insights into the understanding of descriptive social norms and their influence on waste sorting behavior. While the findings by Czajkowski et al. (2019) showed mixed results regarding the impact of descriptive

social norms at different spatial levels of reference groups, our study provides more powerful evidence. Specifically, our results show that the local social norm at the neighborhood level can positively influence individuals' decisions to separate organic waste. Also of note, our findings diverge from those of Mertens and Schultz (2021), who reported no significant differences in the influence of the reference group's spatial level. This discrepancy highlights the importance of our study both in expanding the current body of literature and in offering new insights into the differential impact of descriptive social norms in waste sorting behavior.

The level of identification to a group can greatly affect the degree to which individuals are influenced by that particular group. This concept has been emphasized by Akerlof and Kranton (2000), who highlighted the significance of understanding the role of group identification in shaping economic behavior. Identity can also be linked to various spatial levels, as exemplified by the concept of place identity developed by Scannell and Gifford (2010), whereby attachment to a specific location serves as a partial influence. In our research, we found that respondents exhibited a significantly stronger sense of belonging to their neighborhood than to their city. This observation suggests that identification with a particular group may play a role in shaping individuals' preferences for descriptive social norms.


Our results can also be related to Olson's group theory, as proposed in the logic of collective action (Olson 2009). This theory implies that smaller groups with concentrated interests tend to be more effective in achieving their collective goals, as compared to larger groups with more diffuse interests. This lack of effectiveness arises from both the dilution of benefits and coordination challenges that are inherent to larger groups.

From a public policy perspective, our study suggests that providing information on descriptive social norms related to organic waste sorting behavior at the local level could serve as a supportive measure to promote pro-environmental behavior; such information could be used as a "nudge". In their book, Thaler and Sunstein

(2008) defined a nudge as any aspect of choice architecture that predictably alters people's behavior without forbidding options or significantly changing economic incentives. In our case, a descriptive social norm nudge can be used to highlight the positive behavior of others, in encouraging individuals to adopt an organic waste sorting behavior that conforms with the neighborhood's pro-environmental actions. Applied to Cambodia, where organic waste constitutes half of a typical Cambodian's trash, this approach could significantly reduce the amount of waste sent to landfills. As a direct consequence, it would extend the lifespan of these landfills and decrease the need for continual expansion, which contributes to soil erosion. Its implementation can be relatively straightforward, only requiring information on the proportion of individuals within each neighborhood who actually sort their organic waste. Since we have noticed the presence of a threshold effect, this nudge should be introduced once the behavior has already been adopted by a majority of the population.

Nevertheless, it is important to acknowledge the limitations of our study. First, our sample was not fully representative of the population, as certain characteristics were overrepresented and failed to capture the diverse features of different neighborhoods. Another limitation concerns the cultural context, which could have potentially altered our findings. Responses to social norms may exhibit variations across different cultures.

Lastly, the trade-off between program features and descriptive social norm attributes may prove to be difficult. While our study has focused on the influence of descriptive social norms with respect to waste sorting behavior, practical considerations such as convenience and accessibility are also important influential factors in individuals' decision-making processes. Balancing these program attributes with the descriptive social norms can become complex as individuals weigh the benefits of adhering to social expectations against their own practical constraints. To address this comment more fully, analogies can be drawn with other areas where similar trade-offs occur. Let's take for example the case of individuals

choosing videos on YouTube. Apart from considering content, the number of views a video has received may serve as an influence. Consequently, a video less interesting to the viewer but appreciated by others might be chosen.

Despite its limitations, our study offers valuable insights into the influence of reference groups and the use of DCE methodology within this framework, which could serve to encourage future research in further exploring these dynamics. For all future studies on social norms, caution should be exercised when defining the reference group. Failing to consider the group's spatial distance may lead to incomplete or misleading conclusions, potentially resulting in ineffective policy recommendations. Also, from a methodological perspective, our findings suggest that including descriptive social norms as an attribute in a DCE is applicable in specific situations, i.e. where social norms are recognized as influential determinants of decision-making, as was the case in our study for organic waste separation. This approach would enable a more comprehensive and realistic representation of individual preferences in such contexts.

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Appendices

3.1 Questionnaire elements



Figure 3.3 – Illustration for organic waste sorting (produced by the author)

3.2 Conditional logit model

Variable	Social norms continuous Mean (s.e.)	Social norms categorical Mean (s.e.)
Local social norm	0.243*** (0.100)	
Global social norm	-0.088 (0.101)	
Local social norm 50 (vs 25)		0.002 (0.095)
Local social norm 75 (vs 25)		0.126*** (0.051)
Global social norm 50 (vs 25)		0.054 (0.100)
Global social norm 75 (vs 25)		-0.045 (0.051)
<hr style="border-top: 1px dashed black;"/>		
Frequency	0.091*** (0.009)	0.092*** (0.009)
Time certainty (vs certain)	-0.435*** (0.041)	-0.433*** (0.041)
Expenses	-0.208*** (0.016)	-0.217*** (0.019)
ASC opt-out	-1.508*** (0.099)	-1.553*** (0.088)
<hr style="border-top: 1px dashed black;"/>		
LL(final)	-2831.51	-2831.12
AIC	5677.02	5680.23
BIC	5719.34	5734.64

Note: $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table 3.5 – Results of the conditional logit model

3.3 Additional results

Variable	Mean (s.e.)	Std. Dev.
Local social norm	0.502*** (0.162)	0.783** (0.360)
Global social norm	0.494 (0.467)	0.391 (0.439)
Local social norm * Global social norm	-0.657 (0.747)	0.830 (0.808)

Frequency	0.231*** (0.033)	-0.432*** (0.037)
Time certainty (vs certain)	-0.688*** (0.095)	1.078*** (0.127)
Expenses	-2.280*** (0.306)	2.872*** (0.190)
ASC opt-out	-15.940*** (2.424)	-13.730*** (1.953)

LL(final)		-1927.33
AIC		3886.67
BIC		3983.40

Note: $p < 0.1^*$, $p < 0.05^{**}$, $p < 0.01^{***}$

Table 3.6 – Results of the mixed logit model with the interaction variable for social norms

Conclusion générale

Cette thèse permet d'explorer l'effet de l'influence d'un groupe de référence sur un comportement pro-environnemental, en fonction de la proximité spatiale de ce groupe de référence.

Nous avons débuté cette thèse par un état des lieux des interventions basées sur les normes sociales dans la littérature, au sein d'un chapitre intitulé "A local versus global social norm : a meta-analysis of field experiments on pro-environmental behaviors". Pour ce faire, nous avons réalisé une méta-analyse afin de déterminer si les normes sociales locales et globales ont un impact significativement différent sur l'adoption de comportements pro-environnementaux dans le cadre d'expérimentations terrain. Notre étude met en lumière que, de manière générale, les interventions nudges norme sociale sont plus efficaces pour réduire la consommation d'eau par rapport à d'autres comportements pro-environnementaux. Son efficacité est d'autant plus importante lorsque l'action étudiée se déroule dans un espace public et que la culture du pays est collectiviste¹. Également, les interventions basées sur les normes sociales semblent moins efficaces auprès des ménages que sur d'autres types d'agents économiques.

Toutefois, bien que les interventions normes sociales dans leur ensemble aient un effet significatif, la différence d'impact entre les normes locales et globales n'est pas ressortie comme étant statistiquement significative. Avec un échantillon de

1. La culture collectiviste privilégie l'intérêt du groupe et la cohésion sociale sur les besoins individuels, tandis que la culture individualiste met l'accent sur l'autonomie et la réalisation personnelle. Des exemples de pays collectivistes incluent la Chine, le Japon ou la Corée du Sud, tandis que des pays individualistes incluent les États-Unis, le Royaume-Uni ou la France.

65 études correspondant à 71 groupes de références, nous postulons que la taille de l'échantillon est trop réduite pour détecter une différence significative entre les nudges norme sociale locale et les nudges norme sociale globale. Notre étude souligne également le manque de littérature qui s'intéresse à la comparaison de l'effet de la proximité spatiale de différents groupes de référence. Des expérimentations terrains supplémentaires seraient donc nécessaires pour pouvoir étayer la base de données de la méta-analyse. Également, il serait intéressant de mener des recherches supplémentaires pour observer spécifiquement les potentielles différences de comportements en présence d'une norme sociale locale et globale en condition expérimentale similaire.

Le chapitre 2, intitulé "Local Reciprocity in Linear Public Goods Games : Theory and Experiment", examine le concept de réciprocité locale sur les plans théorique et expérimental, pour mieux comprendre les dynamiques sous-jacentes des contributions volontaires aux biens publics, où la proximité spatiale entre individus joue un rôle. Ce chapitre permet dans un premier temps d'éclaircir la différenciation de la réciprocité locale par rapport à la réciprocité globale de manière conceptuelle et théorique. Un jeu de bien public a ensuite été mis en place en laboratoire pour corroborer les résultats théoriques et démontre que les individus tendent à adapter leurs contributions en fonction de celles de leurs voisins immédiats plutôt que de l'ensemble du groupe.

Grâce à l'expérience en laboratoire, nous montrons que des informations sur les contributions locales, c'est-à-dire les contributions qui concernent les voisins directs, par opposition à l'information agrégeant l'ensemble des contributions des individus du réseau, favorisent non seulement un taux de contribution plus élevé mais aussi une diminution des écarts de contribution entre individus. Contrairement à d'autres études sur les biens publics, ce chapitre révèle une moindre décroissance des contributions au fil du temps, suggérant que la réciprocité locale puisse stabiliser à un niveau plus élevé la coopération sur le long terme. Les résultats expérimentaux montrent également que l'ajout d'un lien entre deux groupes

de contributeurs² réduit en partie la variance des contributions, appuyant ainsi l'hypothèse selon laquelle les agents réagissent à l'information locale, c'est-à-dire à l'information des contributions de leur voisinage immédiat. Cet apport théorique et empirique est utile pour les initiatives visant à encourager la coopération et les contributions aux biens publics. En démontrant que la réciprocité locale peut être un mécanisme de maintien de la coopération, ce chapitre propose de concevoir des systèmes d'incitation plus efficaces par le biais d'une diffusion d'une information plus locale. Ce travail permet d'enrichir la compréhension des motivations individuelles à contribuer volontairement aux biens publics, tout en soulignant l'importance des dynamiques de voisinage dans ces processus.

Dans le chapitre 3 intitulé "A local versus global descriptive social norm : A DCE applied to the waste sorting behavior in Phnom Penh, Cambodia", nous avons mené une expérience de choix discrets (DCE) pour évaluer les préférences des individus quant aux normes sociales locales et globales en matière de tri des déchets organiques. Les résultats de cette étude indiquent que les individus se conforment davantage à la norme locale, définie à l'échelle du quartier, plutôt qu'à la norme globale, définie à l'échelle de la ville. Ce constat contraste avec les conclusions issues de la méta-analyse, qui n'observaient pas de différence marquée entre les effets des normes sociales locales et globales. De plus, il renforce l'hypothèse selon laquelle, dans certains contextes, la proximité géographique peut avoir un impact significatif sur l'efficacité des nudges normes sociales. Cette divergence avec le résultat de la méta-analyse peut s'expliquer par plusieurs facteurs.

Premièrement, l'aspect culturel peut jouer un rôle important. Les données de cette étude proviennent du Cambodge, un pays à la culture collectiviste, alors que peu d'études incluses dans la méta-analyse portaient sur des pays à cette caractéristique culturelle. Par manque de données, la méta-analyse ne permettait pas de tester l'effet de la culture du pays, et nous supposons qu'il soit possible

2. Dans le cadre des politiques publiques, créer du lien entre deux groupes initialement distincts peut s'effectuer, par exemple, en organisant des événements publics, permettant ainsi de réunir des individus issus de différents milieux.

que les résultats varient en fonction de ce paramètre. Une réplication de l'étude dans une culture individualiste permettrait de comparer les résultats et d'évaluer le caractère généralisable de cette tendance préférentielle pour la norme locale.

Deuxièmement, il est essentiel de souligner la distinction méthodologique entre les études incluses dans la méta-analyse et le DCE du chapitre 3. Le DCE que nous avons mené permet d'analyser la prise en compte potentielle des attributs liés aux normes sociales locales ou globales dans le processus de choix du tri des déchets organiques, en se basant sur des réponses déclaratives dans un contexte hypothétique. En revanche, les études de la méta-analyse se concentrent principalement sur l'effet des interventions nudge norme sociale, réalisées dans le cadre d'expérimentations de terrain, où les individus sont confrontés à des conditions réelles. Dans leur étude, LIST et GALLET (2001) définissent le « biais hypothétique » comme la différence entre les déclarations de valeur dans un contexte hypothétique et celles dans un contexte réel, ces dernières étant obtenues à partir d'expériences impliquant des engagements économiques concrets. Malgré les efforts pour rendre les études les plus conséquentielles possibles, le biais hypothétique pourrait entraîner une tendance des individus à surestimer leurs préférences. Les résultats empiriques de LIST et GALLET indiquent que les participants surévaluent leurs préférences dans un contexte hypothétique avec un facteur d'environ 3 par rapport à un contexte réel. Il est donc probable que l'effet des nudges norme sociale soit moins prononcé dans les études de terrain, ce qui pourrait expliquer la nécessité d'un plus grand nombre d'études dans les méta-analyses pour observer un effet significatif. Une piste de recherche future serait de mettre en oeuvre une intervention de terrain au Cambodge, permettant de tester l'efficacité des nudges basés sur les normes locales et globales, afin de comparer les résultats obtenus à ceux de notre étude expérimentale présentée dans ce chapitre.

Par ailleurs, nous avons observé que les individus ayant un sentiment d'appartenance plus fort à leur quartier qu'à leur ville sont proportionnellement plus nombreux que ceux se sentant davantage attachés à leur ville. Cela pourrait expli-

quer en partie la préférence constatée pour la norme locale. Toutefois, en raison de la taille de notre échantillon, il n'a pas été possible d'explorer cette piste de manière approfondie. Il serait crucial de mener des recherches futures pour distinguer la part relative de l'identité et de la spatialité dans le conformisme aux normes sociales. L'étude de GOLDSTEIN et al. (2008) offre un exemple pertinent de cette distinction en comparant l'efficacité de différentes normes sociales, certaines basées sur l'identité, comme le genre, et d'autres sur la proximité spatiale, comme la comparaison avec d'autres clients d'un hôtel ou ceux d'une même chambre. Ils concluent que les interventions fondées sur la proximité spatiale sont plus efficaces que celles basées sur l'identité. Toutefois, lorsqu'il s'agit de voisinage, la distinction entre identité et proximité spatiale peut devenir complexe. Cela appelle à des études plus fines qui examineraient l'impact des nudges normes sociales dans des groupes de voisinage hétérogènes en termes de caractéristiques individuelles, et les compareraient avec des groupes homogènes, afin de mieux comprendre les mécanismes de conformisme qui sous-tendent ces dynamiques.

Les résultats de cette thèse ouvrent des perspectives pour la conception de politiques publiques visant à encourager les comportements pro-environnementaux. Premièrement, nous avons montré que les nudges basés sur les normes sociales sont efficaces pour promouvoir ces comportements. Cette approche est relativement facile à mettre en oeuvre pour les pouvoirs publics, à condition qu'ils disposent de données pertinentes pour l'application de ces interventions. Ensuite, les résultats suggèrent que les campagnes de sensibilisation et les interventions fondées sur les normes sociales devraient se concentrer sur des groupes de référence spatialement proches, tels que les quartiers, plutôt que sur des échelles géographiques plus vastes. De plus, intégrer des initiatives qui renforcent le sentiment d'appartenance, telles que l'organisation d'événements communautaires, la création d'espaces publics accueillants ou l'encouragement à la participation citoyenne, pourrait améliorer l'efficacité de ces politiques. Enfin, l'intégration du concept de réciprocité locale dans les programmes incitant à la coopération pour la gestion des biens publics est également suggérée. Cela pourrait se traduire, par exemple,

par la diffusion d'informations sur les comportements vertueux de certains habitants du quartier.

Comme mentionné précédemment, les perspectives d'approfondissement des travaux de cette thèse sont nombreuses. Bien que nous n'ayons pas encore pu explorer en détail toutes les idées et suggestions soulevées par ces travaux, une étude exploratoire a déjà été réalisée sous la forme d'un pré-test pour préparer la mise en place d'une expérimentation de terrain³. Son objectif est de tester l'efficacité des nudges basés sur les normes sociales locales et globales dans le contexte de la réduction des apports de déchets verts en déchèterie, un enjeu important pour l'agglomération de Redon. Avec un échantillon de 67 répondants, nous avons recueilli des informations permettant d'affiner l'approche en vue d'une mise en oeuvre plus large. Nous explorons également la volonté des individus de modifier leurs habitudes d'élimination des déchets verts dans les centres de collecte des déchets ainsi que leur sentiment d'appartenance aux groupes de références locaux et globaux de l'étude. Ci-dessous est proposée une présentation de cette étude exploratoire ainsi que les perspectives de déploiement.

Contexte : Les déchets verts des ménages en France, comme les feuilles mortes et les résidus de jardin, posent un défi majeur pour la gestion des déchets. Selon l'ADEME (Agence de l'environnement et de la maîtrise de l'énergie), chaque personne génère en moyenne 160 kg de déchets verts par an, dont 41% étaient recyclés en 2017, ce qui concerne environ un particulier sur deux possédant un jardin (ADEME 2018).

La gestion des déchets verts dans les centres de recyclage pose un certain nombre de problèmes. Cela peut entraîner une surcharge des centres de collecte, augmentant les coûts de transport et de traitement, et contribuant aux émissions de CO₂. Le traitement à domicile, comme le compostage ou le mulching (tonte sans ramassage), peut favoriser la biodiversité et alléger ces problèmes. Pour répondre à ces

3. Cette étude exploratoire a été réalisée en collaboration avec François-Charles Wolff.

défis, des collectivités locales encouragent de telles pratiques pour améliorer la gestion des déchets verts.

Notre étude se concentre sur le cas de l'agglomération de Redon, dans l'ouest de la France. Depuis juin 2019, un système de monitoring a été mis en place pour suivre la venue des usagers dans 3 de leurs 8 centres de tri. Dans ces 3 déchèteries, 4 785 tonnes de déchets verts ont été déposées en 2022, ce qui représente 76% du total des déchets verts déposés dans les déchèteries sur l'ensemble du territoire. C'est dans ces trois sites que notre étude sera menée.

Nudge norme sociale : Nous avons défini des nudges basés sur les normes sociales locales et globales en utilisant les données fournies par Redon Agglomération. Ces données comprennent les numéros de badge, la ville de résidence des individus, ainsi que la date et l'heure de leur passage au centre de tri. La période d'analyse s'étend de février 2019 à juillet 2023. Cependant, pour exclure la période de fermeture des centres de collecte des déchets due à la pandémie de COVID-19, nous avons focalisé notre étude sur les données de trois années complètes, de juillet 2020 à juillet 2023.

Nous avons constitué des groupes de référence distincts en fonction de deux niveaux de proximité spatiale. La norme sociale locale est définie au niveau de la commune de résidence des usagers, tandis que la norme globale est définie à l'échelle de l'ensemble du territoire de Redon Agglomération, qui comprend toutes les communes de cette région. L'utilisation annuelle des déchèteries par un individu est comparée à celle des usagers de son groupe de référence. Voici un exemple de nudge norme sociale locale auquel les participants ont pu être exposés :

En moyenne, les habitants de **Guemene Penfao** déposent leurs déchets verts **6.5 fois par an**, tandis que **vous y allez 2 fois**.*

*Depuis 2020 et dans les déchèteries ayant une plateforme à déchets verts

FIGURE 4.1 – Nudge norme sociale locale

Design du questionnaire : La première section du questionnaire examine les habitudes des individus en matière de gestion de leurs déchets verts. Conformément à l’approche de ZHANG et WANG (2020), nous nous concentrons sur les comportements déclarés par rapport à l’année passée. Par exemple, si un individu possède des déchets de tonte de gazon, il lui est demandé : « A quelle fréquence avez-vous utilisé les alternatives ci-dessous pour éliminer vos déchets de tonte au cours des 12 derniers mois ? ». Pour chaque alternative, les réponses possibles sont : 1 = Jamais, 2 = Rarement, 3 = Parfois, 4 = Souvent, 5 = Toujours. Un exemple est illustré par la Figure 4.2.

Que faites-vous de la tonte de votre pelouse ?

Indiquez pour chaque élément la fréquence :

Dépose en déchetterie	✓ -- Choisissez -- Jamais Rarement Parfois Souvent Toujours
Compostage	
Tonte sans ramassage	
Autre	

FIGURE 4.2 – Capture d’écran de la question permettant d’évaluer la fréquence du traitement des déchets verts pour chaque alternative

Après la présentation des solutions alternatives (compostage, mulching), le nudge apparaît de manière aléatoire. Les individus ont une chance sur trois d’être assignés au groupe de contrôle, au groupe de traitement de la norme locale ou au groupe de traitement de la norme globale. Si un individu fait partie du groupe de contrôle, aucune information sur la norme sociale n’est affichée.

Ensuite, nous avons cherché à évaluer leurs propensions à changer leurs habitudes en matière de traitement des déchets verts. À cet effet, nous avons demandé aux individus s’ils seraient amenés à utiliser davantage, moins ou de la même manière chaque alternative pour gérer leurs déchets verts. La question posée pour évaluer le changement de comportement était la suivante : « Supposons que, au

cours des 12 prochains mois, vous avez la même quantité de *déchets de tonte de gazon / déchets de taille de haies et d'élagage / feuilles mortes* que l'année précédente. Que feriez-vous par rapport à l'année dernière ? ». Pour chaque alternative, il était possible de répondre « Beaucoup moins souvent », « Moins souvent », « Aussi souvent », « Plus souvent », « Beaucoup plus souvent ».

Résultats : Les entretiens en face à face ont été menés du 3 au 19 novembre 2023, puis du 19 au 20 avril 2024, permettant de recueillir un total de 67 données exploitables. Concernant les données socio-démographiques, si notre échantillon présente une sous-représentation des femmes (16% vs 51%) et une sur-représentation des personnes âgées (42% vs 22%), le niveau de diplôme est relativement conforme à la population étudiée (57% vs 52% ont le niveau baccalauréat ou moins). Par ailleurs, l'échantillon se révèle assez homogène en ce qui concerne la taille des jardins (69% détiennent 1000m² ou plus) ainsi que la possession d'une tondeuse (99%), d'un composteur (70%) et d'un broyeur (24%).

Le premier objectif de ce pré-test est d'évaluer la disposition des individus à modifier leurs habitudes de gestion des déchets dans les centres de collecte. La première partie du Tableau 4.1 montre que 91% des individus détenant des déchets de taille de haies et d'élagage les déposent en déchèterie, contre 51% pour les déchets de tonte de gazon et 48% pour les feuilles mortes. Pour chacun des trois types de déchets, entre 21% et 24% des individus ont déclaré souhaiter réduire la fréquence de leurs visites aux centres de tri.

	Tonte gazon	Taille haie et élagage	Feuilles mortes
<i>Situation actuelle déclarée</i>			
Produit le déchets verts	N = 67	N = 58	N = 48
Dépose le déchet vert à la déchèterie	N = 34	N = 53	N = 23
<i>Changement déclaré concernant l'usage de la déchèterie pour traiter les déchets verts</i>			
Beaucoup moins souvent	N = 1	N = 1	N = 0
Moins souvent	N = 7	N = 10	N = 5
Plus souvent ou Beaucoup plus souvent	N = 0	N = 0	N = 0

TABLE 4.1 – Nombre de répondants indiquant un changement de comportement concernant l'usage de la déchèterie pour traiter les déchets verts

Nous avons ensuite évalué le niveau de sentiment d'appartenance des individus à leur ville et à l'agglomération de Redon. Nous avons constaté que 25% des personnes se sentent davantage liées à leur ville qu'à l'agglomération, tandis que 12% ressentent un lien plus fort avec l'agglomération qu'avec leur ville. Cela suggère que les nudges basés sur les normes locales et globales pourraient avoir des effets différents sur les comportements en raison de cette asymétrie d'identification. La Figure 4.3 illustre cette différence de sentiment d'appartenance.

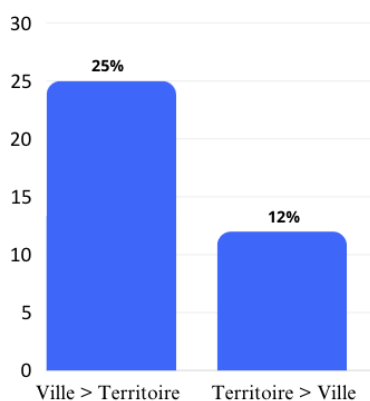


FIGURE 4.3 – Comparaison du sentiment d'appartenance à la ville et au territoire du groupe de référence

Perspective de déploiement : Dans le cadre du futur déploiement de l'expérimentation terrain, nous utilisons le logiciel G*Power (FAUL et al. 2009) pour déterminer la taille d'échantillon nécessaire à la détection d'effets significatifs des

traitements, avec un intervalle de confiance de 95%. Le calcul est réalisé pour comparer le groupe de contrôle avec le groupe recevant le nudge local, le groupe de contrôle avec celui recevant le nudge global, ainsi que les deux groupes de traitement entre eux. Suivant les recommandations de MAYR et al. (2007), nous calculons d’abord le d de Cohen pour ces trois comparaisons⁴. Pour chaque groupe, nous calculons la moyenne des changements de comportement déclarés concernant les déchets verts déposés en déchèterie (avec 1 = beaucoup moins souvent, 3 = autant, 5 = beaucoup plus souvent), puis nous divisons la différence entre ces moyennes par la somme des écarts-types des groupes. Nous constatons que les moyennes entre le groupe de contrôle et le groupe avec nudge local sont très proches, nécessitant 2750 individus pour observer une différence significative. En revanche, seulement 206 individus sont requis pour une différence significative entre le groupe de contrôle et le groupe avec nudge global. Enfin, 318 individus seraient nécessaires pour détecter une différence entre les deux groupes de traitement. Les résultats de cette analyse sont présentés dans le Tableau 4.2.

	Contrôle vs Nudge local	Contrôle vs Nudge global	Nudge local vs Nudge global
Différence des moyennes	0.05	0.24	0.19
Écart-types	0.39	0.51	0.51
D de Cohen	0.13	0.46	0.37
Taille totale de l’échantillon requis	2750	206	318

TABLE 4.2 – Taille de l’échantillon nécessaire pour détecter les effets de manière significative

Pour conclure, ce pré-test vise à tester un questionnaire conçu pour mesurer l’impact de la proximité spatiale d’un groupe de référence sur l’efficacité de nudges norme sociale, visant à réduire les dépôts de déchets verts dans les déchèteries. La réalisation de ce pré-test permet de recueillir des informations sur la faisabilité d’une expérimentation de plus grande envergure. Il permet de montrer qu’une partie des individus sont disposés à modifier leur comportement après la présentation

4. Le d de Cohen est une mesure de la taille d’effet permettant d’évaluer la différence entre deux groupes.

des solutions alternatives et du nudge. Environ un quart des répondants déclarent souhaiter réduire la quantité de déchets verts apportés dans les déchèterie, ce qui pourrait entraîner des bénéfices notables en termes de réduction des émissions de CO₂ liées au transport et de diminution de l'espace occupé par les déchets verts dans ces centres. De plus, l'effet rebond semble limité, car aucun individu n'a exprimé l'intention d'augmenter ses dépôts de déchets verts suite aux différents traitements. Les résultats encourageants quant à la propension au changement de comportement et à la différence d'identification aux groupes de références de l'étude nous incitent à envisager un déploiement à plus grande échelle via une expérimentation sur le terrain. À cette fin, le calcul de puissance statistique effectué avec G*Power montre que 318 répondants sont nécessaires pour détecter un effet significatif entre nos deux nudges basés sur les normes sociales. Par ailleurs, lors du déploiement de l'expérience de terrain, il serait pertinent de comparer les changements de comportement déclarés avec les comportements réels, en analysant les fréquences de visite aux déchèteries sur l'année suivant l'enquête.

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Titre : Normes locales et fournitures privées de biens publics environnementaux

Mots clés : Normes locales, Biens publics environnementaux, Économie comportementale, Économie expérimentale

Résumé : Cette thèse examine les effets des normes locales sur les comportements pro-environnementaux. Nous avons réalisé une méta-analyse d'études sur les nudges normes sociales afin de comparer la différence d'effet de nudges norme sociale locale et globale. L'échantillon sur lequel se base la méta-analyse ne permet pas d'observer une distinction significative entre les deux normes. Nous postulons que de travaux complémentaires sont nécessaires afin de renforcer la base de données et affiner les résultats. Nous avons ensuite développé un modèle de réciprocité locale au sein d'un réseau d'individus placés en groupes, appelés *communautés*, ainsi que mis en place une expérimentation en laboratoire pour corroborer les résultats du modèle. Nous montrons que les individus contribuent de

manière complémentaire avec leurs voisins et que lorsque deux individus de chaque groupe peuvent s'observer, une diffusion partielle de comportement peut avoir lieu entre groupes. Enfin, nous avons montré par la méthode des choix discrets lors d'une étude menée à Phnom Penh au Cambodge que les individus ont une préférence pour les normes locales concernant le tri des déchets organiques. Un fort sentiment d'appartenance au groupe de référence local pourrait contribuer à ce résultat. Les résultats de la thèse soulignent donc l'importance d'adapter les interventions publiques aux groupes locaux, de renforcer le sentiment d'appartenance communautaire, et d'intégrer des stratégies de réciprocité locale dans les politiques de gestion des biens publics.

Title : Local norms and private provision to environmental public goods

Keywords : Local norms, Environmental public goods, Behavioral economics, Experimental economics

Abstract : This thesis investigates the influence of local norms on pro-environmental behavior. A meta-analysis of social norm nudge interventions was conducted to compare the differential impact of local and global social norm nudges. The sample on which the meta-analysis is based does not permit the identification of a significant distinction between the two norms. It is proposed that further work is required in order to reinforce the database and to refine the results. Subsequently, a model of local reciprocity within a network of individuals situated in groups, designated as communities, was constructed, and a laboratory experiment was conducted to corroborate the results of the model. The findings demonstrate that individuals

contribute in a complementary manner to their neighbors and that when two individuals from each group are able to observe each other, a partial diffusion of behavior can occur between groups. Finally, employing the discrete choice method, our study conducted in Phnom Penh, Cambodia, demonstrated that individuals exhibited a preference for local norms for sorting organic waste. A stronger sense of belonging to the local reference group may contribute to this result. The findings of the thesis thus emphasize the necessity of adapting public interventions to local groups, reinforcing the sense of community belonging, and integrating local reciprocity strategies into public goods management policies.