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PREFERENCES HETEROGENES DES GRANDS PROJETS MINIERS : TROIS ESSAIS EN EVALUATION NON MARCHANDE

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La thèse se présente comme une étude approfondie des sources de l'hétérogénéité de la population qui sont susceptibles d'affecter l'adhésion de la population au développement minier. Le cadre d'étude est la méthode des choix expérimentaux, qui se présente en une série de scénarios hypothétiques et où les répondants reportent leurs choix préférés parmi un ensemble de scénarios combinés. L'étude des choix expérimentaux considère en particulier un contexte de découverte de gisements miniers pour trois ressources données : l'or, les terres rares et l'uranium. Ces gisements sont mentionnés être suffisamment rentables pour permettre leur mise en exploitation. La zone d'étude est délimitée à la province canadienne du Québec, où l'étude des choix expérimentaux a été réalisée par internet auprès d'un panel d'un peu plus de 3 000 répondants, incluant 1 017 réponses pour l'or, 1 046 pour l'uranium et 941 pour les terres rares. Les données collectées sur les préférences des individus, dans un format proche de données de panel, sont traitées, analysées et contrôlées pour un ensemble de déterminants qui retranscrivent les changements majeurs de bien-être dus au développement minier.

Le projet de recherche est articulé en trois principaux axes de réflexion autour duquel l'analyse des préférences hétérogènes constitue le cœur des travaux de recherche. Le premier axe de recherche s'interroge des effets de la distance d'une mine sur le niveau d'adhésion de la population. Ce premier article avec co-auteurs suppose que la distance est une fonction linéaire décroissante de l'utilité (et donc du bien-être des individus) et il teste empiriquement cette hypothèse, en considérant plusieurs dégradations des conditions du projet minier, compte tenu de l'hétérogénéité des ressources. Ainsi, nous estimons et comparons les effets de la distance sur des estimés de bien-être de la population entre des mines d'or, d'uranium et de terres rares. Les principaux résultats révèlent que la dégradation des conditions minières peut affecter sur de longues distances le bien-être. Ces effets peuvent être positifs ou négatifs selon le minerai et les changements majeurs visés par le projet minier.

Un deuxième axe de recherche valorise le rôle de l'expérience dans une démarche d'analyse plus robuste des préférences. La littérature concède que la mesure des préférences devient plus précise avec l'expérience des individus ; les études de choix expérimentaux illustrent empiriquement le bénéfice de l'expérience. A contrario, le manque d'expérience est

un défi méthodologique, et peut mettre en doute la fiabilité des résultats des estimés de préférences d'une nouvelle technologie, d'une politique innovante ou d'un projet unique. Dans un second article, je tire avantage du passé minier d'exploitation de l'or dans la province du Québec pour étudier les effets potentiels de cette expérience (indirecte) sur la mesure des préférences du développement de mines de terres rares pour la première fois de son histoire. Les résultats suggèrent après une série de robustesse, que l'expérience même indirecte peut devenir bénéfique dans la mesure des préférences.

Le dernier axe de recherche évalue les effets hétérogènes de l'information dans l'analyse des préférences. La littérature la plus récente trouve des résultats mitigés de l'information, entre aucun effet ou des effets positifs/négatifs. Pour aider à expliquer ces résultats, le troisième article pointe comme source potentielle d'hétérogénéité l'importance des croyances des individus. Celles-ci pourraient faire varier l'interprétation de l'information, et donc la mesure des préférences. Dans le troisième article, je teste cette hypothèse et je propose un riche cadre d'étude expérimentale me permettant de contrôler le type d'information et le contexte spécifique à la ressource. Avec pour principal résultat, je trouve que le contexte donné modifie les croyances des individus, celles-ci peuvent conduire à des effets différenciés d'une même information, affectant différemment les préférences des individus.

Les trois articles mis ensemble couvrent plusieurs sources principales d'hétérogénéité des préférences et ils contribuent à une série d'évidences originales des effets potentiels du développement minier sur le bien-être de la population.

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ABRÉVATIONS

ASC	Alternative specific constant
BU	Bayesian updating
CAD	Canadian dollars
CE	Choice experiment
CL	Conditional logit
DCE	Discrete choice experiment
G-MNL	General multinomial logit
GDP	Gross domestic product
H-CL	Heteroscedastic Conditional logit
IIA	Independent and irrelevant assumption
LL	Log-likelihood
MERN	Ministère de l'énergie et des ressources naturelles
MXL	Mixed logit
NGOs	Non-governmental organisations
NI	No information
OECD	Organisation for Economic Co-operation and Development
PI	Persuasive information
REEs	Rare earths elements
RPL	Random parameter logit
SD	Standard deviations
SI	Scientific information
SP	Stated preference
SQ	Statu quo
WTA	Willingness-to-accept

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Le projet de thèse défendu fait suite à un appel à concours lancé conjointement par le Ministère de l'énergie et des ressources naturelles (MERN) et le Fond de la recherche du Québec – Natures et Technologie en Août 2016, pour établir une recherche en partenariat entre le Ministère de l'Énergie des ressources naturelles (MERN), le milieu universitaire et une entreprise minière, i.e., dans notre cas, ArcelorMittal Canada. Je tiens à exprimer ma reconnaissance la plus sincère pour avoir eu le privilège d'être récipiendaire d'une bourse de recherche tout au long du projet de recherche. Plus particulièrement, je remercie Monsieur Bienvenu, pour son suivi et son accompagnement tout au long du processus de recherche. Le projet de recherche a bénéficié des commentaires d'un ensemble de parties prenantes au Québec qui sont en relation avec l'industrie minière, les Ministères, les citoyens et les associations environnementales.

Ce projet a été l'opportunité pour moi de mieux me familiariser avec les enjeux du secteur minier dans un contexte d'étude appliqué au Québec. Les résultats de la recherche ont été présentés et vulgarisés dans une série de congrès, conférence et séminaire de recherche incluant mais non limités, *WONV*, *CIREQ*, *FAERE*, *Ulvon conférence*, *ESA Asia Pacific Meeting*, *85th congrès annuel ACFAS*.

Les personnes suivantes ont contribué aussi bien de près comme de loin à ce projet de thèses notamment à travers des commentaires, retours et échanges nourrissant et améliorant les questions de recherche mises en évidence dans cette thèse. Mes sincères remerciements et salutations vont à Jaime de Melo, Martino Pelli, Catherine Choquette, Jean Cadieux, Thomas Poder, Mamour Fall, Sadio Coulibaly, Philippe Kaboré, Jocelyn Diab, Jérémy Tallier, Aminata Kane. Enfin, mais non pas des moindres, ce projet de la thèse n'aurait pas été possible sans le soutien inconditionnel de mes proches, mes parents, ma famille et mes collègues de travail qui m'ont accompagné à ce moment précis de ma vie. Mes pensées particulières vont à Jules et Alice.

INTRODUCTION GÉNÉRALE

L'attractivité du développement minier ouvre un grand débat public d'acceptabilité des projets miniers. Ces grands projets marquent de profonds changements sur le marché de l'emploi, la croissance, l'urbanisation et l'environnement. La nature de ces changements peut soulever des inquiétudes de la population à savoir si les bénéfices du développement minier l'emportent sur les coûts. L'analyse fine des coûts, bénéfices et risques d'un grand projet minier peut s'avérer être un exercice d'évaluation relativement complexe (Northey, Mudd et Werner, 2018). Une partie des coûts et des bénéfices sont imputés à des externalités difficilement quantifiables (Werner et al., 2020), non marchandes (Garrod et Willis, 2000) qui se réalisent sur un horizon incertain à long terme (Northey, Mudd et Werner, 2018). Le gouvernement fait alors face à un dilemme entre maximiser le bien-être social d'une part et limiter les externalités négatives d'autre part (Pearce, Atkinson et Mourato, 2006).

Le développement minier porte à première vue le potentiel d'accélérer la croissance économique d'un pays donnant aux nations des opportunités de transformations productives notamment dans les pays en développement (Dollar, 1992). La découverte de gisements miniers représente une aubaine pour un pays, susceptible d'influencer positivement l'opinion publique. Des évidences empiriques nuancent ce point de vue montrant que les économies riches en ressources enregistrent des performances de croissance plus faibles en moyenne que celles des économies pauvres en ressources (Sachs et Warner, 1995).

La découverte de nouveaux gisements miniers pourrait devenir une « malédiction » (Van der Ploeg, 2011), même si toutes les économies riches en ressources ne semblent pas être impactées de la même façon. Les pays bénéficiant d'institutions plus fortes (e.g. Canada) disposent de leviers plus importants pour atténuer les potentiels effets macroéconomiques récessifs liés à la découverte de ressource. Une évaluation plus granulée des impacts miniers peut aussi modifier les conclusions sur le débat d'aubaine ou de malédiction. Une série de travaux microéconomiques contribuent à mettre en évidence certains effets du développement minier souvent occultés par l'analyse macroéconomique (Van Der Ploeg et Poelhekke, 2017).

La thèse d'aubaine est soutenue par plusieurs auteurs évaluant les impacts locaux de la mine (e.g. Aragón et Rud 2013 ; Gradstein et Klemp, 2020 ; Loayza et Rigolini, 2016). Les projets miniers contribuent au développement local des infrastructures routières et réduisent les coûts de transport des petites et moyennes entreprises (De Haas et Poelhekke, 2019). Le développement minier a le potentiel de favoriser un pouvoir d'achat plus élevé chez les habitants vivant à proximité de la mine (Aragón et Rud, 2013) et il augmente l'accès à une meilleure qualité de biens publics (Corral, Henderson et Miranda, 2019).

La thèse de malédiction n'est pas pour autant évincée. Des coûts non observés de la mine contrebalancent les bénéfices précédemment identifiés. L'ouverture de nouvelles mines peut entraîner à proximité des conflits sociaux plus élevés couplés parfois à des effets de débordement au-delà des frontières pays (Berman, Couttenier, Rohner et Thoenig, 2017). Le rendement des terres agricoles peut décroître lorsque celles-ci se situent plus proches des zones minières. La fermeture des mines peut restructurer le marché de l'emploi, où les femmes ont relativement moins de chance de trouver un nouvel emploi par rapport aux hommes (Aragón, Rud et Toews, 2018).

La diversité des résultats entre aubaine et malédiction peut également dépendre du type de minerai considéré par l'analyse empirique. Certaines ressources telles que le pétrole ou le gaz de schiste semblent plus susceptibles de révéler la présence de malédiction (Ross, 2001), et les travaux pointant des effets hétérogènes entre les ressources restent plus rares (Pelzl et Poelhekke, 2018).

Juger de l'acceptabilité sociale des grands projets miniers revient à questionner si le développement minier se manifeste en aubaine ou malédiction mais du point de vue de la population. L'évaluation plus granulée des coûts et des bénéfices de la mine donne une lecture plus fine des enjeux de l'extraction. Elle renseigne peu sur comment les pratiques minières affectent le bien-être social (Mignamissi et Kuete, 2021) et donc les préférences de la population générale. Par exemple, le type d'extraction par voie souterraine ou à ciel ouvert va-t-il avoir des effets différenciés sur le bien-être de l'individu ? Comment de bonnes ou mauvaises pratiques minières influencent-elles le bien-être des communautés d'accueil et le bien-être des populations plus éloignées ?

Des questions clés sur les changements de bien-être au sein de la population subsistent dans le contexte minier aussi bien dans les pays développés que dans les pays en développement. Après l'annonce d'une découverte de gisements miniers, il est difficile de prédire comment la population réagit à l'aubaine de cette découverte. Les perceptions des individus peuvent varier sur les effets d'aubaine, pouvant renforcer le climat social polarisé entre les opposants à la mine et les supporters. Une fois le projet minier lancé, les pratiques des projets miniers peuvent tendre à s'aligner aux attentes de la population ou à s'en écarter. De bonnes pratiques minières peuvent contribuer à favoriser le processus d'acceptabilité sociale, tandis que les chances de succès ou d'échecs de projet dépendent étroitement du contexte minier considéré (e.g. le type de ressource, la distance à la mine).

La thèse propose d'évaluer le niveau d'acceptabilité sociale des grands projets miniers. Elle emploie la méthode des préférences déclarées, outil souvent plébiscité par les décideurs publics pour mieux identifier les facteurs clés de l'acceptabilité sociale. Cette méthode présentée en format d'enquête expérimentale vise à mesurer la valeur des préférences de la population suite à la proposition de changements majeurs hypothétiques d'une nouvelle politique ou d'un nouveau projet (Johnston et al., 2017).

La thèse s'inspire en partie de l'article pionnier de Carson, Wilks et Imber (1994) qui à notre connaissance compte parmi les premières applications de préférences déclarées dans le contexte minier. Les auteurs estiment la valeur des préférences de la population à 435 millions de dollars australiens pour préserver la réserve naturelle du parc national de Kakadu des impacts miniers de l'ouverture d'une mine d'or. Les conclusions des auteurs appuient que le bien-être social serait plus élevé en priorisant la préservation de la réserve naturelle par rapport à un scénario d'extraction minière. Cette étude fut l'objet de plusieurs vives critiques sur l'emploi de la méthode des préférences déclarées et la fiabilité des résultats empiriques. Une critique majeure porte sur la sensibilité des estimés de préférence au contexte d'étude donné (Carson, Wilks et Imber, 1994). Une autre critique pointe l'inadéquation entre la mesure des préférences et l'application simplifiée de la théorie de l'agent néoclassique (Kling, Phaneuf et Zhao 2012). La thèse prend acte de ces critiques et les confrontent dans une application de la méthode des choix expérimentaux au contexte minier.

Notre contexte d'étude est donné par la province canadienne du Québec, où nous y mesurons la valeur des préférences de la population par rapport à l'annonce hypothétique de la découverte et la mise en exploitation de nouveaux gisements miniers. Des contextes miniers différents sont présentés aux participants pour mieux prendre en compte la sensibilité des valeurs estimées des préférences selon le contexte envisagé. Les travaux de Carson, Wilks et Imber (1994) ont notamment souligné que les préférences déclarées sont reliées aux opinions ou croyances partagées par la population et au niveau de connaissances des impacts miniers. Nous exploitons ces potentielles variations au sein de la population pour tester l'hypothèse d'agent rationnel Bayésien dans la théorie néoclassique, avec pour implication principale que les individus avec différents types de croyances ont une interprétation commune de l'information.

La collecte des données des préférences déclarées procède en distribuant aléatoirement plusieurs versions de questionnaire en ligne aux participants où le contexte minier change selon la ressource[1] (or, uranium, terres rares) et la distance

[1] Au Québec, le premier minerai d'or est exploité depuis près de deux cents ans tandis que les deux autres minerais ont démontré un fort potentiel d'exploitation sans aboutir à leur extraction.

à la mine. L'analyse propose en plus de faire varier le niveau d'information entre les répondants pour mesurer les effets d'une nouvelle information les estimés de préférences. Nous proposons un riche cadre d'analyse des préférences dans une étude déclinée en vingt-sept versions de questionnaires combinant trois ressources évaluées, trois distances à la mine et trois flux d'information. Ce type de changements apportés au contexte minier peut entraîner une variation de l'adhésion de la population à un grand projet minier et nous mesurons leurs effets sur les préférences des individus.

La thèse s'inscrit à un corps de la littérature en évaluation des préférences déclarées qui mesurent les changements des préférences pour différents scénarios de projets miniers (e.g. Garrod et Willis, 2000 ; Mendes, Dias-Sardinha et Milheiras, 2013) ou différents scénarios d'externalités environnementales liées au développement minier (e.g. Marella et Raga, 2014). Bien que la majorité de ces travaux contribuent à une série d'évidences empiriques sur les estimés des préférences dans le contexte minier, ils ne retranscrivent pas les sources importantes d'hétérogénéité des préférences. Cette littérature donne peu de lisibilité aux résultats empiriques de la malédiction des ressources naturelles qui insistent sur l'hétérogénéité des impacts miniers (e.g. méthode d'extraction, type de minerai). Ces études donnent aussi peu de recul sur l'étendue des impacts miniers sur les préférences de la population.

La thèse motive l'importance d'analyser les préférences au-delà d'une valeur moyenne estimée, comme cela a pu être suggéré par Tonsor et Shupp (2011) dans le contexte agricole. En identifiant explicitement les principales sources d'hétérogénéité, l'analyse des préférences peut gagner en fiabilité et robustesse. Cette démarche contribue également à raffiner les implications des recommandations de politiques économiques en ciblant l'hétérogénéité des caractéristiques de la population (Hanley et Czajkowski, 2017).

Pour ce qui suit, j'identifie les travaux de recherche qui mettent en évidences des sources importantes d'hétérogénéité, susceptibles d'influencer les estimés des préférences moyennes des individus. Une brève discussion est menée en parallèle sur les implications potentielles dans le contexte minier.

Le contexte géographique peut influencer la structure des préférences de la population. La littérature met en lumière une relation empirique linéairement négative entre la distance à la ressource et la valeur des préférences estimées (Hanley et al., 2003). Ceci implique qu'au-delà d'une certaine distance, les préférences sont prédites diminuer jusqu'à tendre vers une valeur nulle. Certains biens et services environnementaux semblent cependant insensibles aux effets de la distance (De Valck et Rolfe, 2018), où même les populations les plus éloignées peuvent partager de fortes préférences pour une ressource en mutation/changement.

Les études des préférences jusqu'à lors examinent le contexte minier à une échelle exclusivement locale (e.g., Windle et Rolfe, 2013), laissant inexpliquée la part de variation de la valeur des préférences avec la distance de la mine. Ce manque d'évidences ne permet pas de conclure sur l'importance du contexte géographique, alors que les études empiriques abordant la malédiction/aubaine des ressources naturelles suggèrent des effets du développement minier sur de longues distances (e.g., De Haas et Poelhekke, 2019).

En plus du contexte géographique, l'adhésion d'une population à de grands projet miniers peut dépendre du niveau de connaissances et du passé minier. La littérature en évaluation des préférences apporte des éléments de clarification sur ce point. Les individus familiers et expérimentés devraient être plus susceptibles de déclarer des préférences plus proches de leurs vraies préférences (e.g., LaRiviere et al. 2014). Ils seraient aussi moins en proie aux effets d'incertitude (Cameron et Englin, 1997). Ceci a de fortes implications pour la mesure robuste des préférences, qui est une préoccupation centrale de la littérature des préférences déclarées.

Des répondants « novices » avec la ressource étudiée auront plus de difficulté à déclarer le ou les choix préférés d'arbitrage, car ils ont été peu ou jamais confrontés à la situation donnée par le contexte d'étude. Cela compte dans le contexte minier, car l'ouverture d'une mine est souvent source d'incertitudes chez la population. Ce manque d'expérience ou/et de connaissance peut être renforcée lorsque la ressource extraite est méconnue par le grand public, comme par exemple dans le cas des projets miniers de terres rares.

Si la majorité des individus dispose de peu ou aucune connaissance/expérience sur la ressource évaluée, la littérature des préférences déclarées préconise de fournir toutes informations nécessaires et pertinentes à la prise de décision. Cela conduit une riche littérature des préférences à s'interroger des effets du contenu et du format de l'information. Ces études identifient les effets d'une nouvelle information sur les préférences en comparant un groupe de répondants informés avec un groupe de contrôle (non informé). Elles montrent des effets contrastés de l'information suggérant la sensibilité des résultats à différents types d'information (e.g. information scientifique/persuasive) ou différents formats (e.g., avec ou sans illustration graphique).

L'information spécifique aux minerais devrait jouer un rôle clé dans l'arbitrage des coûts et bénéfices d'une nouvelle mine. L'extraction de différents minerais ont des conséquences environnementales qui varient par type d'effet et en termes relatifs d'impacts (e.g. Northey, Mudd et Werner, 2018). Une meilleure familiarité de l'individu avec les impacts miniers ou toute autre information pour juger de la pertinence d'un projet minier devrait contribuer à améliorer le report plus précis des préférences déclarées (Bergstrom, Stoll et Randall, 1989).

Contributions générales de la thèse et liens

Ce bref survol de la littérature a mis en lumière trois principales sources d'hétérogénéité présentes en analyse des préférences. L'identification de ces effets peut amener à nuancer l'interprétation de la mesure moyenne estimée des préférences. La thèse développe en trois articles une analyse plus approfondie de ces sources d'hétérogénéité des préférences dans un même cadre unifié d'étude. L'article 1 compare et mesure les effets de la distance à la mine sur les préférences taclant l'importance du contexte géographique. L'article 2 cherche à mettre en évidence les effets de l'expérience et des connaissances sur l'adhésion de la population à un projet minier. L'article 3 adresse et teste comment l'information vient affecter la mesure des préférences déclarées.

Le lien étroit entre les articles est de chercher à mieux expliquer les différences observées d'acceptabilité sociale des projets miniers. Certains projets miniers semblent remporter l'adhésion majoritaire de la population, tandis que d'autres font émerger des conflits sociaux parfois majeurs divisant la société. L'analyse des préférences met en avant plusieurs sources d'hétérogénéité qui pourraient être à l'origine de ces différences. En particulier, l'adhésion d'un individu à un projet minier peut dépendre de la distance entre la mine prévue et son lieu d'habitation, le niveau d'expérience et de connaissances que l'individu partage, la communication d'informations clés sur le projet.

Les trois articles ensemble contribuent à proposer une approche empirique robuste pour intégrer ces sources d'hétérogénéité dans l'analyse des préférences.

Chaque article peut avoir une contribution spécifique à la littérature des préférences déclarées. L'article 1 avec co-auteurs propose de mesurer les préférences sur la base d'une approche à échantillons séparés qui fait varier aléatoirement le contexte minier selon trois intervalles de distance (0-20 kilomètres ; 20-100 kilomètres ; supérieur à 100 kilomètres) et trois ressources minières (or, uranium, terres rares). Le choix des intervalles de distance sont calibrés selon l'étendu spatial mesuré empiriquement des impacts miniers[2]. La première contribution de l'article est de tester l'hypothèse de relation linéairement négative entre la distance à la mine et la localisation de l'individu. La deuxième contribution liée est de contraster les effets de la distance selon l'hétérogénéité des

[2] La littérature empirique met en évidence des effets spatiaux de la mine circonscrit à un rayon de 20 kilomètres autour de la mine (e.g. Aragón et Rud, 2013 ; Dell, 2010). Ces effets peuvent se diffuser jusqu'à une distance de 100 kilomètres de la mine et s'estomper au-delà (Aragón et Rud, 2013 ; De Haas et Poelhekke, 2019).

minerais[3]. A notre connaissance, cet article est la première analyse des préférences de ce genre appliquée au contexte minier.

L'article 2 s'intéresse au rôle de l'expérience avec le développement minier pour juger l'adhésion d'un projet d'extraction d'un minerai méconnu tel que les terres rares. Bien que l'évaluation d'une ressource méconnue par le grand public devrait poser un défi méthodologique en analyse des préférences, l'article soutient empiriquement que la valeur des préférences peut être estimée de façon robuste. Pour ce faire, je mesure l'expérience indirecte des individus avec un minerai familier (l'or) et je teste si différentes formes d'expérience agissent favorablement sur les estimés des préférences liées à l'extraction des terres rares. Le contexte du Québec est en plus un cadre idéal d'étude car la province bénéficie d'un long historique minier[4] dans l'extraction de l'or, tandis que les gisements de terres rares ont récemment démontré un fort potentiel d'extraction.

Le troisième article contribue à plusieurs égards à la littérature des préférences déclarées. Bien que la littérature présente des effets souvent mitigés de l'information (positif, négative, nul), cet article évalue les effets du type de l'information dans le contexte minier. Pour mieux cerner la possible sensibilité au contexte, l'analyse des préférences propose de comparer un contexte minier plus polémique (mine d'uranium) avec un contexte moins sujet à polémique (mine d'or). L'étude mesure les croyance ex-ante des individus sur l'aubaine d'un projet minier dans chaque contexte de ressource et fournit aléatoirement trois traitements d'information : aucune information supplémentaire, une nouvelle information persuasive et une nouvelle information scientifique. Par cette approche, l'article contribue à vérifier si des individus avec différentes croyances (neutre, opposant, supporter) sur l'aubaine d'une mine ont la même interprétation de l'information et

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[3] Krautkraemer (1998) montre que la qualité et le type de minerai ont des effets différenciés en analyse économique. Un exemple documenté (Winde, 2006) concerne des effets différenciés de l'extraction tels que des rejets de cyanure pour l'or et des rejets radioactifs pour l'uranium.

[4] Plusieurs auteurs montrent empiriquement la persistance de transformations économiques à long termes entraînés par les opérations minières telles que sur la consommation (Dell, 2010), la dynamique de croissance (Alexeev et Conrad, 2009) et la structure du marché de l'emploi (Bennett, Ravetti et Wong, 2020 ; Frederiksen et Kadenic, 2020).

révise l'adhésion au projet minier de façon similaire. L'article contribue à souligner que la nature polémique du contexte peut influencer les croyances des individus, qui à leur tour affectent l'interprétation de l'information et les préférences des individus.

Fort de ces contributions, la thèse fournit une série d'évidences empiriques sur comment le développement minier affecte les préférences de la population. Les principaux résultats des articles peuvent être regroupés ainsi.

L'article 1 trouve que le contexte géographique est important en analyse des préférences. Les estimés de préférences peuvent diminuer avec la distance à la mine, tandis que les effets mesurés de la distance dépendent du type de ressource extraite et des changements entraînés par les pratiques minières. En particulier, le contexte d'une mine pour une ressource donnée révèle que les effets de la distance peuvent s'étendre au-delà de 100 kilomètres du site minier.

L'article 2 met en évidence que l'expérience indirecte avec l'extraction de l'or peut agir favorablement sur l'adhésion des individus à un projet de mine de terres rares. Ces résultats sont encourageants pour les études des préférences de ressources méconnues et complexes, même dans une situation où une majorité des individus ne disposent que de peu d'expériences sur la ressource étudiée. Le contexte historique joue un rôle clé dans le jugement et la formulation des préférences de la population pour juger l'aubaine d'un nouveau projet minier.

Enfin, l'article 3 trouve des résultats consistants avec la littérature, où l'information a un faible effet (contexte de mine d'or) ou aucun effet (contexte de mine d'uranium) sur les préférences. Cette conclusion est à nuancer en distinguant les effets de l'information selon l'hétérogénéité des croyances. De façon générale, nous trouvons que les effets de l'information sont significatifs pour les individus avec des croyances neutres sur l'aubaine d'une mine. Par contre, les groupe d'opposants et supporters réagissent moins fréquemment à l'information et parfois, la même information peut produire des effets divergents sur les préférences entre opposants et supporters. Les résultats mis ensemble soulignent la grande variabilité des réponses à l'information selon le type de croyances et ces effets restent souvent masqués par l'analyse des préférences moyennes.

Ce chapitre introductif résume les contributions originales de la thèse et les principaux résultats. Les pistes de réflexion abordées permettent en partie d'enrichir les réflexions sur les enjeux de l'acceptabilité sociale des grands projets miniers. La thèse montre comment la méthode des préférences déclarées pourrait être pertinente dans le contexte minier pour aider à mesurer les préférences des citoyens. L'application de cette méthode est sujette à certaines mises en gardes, où nous montrons que l'analyse des préférences moyennes peut masquer une forte variabilité des préférences au sein de la population. Les travaux de recherche de la thèse ont ainsi conduit à identifier trois principales sources d'hétérogénéité telles que le contexte géographique, l'expérience individuelle et l'information. Les principaux résultats soulignent des éléments d'explication pour mieux comprendre les différences souvent observées d'acceptabilité sociale d'un projet minier à un autre. Les conclusions de la thèse ne se limitent pas uniquement au contexte minier, et peuvent couvrir plus généralement tout projet de valorisation des ressources qui apporte des changements majeurs sur le territoire comme dans le cas du développement minier.

1. IS MINING SPATIALLY BLIND ON POPULATION WELFARE? EVIDENCE FROM A DISCRETE CHOICE EXPERIMENT

Adrien Corneille[5,6], Jie He[2] and Thomas G. Poder[7],

Abstract

What are the long-distance effects of a mining project on population welfare? This paper helps understand if mining is space blind over population welfare, which means that a mining project could raise global population concerns beyond the local context. A stated preference approach based on a discrete choice experiment proposes to measure welfare changes following a deterioration of mining conditions. The study focus addresses the welfare implications of the distance-to-the mine given a crossed-resource comparison between gold, uranium, and rare earths. A key result of the study highlights that welfare loss can be stronger in the vicinity of the mine but decline with longer distances. Such result of a distance-effect closely relies on the type of mineral extracted and the transformations due to degrading conditions of mining. Our findings further suggest that for certain mineral often perceived as dangerous, expected effects of mining could be mostly space blind on population welfare becoming a major issue to the society.

Key words: Distance decay effect, Mining, Discrete choice experiment

JEL codes: D62 ; L72 ; C93 ; P28.

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1.1. Introduction

Mining projects strongly transform populated areas that involve major economic, environmental, and social changes. The nature of changes often failed being reflected by the resource price (Garrod and Willis, 2000) because of frequent market failures in covering full externalities altogether. During the life cycle of a mine, mining operations contribute among others to regional growth, employment, and expanded transport and energy infrastructures. Mining development can also have hidden impacts on resource preservation and land usage for agriculture and tourism industry (Aragón and Rud, 2016). The complex deal of mining externalities challenge policymakers in ensuring that mining practices effectively align with the support of the population. This is partly because mining externalities happen unevenly distributed across space (Northey, Mudd and Werner, 2018) and will affect the population in different ways.

A burgeoning literature supports that mining development is far to be blind across space. These studies showed that the majority of mining impacts are concentrated within a delimited geographical area affecting a variety of economic outcomes (e.g., Aragón, Rud and Toews, 2018; Berman et al., 2017; Gradstein and Klemp, 2020; Loayza and Rigolini 2016). Authors also found that long-range impacts of mining could reach distances to the mine up to 100 kilometers. Less attention is paid on how mining impacts would affect well-being specially their effects on the population across space. A plenty of stated preference studies addressed welfare changes associated with mining in a local context (Gillespie and Kragt, 2012; Marella and Raga, 2014; Mendes et al., 2013; Pemberton, Harris-Charles, Patterson-Andrews, 2010). These typical contexts have tendency to narrow the scope of population welfare changes since mining impacts can sometimes extend over longer distances. This is a likely concern for certain resources that include long-distance effects from gas flare and oil (Farrer, Holahan et Shvetsova, 2017).

This paper provides substantive basis for the discussion on spatial matters in a welfare's analysis about mining. The application of a discrete choice experiment was performed to evaluate welfare changes in the context of a mineral-rich Canadian province of Quebec. More precisely, changes in welfare were measured to balance deteriorations in mining conditions. Our primary focus served to detect potential differences of welfare changes caused by the distance to the mine. This welfare's analysis associated the long-distance effects of mining with the matter of mineral heterogeneity. Adopting a split-sample strategy, the survey considered and related the distances between the mining areas and the respondents' residence with a crossed-resource study about gold, uranium and rare earths.

Our research work joined a vast stated preference (SP) literature that addressed the distance-decay effects at the core of welfare changes (Glenk, Johnston, Meyerhoff and Sagebiel, 2019). For a large class of environmental goods and services, population welfare is expected falling with the distance from one vital resource, which means that local populations are much more likely to care about protection policies on water quality, endangered species, or cold-water coral (Hanley et al., 2003; Pate and Loomis, 1997; Sutherland and Walsh, 1985). This finding balanced with another set of studies failing to show the presence of distance-decay effects (Bulte et al., 2005; Johnston, Holland and Yao, 2016; Lizin et al., 2016; Payne et al., 2000) which further suggests that even distant populations can feel highly concerned. Mixed findings of the literature were partly attributed to the resource focus of the study (Hanley, Schläpfer and Spurgeon 2003) such as local public good, the extension of policy or project changes over longer distances (Rolfe and Windle, 2012) and the type of welfare measures (Bateman et al., 2006).

Mining development continues to play a significant role in changing places of living and in particular the way of managing environmental goods and services. There is a limited comprehensive framework on what happens or does not happen for changes in population welfare over long distances. By setting the current debate of the distance-decay effect in an almost new context of mining, this paper contributes to provide new pieces of evidence on the existing links between distances to the mine and population welfare.

To the best of our knowledge, only two notable studies identified potential welfare changes in distant areas. Windle and Rolfe (2012) elicited estimates of welfare changes for a distant coal mining project in the political capital of Southern Queensland, Brisbane (Australia). Their findings reported important welfare gains for stricter environmental monitoring and benefits of job creation. Gillespie and Kragt (2012) found similar welfare patterns between local residents and distant residents living in the Southern Coalfield region of Australia. While the two studies went beyond the local context, authors did not explicitly measure the effects attributed to the distance to the mine, nor did it cover the substantial effects of mineral heterogeneity in a welfare's analysis.

Spatial heterogeneity is a matter of central importance for most resource projects coupled with large emissions of pollution and a variety of economic externalities. Many stated preference studies revealed more significant welfare changes with respect to shorter distances from nuclear central plants (Contu, Strazzera and Mourato, 2016), wind turbines (Krueger, Parsons and Firestone, 2011) and landfills (León, Araña, de León and González, 2016). The inclusion of spatial dimensions in a welfare's analysis helps aggregate and extrapolate welfare estimates of the population in a more consistent and accurate way (Bateman et al., 2006; Morrisson, 2000; Pate and Loomis, 1997).

If welfare's analysis continued to be spatially blind in the mining context, the adverse result could lead in the worst case to biased estimates of population welfare. A research focus on narrow mining areas may inevitably swap the welfare variations over longer distances if present, which fails in the meantime to mirror the importance of resource heterogeneity. Our study contrasted and compared the distance effects between different minerals, given the Quebec context of a mineral-rich economy. Our split sample strategy magnifies the importance of spatial matters in a mining context by considering varying distance treatments from the fixed location of mineral deposits. We highlighted how people's welfare responded to variable conditions of mining in the fields of extractive technology, environmental monitoring, information campaign, partnership structure, job creation and tax rebate compensations. The focus on three different minerals serves to disentangle how people perceive mineral-specific risks and could reconsider the long-distance effects of mining in different ways. The survey consequently measured how risk perceptions on water quality can influence the project support of the population. The welfare's changes of the population are elicited by the means of the usual conditional logit (CL) model and in assumed presence of unobserved preference heterogeneity, the random parameter logit (RPL) model.

This paper is composed of six sections. Section 1.2 presents the study area and section 1.3 describes the survey design of the discrete choice experiment. Section 1.4 justifies our empirical strategy to account for the distance-decay effect in a context of mining. Section 1.5 analyses the results about the effects of the distance-to-the mine and provides a welfare comparison between minerals. Finally, section 1.6 discusses our main findings and section 1.7 concludes the methodology implications.

1.2. A Quebec context

As a geographical part of one greatest world resource reserve, (Bondu, Cloutier and Rosa, 2018), the Canadian province of Quebec presents high mineral potential within the Canadian Shield. It follows that mining operations almost cover 4.4% of the total province area and the mining development counted 21 major active mines and about 224 inactive mines (MERN, 2016). Among 30 minerals recently identified, 42% of the Quebec production exclusively served the mining industry of gold.

The significance of mining impacts and economic benefits can widely vary across and within the 17 administrative regions of the Quebec province. Mining operations are geographically scattered in five resource regions including Bas-Saint-Laurent, Abitibi-Témiscamingue, Côte-Nord, Nord du Québec and Gaspésie-Îles-de-la-Madeleine. These regions alone contributed to the Quebec economy by 14.3% of the GDP in 2016, more than 40 000 direct jobs and billions of investments in energy and transportation sectors (MERN, 2016).

The economy of Quebec can certainly benefit from mining development and expansion. In the meantime, the discovery of new mineral deposits become closer to places of living following the major trend of growing urbanization within the province. The parallel dynamics of urbanization and mining development pose a complex and serious challenge for public authorities since mining operations can contribute to the provincial economy with a range of benefits but shall align with population welfare especially for local communities affected.

By the past, mining development was globally well accepted across the province of Quebec. Only a minority of mining projects galvanized a flow of public protests. As for example in 2013, the discovery of 8 800 tons of uranium and the promising interests of uranium mining led to feeding widespread contests at the provincial level. The proposed mining project was finally stopped in 2015 for major reasons of technology uncertainties in mining. This episode followed a vast campaign of public audience to better understand what the key drivers of project acceptance were. Lacking evidence on welfare effects partly motivated the rationale of our discrete choice experiment study in the mining context of Quebec.

1.3. Survey description and data

This section proposes the choice of a stated preference approach to evaluate welfare changes occurring with mining development. The primary focus is on explaining the design of the discrete choice experiment (DCE) study which is mostly relevant to capture spatial matters within a mining context.

1.3.1. Study area

The study area of our choice experiment study is in the Quebec province of Canada. In August 2017, an on-line survey sampled a geographically balanced coverage of 3 004 respondents among the Quebec population. A Canadian professional survey company administered the survey, and we limited our sampling frame to respondents which were 18-year or older. Figure 1.1 illustrates the geographical distribution of the sampled respondents in the study area, and this distribution mainly follows the more densely areas. In the North of Quebec, a smaller share of the Quebec population includes First nations communities and other communities with distinct welfare patterns. For budget and time matters, the sampling survey was limited to the rest of the population.

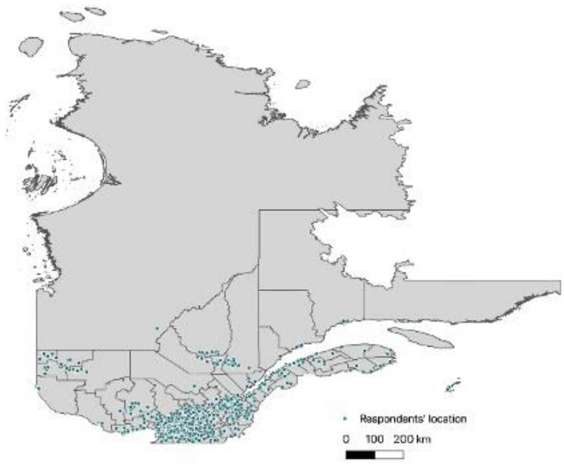

Figure 1.1 Sampled population in Quebec

Source: Respondent's location from the choice experiment study.
Adrien Corneille (2021)

1.3.2. Design of mining scenarios

As common in discrete choice experiment study, our web-based survey proposed to respondents a series of hypothetical new mining projects declined in a range of key project attributes such as listed in table 1.1. Project attributes had been priorly identified by the means of an extensive qualitative study with 63 experts whose job directly related to activities in mining sectors. Experts were representants, geographers, economists, lawyers, mining engineers, committed citizens that can be grouped into ministries (37%), mining companies (20%) and environmental NGOs (44%). The qualitative study took place in different cities of the Quebec province as shown by figure 1.2 and was in the form of a semi-directive questionnaire composed mostly with open-ended questions. Our qualitative study permitted to identify key project factors that might influence population welfare, and these results were linked in a second step to a literature dealing with the impacts of mining.

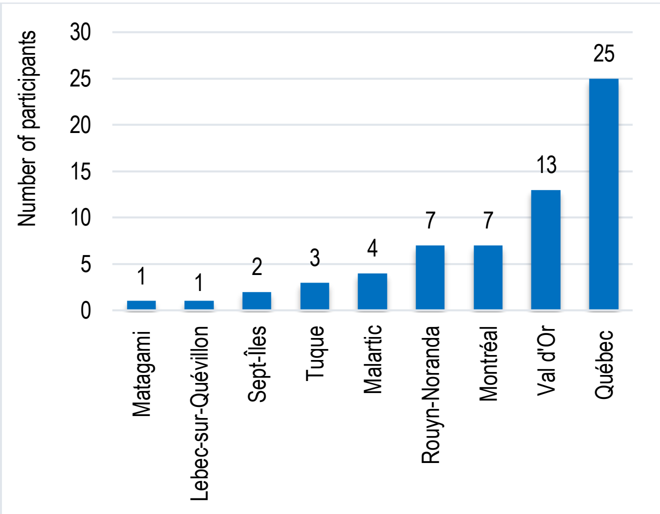

Figure 1.2 Experts' location by city during the qualitative study

Source: Information collected from a qualitative survey among selected experts in the mining industry.
Adrien Corneille (2021)

Table 1.1 presents the selected list of project attributes for the design of hypothetical mining projects, from which we expect that the proposed project changes may potentially affect population welfare. The first project attribute reports the mine status which captures the types of extraction techniques. Literatures have shown that extraction techniques (underground versus open-pit) matter for the varying effects of mining on the environment and landscape (Cameron and Stanley, 2017; Pelzl and Poelhekke, 2018; OECD, 2019). The technique of open-pit mining is among the most visible impacts. The valuation scenario considered a deterioration through open-pit mining posing the underground mine as the best case. A short description and pictures were additionally given in the survey to make the landscape changes clearer in the mind of the respondents.

Table 1.1
Presentation of project attributes and levels

Attributes	**Levels**
1. Mine status	Underground mine *Openpit mine*
2. Monitoring scheme of water quality	Independent committee *Government* *Mining company*
3. Communication plan	Co-construction with community *Mediation in information session* *Newspaper advertisement*
4. Structure of partnership	Private sector & regional partners *Private sector & Government* *Private sector*
5. Job creation	200 jobs 500 jobs 800 jobs
6. Profit distribution as a tax rebate	\$100, \$200, \$300, \$400, \$500, \$600 each year for 10 years

Note: Attribute levels in italics corresponds to a degradation from a high to a lower attribute level, for instance a move from underground to openpit mining. Attribute 6 is the monetary attribute.
Adrien Corneille (2021)

Our qualitative study reveals that Quebec population in general shared a common and sensitive concern about the changes exerted by mining activities on water quality. A similar pattern was also reported in the related studies such as Ossa-Moreno et al. (2018), Chuhan-Pole, Dabalen and Land (2017) and Windle and Rolfe (2013). We believe that in the Quebec context, residents are likely to be concerned by the environmental monitoring of mining project, and in particular the agency type in charge of the monitoring. The degree of independency can be central for delivering credible and independent information (Brown et al., 2017; Morgan, Martin and Huth, 2009) following the monitoring of water quality. Our valuation scenario consequently proposed three agents whose independency varies from the higher (totally independent committee) to the lower levels (joint committee and firms).

The literature also confirmed that better planification of a mining project shall encourage more public participation and local partnership structure. This can to a certain extent assure a more efficient environmental monitoring system. Public acceptance is therefore expected to be larger when affected population is actively involved within the organization and the decision-making of the project (Ek and Persson, 2014). This also increases the engagements from local partners in the development of the project (Moffat and Zhang, 2014). We include this key project dimension as an environment and social-related attribute in our design.

Last, but not least, the creation of job market opportunities can significantly increase the economic benefits within a region (Gillespie and Kragt, 2012; Windle and Rolfe, 2013). This is especially true for populations living in remote and economically vulnerable areas. Relevant to the mining context of Quebec, we adapted the level of job creation in line with stakeholders' opinions from the qualitative study. To compensate the potential negative impacts on welfare, each mining scenarios proposed an annual tax rebate, whose amount is \$100, \$200, \$300, \$400, \$500 or \$600 per year. As our survey was conducted only one month before the Quebec political election, we believe promising a tax cut policy can be a highly credible measure from respondents' perception.

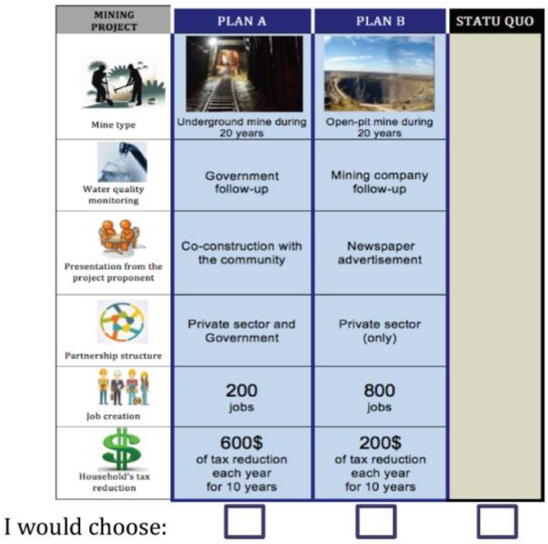

Figure 1.3 Example of a choice card

Source: This choice card (translated from French to English) is taken from the survey as given to respondents and was presented as a mining tradeoff.
Adrien Corneille (2021)

Based on these project attributes and their corresponding levels, we built a factorial fractional experimental design using the SAS software. The full factorial from all 972 possible choice situations were effectively reduced to a partial factorial of 36 choice situations with a D-efficiency score of 94.7%. Figure 1.3 illustrates an example of one of our 6 choice cards which were randomly distributed in six versions (blocks). Each respondent had one version of 6 choice sets to answer which proposed a trade-off of two mining project options and a status quo, i.e., no mining project opt-out.

1.3.3. Inclusion of spatial matters

A central methodological issue for our research question is how to implement long-distance effects of the mine into a discrete choice experiment study. Although a distance-related attribute was employed before in a number of studies about energy projects (Contu, Strazzera and Mourato, 2016; Krueger, Parsons and Firestone, 2011; León et al., 2016), this approach is not adapted to a situation of a mining project. Because of inflexible location of the mineral deposits, participants in the pre-test survey felt highly irrelevant and inconsistent a proposed project that may vary with the distance. To combine the distance matters within the framework of a discrete choice experiment study, we opted to vary the survey version of the geographical contexts across respondents.

More specifically, the survey strategy proposed a split-sample approach in areas where mining impacts are likely to produce the most significant impacts. A large body of research helped identify that major mining impacts mainly occur within a radius of 20 kilometers of the mine (Aragón and Rud, 2015; Dell, 2010) overlapping with reduced effects of mining up to 100 kilometers. This follows our split-sample strategy that divided variable geographical contexts given by a) the immediate area of mining between 0 and 20 kilometers from the mine, b) the neighboring area located at a distance from 20 to 100 kilometer of the mine, and c) non-mining areas beyond the cutoff of 100 kilometers. Each respondent randomly received one of the three area treatments at the beginning of the mining context presentation and before answering the series of hypothetical mining tradeoffs.

Importantly, the distance treatment over 0-20 kilometers from the mine was subject to important cautious for people living in big cities. Participants in the pre-test survey remarked that a mine’s opening is highly unlikely to happen within a big city. The split-sample strategy considered this issue by excluding respondents living in the largest cities (up to 500 000 people) from a local context of mining. During the survey process, a pre-screening question randomly assigned to them distance treatments about 20-100 kilometers or up to 100 kilometers.

Related with the geographical context, mineral heterogeneity can lead mining impacts to affect people in different ways. Minerals are heterogeneous in terms of quality, and there are implications for the mining impacts across space. A low-quality grade of one mineral can become economically profitable under the mine status of open-pit mining. This extraction mode likely causes large widespread impacts for miles around. In contrast, the high-quality grade of the mineral often requires digging deeper by underground mining with less visible impacts. This distinction is included in our valuation scenario by the project attribute of mine status as listed in table 1.1.

Minerals also differ in their resource-specific impacts on the environment. Separating the mineral of interest from the rock can require specific chemical inputs among cyanide/arsenic for gold or release radioactive elements in the air and water in the case of rare earths and uranium (Winde, 2006). In addition to randomize the distance areas, we considered a crossed-resource comparison between gold, uranium and rare earths. Each geographical context of the study was randomly associated with one of the three minerals. In a manner that, all respondents faced a mining context of one mineral given a specific distance between their home and the proposed mining site. A brief description was provided to respondents about the resource in question. To resume, the total number of context versions was nine composed in 3 distances to the mine and 3 minerals.

It is plausibly expected that lay people will perceive differently the extraction of gold compared with uranium and rare earths. We conducted a crossed-resource comparison between gold, uranium and rare earth to investigate the perceived impacts from one resource to another. Again, we randomly attributed the three minerals across respondents and there were 9 versions[8] of valuation contexts

[8] The total number of questionnaire versions is 54 such as 3 (distance)*3 (mineral)*6(versions of choice sets block).

presented including three studied resources and three distances-to-the mines. A brief explanation on specific resource characteristics was given to respondents at the beginning introduction paragraphs.

1.3.4. Survey structure and timing

The survey was structured in four main parts that include a) a short quiz test on knowledge, b) a series of six proposed mining projects, c) following-up questions including the risk perceptions, and finally d) the collect of socio-demographic information. In section 1, respondents faced 8 multiple choice-questions to evaluate how respondents were familiar with mining. Appendix 1.A presents the contents of the quiz test. Section 2 consisted of presenting the context of mining for valuation, the reception of resource-specific information, the series of mining trade-offs to be answered.

Section 3 also presented some key following-up questions. One follow-up question evaluated the perceived mining risks associated to water contamination[9]. The exact statement of the follow-up question was formulated as: “What is the percentage of chance that the mine’s opening would contaminate water quality close to your home?”. Given the mining context for valuation, respondents picked a probability value of water contamination risks from 0% to 100%. Higher probability values indicate that respondents anticipated higher mining risks of water contamination. Lastly, section 4 collected key information about respondents such as their age, tertiary education (i.e., with a university degree), income and other relevant respondents’ characteristics.

[9] Regarding the multi-dimensional impacts of mining, it appeared complex to classify gold, uranium and rare earths by dangerousness levels. We chose instead a special focus on the water quality issue and asked respondents’ perceptions about the risks of water contamination.

Table 1.2 underlines the sociodemographic composition of the sampled population to ensure the comparability between the different minerals. Excepting the categorial variables of income and age, all variables considered are dummy coded. Specific to each mineral studied, individual knowledge is a dummy variable coded one if the respondent performed a higher score above the average of the sampled population and zero otherwise.

Risk perceptions about water contamination are expressed in terms of subjective probability (see for instance Delavande, 2008) such that water provision at home could be contaminated by mining.

Table 1.2
Sociodemographic characteristics of respondents

				p-value	
	(1) Gold	(2) Uranium	(3) Rare earths	(1)-(2)	(1)-(3)
Characteristics					
Female (%)	47.3	47.0	48.8	0.871	0.510
Age	53.4	53.1	53.1	0.733	0.714
Educated (%)	38.1	35.1	35.5	0.149	0.224
Income	$CA 66 344	$CA 63 092	$CA 64 834	0.059	0.386
Mining area					
0-20km (%)	18.7	19.2	19.2	0.799	0.666
20-100 km (%)	21.5	18.9	21.3	0.141	0.314
+100km (%)	59.8	61.9	59.5	0.703	0.906
Quiz test					
Knowledge (%)	46.3	46.6	42.9	0.876	0.133
Perceived risks					
Water (%)	34.5	36.9	33.8	**0.048**	0.557
Sample size	1 017	1 046	941		

Source: Authors' calculations based on the survey information collected in August 2017.
Note: Distance treatments bands were randomly attributed across respondents and presented during the valuation context. The variable knowledge is the respondent's proportion who scored above the sample average on a knowledge quiz test provided by the survey. The variable Water quality is about the respondent's perception of water contamination in terms of subjective probability that the water quality could be contaminated. The two last columns of this table reports p-values of the t-test differences between gold (1) and the two other minerals (2) or (3).
Adrien Corneille (2021)

Regarding the respondents' profile, we observe quasi-equal proportions of females, an average age of 53 year's old and more than 35%-38% of them having at least a high degree diploma. We also provided the sample composition by related-context areas, level of knowledge and the degree of risk perceptions about water contamination. About 18%-20% of respondents faced a context of living near 20-100 kilometers from the proposed mine and many of them lived beyond 100 kilometers. The high number of distant residents are partly due to the treatment exclusion of respondents living in big cities to short distance from the mine (0-20 kilometers). Almost one half of respondents shared a good knowledge about mining practices. Participants considered that mining had at least more than 30% of chance to contaminate water quality at home as uranium was perceived as the greatest risks on water quality.

The last two columns of table 1.2 present the results of the t-test differences suggest no significant differences as reported by p-values almost all above 0.1. The null hypothesis of equal risks perceptions is only rejected between gold and uranium at the 5 percent level. The result indicated that mining risks can be perceived differently between minerals and this first insight can be of primary importance for the study of the distance-decay effect.

1.4. Empirical strategy

1.4.1. Random utility model

If people's welfare is affected by a range of mining practices, it can be presented in the form of a utility function. Given a mineral of interest, the Lancaster's consumer theory (1966) permits to associate the changes in mining conditions with a variation in the indirect utility function of the individual. Given the variety of alternative mining practices, the random utility theory (McFadden, 1974) implies that the individual i has an indirect utility for alternative j in choice set t. His or her utility function can be written as $U_{ijt} = V_{ijt} + \varepsilon_{ijt}$ where the former term is the deterministic part of the utility (V_{ijt}) and the latter term is the random part of the utility (ε_{ijt}) that corresponds to any characteristics of the project unobserved to the econometrician. The deterministic part of the utility is a linear combination of project attributes x_{ijt} plus an alternative specific constant ASC. The term ASC is added to capture the preference for a Statu quo situation while in the meantime, it avoids that individuals felt forced choices of a mining project (Zhang and Adamovich, 2011).

We used two estimation models to measure variations in population welfare, namely the Conditional logit (CL) and the Random parameter logit (RPL) models. For simplification, the CL model posits the Independent and irrelevant alternatives (IIA) assumption. In this way, individuals treat independently choice options and make uncorrelated choices. The error term follows an extreme value distribution of type I given by $\varepsilon_{ijt} \sim i.i.d.\left(0,\frac{\pi^2}{6}\right)$. The CL model serves as a first benchmark baseline in our welfare analysis but can suffer from model limitations linked to a) the strong IIA assumption and b) the absence of population heterogeneity.

The RPL model surmounts the two limitations implementing unobserved heterogeneity across all respondents by a random distribution in welfare estimates (Train, 2009). In this model, the vector of welfare parameters is specified as $\beta_i' = (b + \eta_i)'$, where b reflects the mean value of a welfare-related attribute and η_i gives the standard deviation from the mean value to control the presence of unobserved heterogeneity.

Over a sequence of T choice sets (in our case, $T = 6$ choice sets), the utility function is then given by:

$$U_{ijt} = \beta_i' X_{ijt} + \varepsilon_{ijt} \quad [1.1]$$

Estimation models approximate welfare changes following a maximum likelihood procedure. Over a subset of choice sets, an individual has a likelihood of choosing a project option by $P_{ijt} = \frac{exp\ (\beta_i X_{ijt})}{\sum_{j=1}^{k} exp\ (\beta_i X_{ijt})}$.

The joint probability over a sequence of T choice sets is given by the general likelihood of choosing an option (or conditional choice probability) expressed by:

$$P_{ij} = \int \frac{exp\ (\beta_i X_{ij})}{\sum_{j=1}^{k} exp\ (\beta_i X_{ij})} f(\beta) d\beta \qquad [1.2]$$

As true welfare parameters are unknown in the model form, we cannot directly compute the unconditional probability. A maximum likelihood procedure enables approximate possible values through a process of repetitive simulations (Train, 2009).

1.4.2. Individual's utility as a function of distance

As we suspect that the geographical context of mining matters, the welfare's analysis proposed a focus on the effects of the distance to the mine. Equation 1.3 formally expresses how individual's utility can be related to the distance.

$$U_{ijt} = \alpha' V_{ijt} + \gamma' V_{ijt} \cdot neighbored\_area + \delta' V_{ijt} \cdot nonmining\_area + e_{ijt} \qquad [1.3]$$

As highlighted in sub-section 1.3.2, the combination of project attributes comprises a range of degradations in mining conditions and economic benefits in proximity to the mining project. Degraded conditions of mining move from the best mining practice to the worst one and correspond to the mine status, environmental monitoring, communication campaign, structure of partnership. The coding scheme follows linear coding (Daly, Dekker and Hess, 2016) such that α' is the effect-coded parameter and the terms of mining degradations are coded 0 for the best mining practice and 1 for a degradation in the practice. Benefits of the mine are captured by job creation and the compensation measure of tax compensation in the form of categorial variables. In addition, the term ASC is equal to one if the individual chose the SQ situation and (-1) otherwise.

Interaction terms of the area control for changes in the utility associated with longer distances to the mine and different combinations of project attributes. The variable $neighbored\_area$ is coded one if the proposed project was mentioned in the study context at a distance between 20-100 kilometers and zero otherwise. The variable $nonmining\_area$ is noted one for distant areas where individuals live to a distance superior to 100 kilometers and zero otherwise. For each estimation model, the reference group is the local population as the proposed project mentioned distance lower than 20 kilometers. The vector of welfare parameters β indicates the local welfare changes, while parameters γ and δ identify variations in welfare as experienced by more distant people. Welfare estimates provided by the CL and RPL estimation models cannot be interpreted in absolute value, and we focus on the direction of the distance effects (positive/negative).

For extending the conclusion of the results, we further considered how population heterogeneity can influence the support of the mining project. To this end, we applied three-way interactions between the lack of support captured by the Statu quo effects (ASC), the distance-to-mine and relevant individuals' characteristics. Variables selected that could affect the support of the population are the income, the level of knowledge measured by the quiz test and risk perceptions about possible water contamination.

1.5. Results

This section presents the main results derived from the CL model and RPL models. In addition, an augmented version of the RPL models helps explain how the support of people with different characteristics responded to the distance to the mine.

Across all regressions, we compared welfare both within and between gold, uranium and rare earths. Table 1.3 provides the results raised by the CL model, where the estimates of welfare changes were reported following the deteriorations in mining conditions. For welfare changes, the base level is a best case of a mining project that includes an underground mine, an independent committee-led monitoring, a large implication of the population, the presence of regional partners. For each mineral, column 1 presents the main welfare effects on people living in the immediate mining area (0-20 kilometers). Columns 2 and 3 show the interactions effects on individuals living in the neighboring areas (20-100 kilometers) and in distant areas (more than 100 kilometers).

The result firstly shows that people's utility is negatively related to the deteriorations in mining conditions compared to the best case. For each mineral, negative signs of welfare parameters indicate in column 1 that local population anticipated a decreased utility through more visible impacts left by an openpit mine, less independent environmental monitoring, lower population involvement, funding supports led by public or private partners. Local population preferred the environmental monitoring led by the government only in the case of gold mining. In contrast with uranium and rare earths mining, there are no significant differences in welfare changes between an independent committee and the government.

Despite of the degraded conditions of mining, the project is also associated with a range of positive outcomes such as job creation and tax rebate compensations. As expected, both job creation and compensation measures of tax rebate positively motivate the local support of population living within 0-20 kilometers from the mine. The first row of table 1.3 presents the variable ASC which captures a preferred statu quo situation in the absence of the mining project.

Table 1.3
Conditional logit (CL) model and distance effects

	1) Gold			**2) Uranium**			**3) Rare earths**		
	0-20km	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**
ASC	-1.54***	-1.047*	-0.784	-2.043***	-0.0042	0.341	-2.579***	0.986*	0.224
	(0.466)	(0.562)	(0.555)	(0.456)	(0.551)	(0.555)	(0.474)	(0.570)	(0.579)
Openpit mine	-0.525***	0.0547	0.245**	-0.52***	-0.0403	-0.0078	-0.405***	0.0861	-0.059
	(0.0809)	(0.098)	(0.096)	(0.0801)	(0.096)	(0.097)	(0.0808)	(0.098)	(0.099)
Government monitoring	0.182*	-0.24**	-0.183	0.024	-0.052	0.0009	-0.0968	0.23*	0.15
	(0.097)	(0.117)	(0.116)	(0.0943)	(0.114)	(0.114)	(0.098)	(0.119)	(0.12)
Firm monitoring	-0.434***	-0.193	-0.242*	-0.656***	0.0682	-0.0025	-0.654***	0.184	0.0052
	(0.103)	(0.125)	(0.124)	(0.103)	(0.124)	(0.125)	(0.106)	(0.128)	(0.129)
Mediation	-0.094	-0.064	0.021	-0.083	0.0071	0.0164	-0.251**	0.0785	0.148
	(0.101)	(0.122)	(0.121)	(0.0996)	(0.120)	(0.121)	(0.103)	(0.124)	(0.125)
Newspaper advertisement	-0.276**	0.0118	0.0767	-0.260**	0.0404	0.0728	-0.315***	-0.00827	0.0160
	(0.108)	(0.131)	(0.129)	(0.107)	(0.129)	(0.129)	(0.109)	(0.132)	(0.134)
Public partners	0.0447	-0.144	-0.0980	-0.0123	0.0570	0.0806	0.0469	-0.0678	-0.0367
	(0.0970)	(0.118)	(0.116)	(0.0949)	(0.115)	(0.116)	(0.0985)	(0.119)	(0.120)
Private partners	-0.243**	-0.135	-0.0846	-0.28***	0.0376	0.134	-0.349***	0.103	-0.00293
	(0.0974)	(0.117)	(0.116)	(0.0962)	(0.116)	(0.116)	(0.0980)	(0.119)	(0.121)
Job creation	0.0012***	-0.00014	-0.0003	0.0009***	-0.00019	-0.0001	0.0007***	0.00035*	0.000132
	(0.00017)	(0.0002)	(0.0002)	(0.00016)	(0.0002)	(0.0002)	(0.00017)	(0.0002)	(0.0002)
Tax rebate	0.00059**	0.00048	0.0767	0.0007***	0.000092	0.00046	0.001***	-0.00018	-0.0003
	(0.00024)	(0.000295)	(0.129)	(0.00023)	(0.00028)	(0.00029)	(0.00024)	(0.00029)	(0.0003)
Preference heterogeneity	NO			NO			NO		
# of observations	18 306			18 828			16 938		
# of respondents	1 017			1 046			941		
Log-Likelihood	-5 155.9			-5 113.6			-4 720.5		

Source: Results are based on equation 1.3.
Note: * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. Standard errors are in parenthesis. For regressions, the baseline is the mining area 0-20 kilometers, other columns are interaction effects. ASC (Alternative specific constant) captures the Statu quo effects. Preferences are measured following a degradation in mining condition. The project baseline is an underground mine, with independent committee, regional partners, and co-constructed with the population. Adrien Corneille (2021)

Across all minerals, the variable ASC was highly significant, and the interpretation of negative signs of this term means that the support of the local population is high for the best case of a mining project compared with the statu quo situation.

The first piece of CL model's results aligns with literature findings clustered in the narrow local context of mining (Garrod and Willis, 2000; Gillespie and Kragt, 2012; Ivanova and Rolfe, 2011; Marella and Raga, 2014; Mendes et al., 2013; Pemberton et al., 2010; Windle and Rolfe, 2013). It shows that the support of local population depends upon the most effective ways to enhance the management of mining projects in addition to the economic benefits of the mine's opening.

Following the hypothesis of the distance-decay effect, welfare losses caused by degraded mining conditions are predicted to decline over longer distances. Interaction effects in columns 2 and 3 capture the effects of the distance-to-mine in utility determination. We found that beyond 20 kilometers, there are mitigated effects of mining on population welfare. For example, open-pit mining for gold is perceived as less detrimental by people living in the most distant areas due perhaps to less visible impacts on the landscape. This supports the potential presence of distance-decay effects when we noted negative signs for $Underground\ mining$ in areas beyond 100 kilometers from the gold's mine. Besides, we detected additional welfare losses associated with a government-led monitoring in neighboring areas from 20-100 kilometers and a firm-led monitoring in distant areas up to 100 kilometers. It suggests that even the rest of the population can strongly feel concerned for the environmental monitoring of distant mining projects. Consequently, the presence of the distance-decay effect appears to vary from one project attribute to another one.

Compared to the spatial pattern of gold, both uranium and rare earths show very contrasted welfare effects over longer distances. For all degraded conditions of uranium mining, no significant population welfare changes were found beyond 20 kilometers. We detected for rare earths mining that people living at a distance between 20-100 kilometers are likely to prefer a project monitored by the government. They also appreciated a supplementary welfare gain from the benefits of job creation, as can be shown by the positive and significant coefficient of $Job\ creation$. Consistent with the potential presence of the distance-decay effect, individuals living in neighboring areas of a rare earths mine experienced decreased welfare gains from the best proposed mining project. The interaction effect between ASC and the distance to the rare earth mine is highly significant and positive from 20-100 kilometers, which means there is far less support of people living in neighboring areas for the best improved mining conditions.

While no other significant effects appeared across the minerals, the presence of long-distance effects is detected in the contexts of gold and rare earths mining but appears to change with the project improvement into consideration and the mineral of interest. The spatial welfare pattern as highlighted by the CL model can be clarified by using the RPL model that relaxes the assumption of homogeneous preference across individuals.

Table 1.4 presents the results of the RPL model, where the column "S.D." reports the standard deviations of selected coefficients to allow random parameters. All parameters were estimated assuming a random normal distribution, except for the tax rebate as common in the stated preference literature. A common ground between the CL and RPL models reports that most degradations in mining condition negatively affect the local welfare from 0-20 kilometers.

Table 1.4
Random parameters logit (RPL) model and distance effects

	Gold			Uranium			Rare earths		
	0-20km	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**
ASC	-3.711***	-1.169	-1.189	-5.04***	-0.196	0.497	-5.517***	1.422*	0.296
	(0.641)	(0.775)	(0.767)	(0.68)	(0.823)	(0.826)	(0.705)	(0.833)	(0.842)
Openpit mine	-0.799***	0.0349	0.276*	-0.92***	-0.129	-0.0412	-0.852***	0.211	0.0396
	(0.122)	(0.147)	(0.145)	(0.15)	(0.184)	(0.183)	(0.145)	(0.172)	(0.174)
Government monitoring	0.222*	-0.350**	-0.220	-0.08	-0.0471	-0.009	-0.204	0.377**	0.191
	(0.131)	(0.159)	(0.157)	(0.14)	(0.170)	(0.17)	(0.141)	(0.169)	(0.170)
Firm monitoring	-0.700***	-0.211	-0.295*	-1.08***	0.120	0.0437	-1.086***	0.316*	0.0576
	(0.140)	(0.167)	(0.165)	(0.146)	(0.174)	(0.174)	(0.153)	(0.179)	(0.179)
Mediation	-0.123	-0.095	0.0386	-0.077	-0.075	-0.008	-0.371***	0.158	0.247
	(0.13)	(0.159)	(0.157)	(0.137)	(0.166)	(0.166)	(0.137)	(0.166)	(0.167)
Newspaper advertisement	-0.4***	0.00219	0.0634	-0.46***	0.0105	0.147	-0.526***	-0.0357	0.00439
	(0.142)	(0.171)	(0.169)	(0.15)	(0.184)	(0.184)	(0.151)	(0.183)	(0.185)
Public partners	0.0790	-0.198	-0.161	-0.016	0.0307	0.0989	0.0762	-0.103	-0.0590
	(0.123)	(0.149)	(0.147)	(0.13)	(0.161)	(0.161)	(0.137)	(0.165)	(0.167)
Private partners	-0.354***	-0.203	-0.138	-0.43***	0.00014	0.152	-0.593***	0.197	0.0298
	(0.131)	(0.158)	(0.157)	(0.13)	(0.163)	(0.162)	(0.138)	(0.166)	(0.168)
Job creation	0.0015***	-0.00023	-0.000395	0.0012***	-0.0001	-0.00005	0.001***	0.000537*	0.0002
	(0.0002)	(0.0003)	(0.0003)	(0.00025)	(0.0003)	(0.0003)	(0.00025)	(0.0003)	(0.0003)
Tax rebate	0.000813**	0.000725*	-0.000046	0.0013***	0.000122	0.000601	0.00148***	-0.000214	-0.00025
	(0.0003)	(0.00038)	(0.00038)	(0.00034)	(0.0004)	(0.0004)	(0.0003)	(0.0004)	(0.00041)
Preference heterogeneity	YES			YES			YES		
# observations	18 306			18 828			16 938		
# respondents	1 017			1 046			941		
Log-Likelihood	-5 155.9			-5 113.6			-4 720.5		

Source: Results are based on equation 1.3.
Note: * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. S.D. give standard deviations for mean preference parameters supposed as random. Standard errors are in parenthesis. ASC (Alternative specific constant) captures the Statu quo effects. Preferences are measured following a degradation in mining condition. The project baseline is an underground mine, with independent committee, regional partners, and co-constructed with the population.

Compared with the CL model, the RPL model increases the goodness of fit regards to higher values of Log-Likelihood at convergence, higher McFadden Pseudo R^2 and lower value of AIC in all minerals. In much support of better performance, standard deviations of welfare-related parameters were found significant for almost all variable conditions of mining. Besides to the spatial matters, the result indicates the presence of unobserved heterogeneity for which the CL model did not control. One important caveat in the welfare's analysis is to ensure about the consistency of the distance effects between CL and RPL models. We found that while the estimated standard deviations of ASC show that local population living in the area 0-20 kilometers differently experience the disutility from a mine's opening, the ASC mean values changed in the RPL model to be insignificant for gold mining. Population living in neighboring areas of a rare earths' mine continued to be less concerned by significant improvements in mining conditions.

Another major difference appears under the RPL model. Some interactions terms with the distance-to-the mine appear to be significant in presence of controlled unobserved heterogeneity of the population. The support of population living in the 20-100km areas becomes greater for a gold's mine with a large share of tax rebate redistribution, as can be shown by interaction terms between a distance-to-the mine of 20-100 kilometers and the welfare parameter of tax rebate. Adding to that, the long-distance welfare effects of environmental monitoring for a rare earths' mine are decreasing both for a firm's and government's leadership. Otherwise, the welfare effects are globally stable between the CL and RPL models. We found no distance effects observed in the case of uranium mining and similar results in distance effects for gold and rare earths mining.

Again, the results in RPL model suggest the presence of mixed distance decay-effects both within and between minerals. Degradations in mining conditions can imply lower welfare losses from the perspective of distant population, as suggestive evidence of distance-decay effects. We found such effect relevant only for the environmental monitoring of rare earths. In strong contrast, we detected larger welfare losses for gold mining at a distance between 20-100 kilometers associated with degradations in independent monitoring. This pattern can be inconsistent with the distance-decay effect and may appeal to reconsider the focus of a welfare's analysis at the local level.

As the RPL model highlighted unobserved welfare heterogeneity, we extended the results on spatial matters by further investigations on the composition of the population. The support of people with different sociodemographic characteristics and perceptions can react in different ways about the mine's opening. For each mineral, we considered three-way interactions between the variable ASC (capturing the preferred Statu quo option), the distance-to-the mine and relevant individual's characteristics.

Table 1.5 presents the results of the three-way interactions in the RPL model, where we distinguished individuals' support by income, knowledge about mining and risk perceptions on water contamination at home. For each mineral studied, we globally found similar results about the welfare changes following the changing conditions of mining and the increasing distance to the mine. Unlike RPL model results from table 1.4, we found that after controlling for main individuals' characteristics about the SQ effects, terms ASC became insignificant over long distances for gold and REEs mining. It suggests that these individual characteristics can explain a large part of the variation in people's support. Interestingly, SQ effects about uranium mining appeared significant and positive beyond 20 kilometers and can indicate lack of public supports for a mining project over longer distance.

Table 1.5
Augmented Random parameters logit (RPL) model

	Gold			**Uranium**			**Rare earths**		
	0-20km	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**	**0-20km**	**20-100km**	**+100km**
ASC	4.168	-3.787	-2.678	-4.538	9.297**	10.65**	-0.442	0.787	-0.645
	(4.407)	(5.209)	(4.961)	(3.337)	(4.138)	(4.211)	(3.599)	(4.595)	(5.211)
Openpit mine	-0.805***	0.0586	0.263*	-0.963***	-0.139	0.0824	-0.802***	0.118	-0.0410
	(0.130)	(0.156)	(0.154)	(0.145)	(0.173)	(0.175)	(0.141)	(0.170)	(0.172)
Government monitoring	0.194	-0.332**	-0.211	-0.0345	-0.0637	0.00104	-0.205	0.356**	0.229
	(0.138)	(0.166)	(0.163)	(0.130)	(0.157)	(0.158)	(0.146)	(0.174)	(0.176)
Firm monitoring	-0.745***	-0.184	-0.273	-1.048***	0.103	0.0413	-1.037***	0.284	0.0600
	(0.145)	(0.172)	(0.171)	(0.143)	(0.168)	(0.169)	(0.149)	(0.176)	(0.177)
Mediation	-0.137	-0.0782	0.0358	-0.0912	-0.0595	0.0109	-0.410***	0.185	0.275
	(0.134)	(0.163)	(0.161)	(0.131)	(0.159)	(0.159)	(0.142)	(0.170)	(0.172)
Newspaper advertisement	-0.415***	0.0135	0.0549	-0.479***	0.0599	0.200	-0.536***	-0.0753	-0.00288
	(0.145)	(0.174)	(0.172)	(0.148)	(0.176)	(0.176)	(0.151)	(0.184)	(0.186)
Public partners	0.0678	-0.189	-0.160	-0.0117	0.0544	0.0872	0.0651	-0.0925	-0.0457
	(0.128)	(0.154)	(0.152)	(0.129)	(0.157)	(0.157)	(0.133)	(0.161)	(0.163)
Private partners	-0.355***	-0.153	-0.156	-0.448***	0.0455	0.160	-0.583***	0.189	0.0198
	(0.132)	(0.159)	(0.158)	(0.131)	(0.157)	(0.158)	(0.146)	(0.173)	(0.176)
Job creation	0.00151***	-0.000173	-0.000408	0.0014***	-0.000361	-0.000268	0.00106***	0.000538*	0.000174
	(0.000263)	(0.00031)	(0.00030)	(0.00024)	(0.00028)	(0.00028)	(0.00025)	(0.00030)	(0.00031)
Tax rebate	0.00086***	0.000692*	-0.000038	0.0014***	0.0000279	0.000463	0.00147***	-0.000263	-0.000214
	(0.000324)	(0.00039)	(0.00038)	(0.00032)	(0.00039)	(0.00039)	(0.000341)	(0.00041)	(0.00042)
ASC X Income	-0.652	0.195	0.0682	0.0460	-0.919**	-1.051***	-0.407	0.0466	0.115
	(0.402)	(0.481)	(0.451)	(0.302)	(0.381)	(0.384)	(0.324)	(0.418)	(0.470)
ASC X Knowledge	-1.282**	0.0237	0.876	-2.332***	1.419**	1.578**	-1.478***	0.206	-0.475
	(0.585)	(0.760)	(0.716)	(0.524)	(0.644)	(0.664)	(0.516)	(0.622)	(0.655)
ASC X Perceived risks	0.0173*	0.00842	-0.00483	0.0318***	0.0102	0.0160	0.0488***	-0.0120	-0.0103
	(0.00982)	(0.0114)	(0.0108)	(0.00879)	(0.0108)	(0.0113)	(0.0108)	(0.0127)	(0.0130)
Preference heterogeneity	YES			YES			YES		
# of observations	18 306			18 828			16 938		
# of respondents	1 017			1 046			941		
Log-Likelihood	-5 133.1			-5 080.9			-4 703.1		

Note: * p≤0.10; ** p≤0.5; *** p≤0.01. S.D. give standard deviations for random preference parameters. Standard errors in parenthesis. *Knowledge* is noted 1 if the score of the quiz test is above the average. Perceived risks on water are standard deviations from the mean (e.g., within the mining area from 0-20km). Adrien Corneille (2021)

Regarding the key dimensions of population heterogeneity, the variables of interest are the three-way interactions which indicate how the population support varies across space and with different sociodemographic profiles. We can raise three important remarks on how spatial matters can be associated with the composition of the population.

We found no significant Statu quo effects for the group of high-income earners living in the immediate area of mining for all minerals. We only detected a significant welfare effect in the case of uranium mining beyond the distance of 20 kilometers. In these distant areas, it appears that the support of high-income earners for a uranium mine became stronger as indicated by a negative and significative parameter of the three-way interaction. It further suggests that distant population with higher income can be more supportive of a uranium mining project since they experienced limited welfare losses.

Regardless of the mineral selected, local people with mining knowledge shared a stronger support for the mine's opening. This is shown by negative and significant parameters of the interaction term between ASC and knowledge. For two out of the three minerals, we noted no long-distance effects excepting again for the case of gold mining. The positive and significant three-way interactions indicated that people living in more distant areas (up to 20 kilometers) with strong mining knowledge had a decreased support for the gold's mine. We suggest that the result can be partly explained by previous observations pointed out by our qualitative study. In fact, some participants had ever mentioned that educated people living mostly in big cities can be more opposed to distant mining projects.

Last but not least, all resource welfare patterns show no significant differences in Statu quo effects over long distances that could be attributed to the differences of risks perceptions across people. In strong contrast, we detected that higher risk perceptions over minerals can only weaken the local support of the population as suggested by the positive and significant parameters of the two-way interaction. It suggests that population protests could be stronger in the vicinity of the mine regardless of the mineral heterogeneity. Consequently, people's concerns about water contamination are prominent in a mining context.

The twin focus on the Statu quo effects and the composition of the population enables to detect other potential distance-decay effects. Population support can appear to be related with the distance-to-the mine, but these variations in welfare can also depend on specific individuals' characteristics such as income, knowledge and risk perceptions. These long-distance effects on welfare were also found to be contrasted between minerals, especially concerning uranium.

For robustness and sensitivity of the results, we regarded the spatial pattern of welfare for the sampled population living outside big cities. As mentioned previously for the survey structure, individuals living in big cities only received two distance treatments about 20-100 kilometers and more than 100 kilometers from the proposed mining project. This exogeneous exclusion can potentially affect the observed presence of distance-effects between the minerals. When excluding people living in big cities, appendix 1.B reported similar results of distance effects, which further suggests that our split-sample strategy did not influence the result of space matters in our welfare's analysis.

1.6. Discussion

The welfare analysis studies the distance-decay effect in the mining context. The key result of this paper shows the presence of the distance-decay effects that can be related to the mineral of interest and the project attribute changes. Consequently, a narrow context framing can fail to capture all welfare changes beyond the immediate mining area. How is this conclusion achieved and supported?

Our approach deployed a split-sample strategy and de facto raised a number of advantages and limits. On the positive side, modelling the distance as a project attribute was not relevant to the mining context. The mineral deposit imposes a fixed location. Spatial inequalities across residents can however influence the result of welfare estimates. Mining valuation scenarios need to be credible and realistic as possible by including spatial dimensions if relevant

(Johnston et al., 2017). Alternatively, we deal with this modelling issue by considering a range of band areas (e.g., Bateman and Langford, 1997).

The definition of relevant areas was based on empirical findings delineating the long-distance impacts across space (e.g., Aragón and Rud, 2013). The distance band approach in a discrete choice experiment framework was selected to fit better with the imposed location of the mineral deposit. An area framing allows to define the spatial distribution of the population surrounding the proposed mining project. Residents were aware of the likely mining impacts in proximity to their place of living while at the same time, valuation scenarios still remain realistic as more distant residents are unlikely to know exactly the distance from the mine.

Alongside a number of advantages, some important caveats need to be clarified. While we opted for a range of distance bands, welfare comparison can be extended by considering discrete values of the distance (see for example Rolfe and Windle, 2012). In that case, for instance, respondent A would face the mining project within a distance of 5 kilometers, respondent B would live at 130 kilometers from the proposed mine, and so on. This approach is much more relevant if local residents could have anticipated significant changes close to their homes.

Besides, the result would be more sensitive to spatial dimensions specific to the individual such as living in proximity to a natural park, an ecosystem or even a cultural/historical place. Such feature can however be problematic in practice, as the survey design of a discrete choice experiment shall involve a wide set of discrete values to properly capture the distance effects (e.g. Luisetti, Bateman and Turner, 2011). In our specific case, the survey already comprises three distance bands allocated between three valued minerals and 6 versions of questionnaire, for a total of 3 004 respondents, which means around 60 persons per version of questionnaire. Increasing the number of split samples can be challenging in a discrete choice experiment even for large samples such as our own study.

The concern of the distance-decay effect also addresses the influence of the resource heterogeneity based on a between-subject variation. Different spatial welfare patterns are likely to appear according to the resource of interest (Hanley et al., 2003). With this concern in mind, the discrete choice experiment examined the distance-decay effects between different minerals. The discrete choice experiments specified that respondents only judge mining tradeoffs over a unique mineral. Ideal comparisons could be a hypothetical situation where respondents appreciated mining tradeoffs including the three minerals together. Nevertheless, minerals cannot be presented as a viable alternative of the mining scenario in the interests of realism. Such tradeoff would suppose the discovery of three minerals (like gold, uranium, rare earths) in the same place at the same time and thus the unlikely resident's abilities to pick one mineral option. Likewise, a discrete choice experiment asking the valuation of three minerals into three successive blocks of choice sets would increase the cognitive burden across respondents.

The survey design served the purpose to disentangle distance-decay effects between different minerals. Particular to this discrete choice experiment, resource heterogeneity appeared to drive long-distance effects under particular conditions. Our welfare analysis detected lower utility of distant populations if the mining project considers a deterioration in the independency of the agent in charge of the environmental monitoring. The consideration of similar project improvements can be very different even contradictory between minerals. It is not excluded that people can perceive the mineral of interest differently. This is when for example residents from distant areas were more likely to protest against a uranium mine after controlling for major individual's characteristics. Resource properties and the related public perceptions seem to be closely interrelated. In reaching this conclusion, three main aspects over the resource must therefore be clarified.

First, the symbolic value of the mineral can influence its public perception. The discrete choice experiment valued three particular minerals such as gold, uranium and rare earths. One should pay attention on their relative public image. Gold is universally considered as the symbol of wealth and an international exchange currency as well (Merchant, 1998). Uranium is much more often related to negative feedbacks due to nuclear accidents in history and the danger of nuclear weapons proliferation (Contu, Strazzera and Mourato, 2016). The third mineral, rare earths, is poorly known by the general public although their uses are various like wind turbines, batteries and electric cars (Haque, Hughes, Lim and Vernon, 2014). These considerations can be related to the findings concerning symbolic characteristics of goods, where Rolfe and Windle (2012) found limited distance-decay effects for the category of iconic goods. Intrinsically, symbolic dimension of resource can act positively or negatively on people's judgement.

Second, mining experience widely varies between minerals at the country level, and this also applies to the Quebec context. In the province, uranium mining was poorly experienced such in 2015, a uranium mine was underway but was stopped after active protests at the local, region and provincial levels (Vestergaard, 2015). Rare earths were recently discovered at the moment of the survey, leading to public discussions on the potential of future mining projects. Today, gold largely contributes to the mineral production (almost 40% of the total production in 2017) and their mining operations benefited from a long experience dating back to the 1800's. We suspect here that poor experience relative to the mineral can mitigate the distance-decay effect, by extending global concerns.

Third, and related, public perceptions can be sensitive to specific-resource mining risks. The significance of mining impacts can vary from one resource to another exposing local residents to objective risks including among other explosions, water contamination, biodiversity degradation, health diseases (Northey, Mudd and Werner, 2018). Besides objective risks, public perceptions on the nature of risks matter as well (e.g., Dorner, Brent and Leroux, 2019) and are expected to vary between different minerals. Uranium and rare earths mining pose unique environmental challenges due to the chemical and radiological toxicity of these minerals. We shall expect that the populations may feel less comfortable and confident on the technology abilities to limit environmental and health risks across space.

Taken together, specific mineral properties can influence indirectly the existence of the distance-decay effects through the channel of public perceptions. Distance effects conditional on the resource suggest an extension of public considerations to more global concerns. This can be a situation where the resource into consideration refers to a negative image, poor experience and high-risk perception. The result presented in this paper cannot conclude on the relevance of these dimensional effects of the resource, although we detected important differences of the distance-decay effect between the minerals and across similar project changes.

1.7. Conclusion

This paper measures welfare changes happening at the distance between mining projects located from places of living. To this purpose, a discrete choice experiment investigates the effects of degraded conditions of mining and adopts a welfare comparison between minerals. The main results confirm that the distance-decay effects exist but affect people's evaluation of different project attributes in different ways according to the resource of interest. We point out the resource heterogeneity as a driving force of mixed results for the distance-decay effects.

As evidence of a likely distance-decay effect, studied project dimensions reveal that the visibility of a gold mine and the environmental monitoring on rare earths mine receive less attention by more distant residents. We also find out that the SQ effects can decrease with the distance such as in the case of rare earths mining without considering key population characteristics. Once controlling this source of population heterogeneity, risk perceptions and poor knowledge were found to influence significantly the support of the local population.

As conflicting evidence of the distance-decay effect, people living up to 20 kilometers felt concerned by a tax rebate measure and a firm monitoring for gold mining and job creation related to the rare earths mine's opening. While local residents are still demanding for a better management of the mining project, our results show that distant populations can feel strongly concerned by certain local degradations within mining conditions. Rolfe and Windle (2012) also reported similar evidence about the importance of job creation and environmental monitoring from the perspective of distant populations.

We can discuss different drivers which partly explain an absent distance-decay effect into the mining context. Specific to a Quebec context is closely related to the system of public ownership, which can increase the public considerations for good mining practices. If so, more distant populations can feel legitime to claim part of compensations even over longer distances. While local residents faced a similar exposure to the proposed mine, we detected potential source of welfare heterogeneity across the population. A key dimension of the distance-decay effect can be linked to the intrinsic properties of the minerals. We posit that spatial dimension of a mineral can depend on the symbolic value, people's experience, and their risk perceptions as well. Given that, the distance to the mine may be insufficient to explain alone main variations in people's welfare.

This study has implications for future welfare's analysis in the mining context. It shows that framed narrow contexts can swap part of the welfare changes occurring at long distances. In turn, welfare estimates at the local level would be difficult to transfer across the whole population, without larger measurement errors (Morrisson, 2000; Pate and Loomis, 1997). We recommend paying attention to the resource being valued and the typical resource changes into consideration. In the public policy context, this paper highlights that mine's managers shall pay attention to distinct mineral effects on population welfare. Failing to account for resource heterogeneity can result in a mismatch between a proposed project planification and people's preference. In a worst-case scenario, this mismatch can turn into unexpected social conflicts beyond the local context.

Future works can further explore the distance-decay effect into the context of mining. Starting with the spatial context where the individual lives, proximity to an environmental good (e.g., a natural park, a biodiversity reserve) can influence the distance effects of mining. This is when local residents regularly use an affected environmental resource and would anticipate a larger welfare loss due to mining operations. Additionally, access inequality to energy and transport infrastructures can result in larger variations in welfare changes between regions. If residents are living in places with poor quality of core infrastructures, they could be more in favor of any mining projects investing in the provision of public goods. In that case, valuation scenarios can increase in credibility and realism by virtually mapping the attributes of proposed mine, attributes of mining project's location and other spatial features (see recent applications from Badura et al., 2019 or Johnston, Holland and Yao, 2016) to get better policy consideration insights.

While this research area merits further investigations, a valuable contribution is the identification of the sources of resource heterogeneity. Why does distance-decay effect contrast between one resource and another? Our results support the idea that the resources of interest can lead to different spatial welfare patterns, but the effects of resource dimensions on public perceptions are mostly left unexplored. Beyond the resource itself, specific characteristics can be responsible for mixed results of the distance decay effect. How space does really matter remains an important and opened question in stated welfare valuation, and this paper illustrates their potential implications within a mining context.

2. STATED PREFERENCE VALUATION OF UNFAMILIAR RARE EARTHS MINING: MAY INDIRECT EXPERIENCE HELP?

Adrien Corneille[10,11]

Abstract

Discrete choice experiment (DCE) studies increasingly extended the environmental valuation to cover an overlooked class of unfamiliar resources. Limited or no experience with unfamiliar resources has however challenged the validity of stated preference data. How could people anticipate their own preference for resource tradeoffs they never experienced before? In the study context of Quebec province (Canada), I take advantage of a long history of gold mining to estimate the role of past and indirect experience in determining people's preferences for unfamiliar minerals. The objective of this paper is to confront beneficial effects of indirect experience even if the resource was never experienced. The research focus on rare earth elements (REEs) provides an ideal case study of no mining experience in Quebec. I test if indirect experience from gold mining helps population's support for unfamiliar REEs and see whether it can improve the validity of stated preference data.

Key words: rare earths, indirect experience, discrete choice experiment

JEL codes: D83, H43, L72

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2.1. Introduction

Rare earths elements (REEs) belong to a strategic group of 17 non-ferrous metals crucial for the manufacturing of high technology goods that we use every day. For instance, electric vehicles, wind turbines, computers and smartphones contain REEs that have clear advantages for making electronic components much smaller (Vikström, 2017). Although REEs are almost anywhere on earth, few REEs deposits provide the mining conditions of a high resource concentration that guarantees a convenient return on investment. The extraction of REEs is traditionally supplied from sources located within China, Russia and India. A recent REEs discovery in the Canadian province of Quebec have so far attracted many investors. The likely scenario of REEs mining may appeal both public interests and concerns for the benefit of all Quebec population.

In one plausible scenario where REEs mining takes place in Quebec, the population potentially affected should well understand the range of costs, benefits and risks covered by the novel experience of REEs mining. It appears that ordinary people may have a limited knowledge about REEs especially their environmental consequences and the opportunities for the high-tech industry value chain. The Quebec province shares in the meantime an important cultural heritage related the mining development whose influence persists even today. The province had almost two-century history of gold mining. A key question remains how people's preference may or may not support the possible development of REEs mining for the first time in its history.

Mining development can transform people behaviors and preferences in the society. Long run effects of mining were shown to be persistent over consumption and economic development (Barbier, 2010; Dell, 2010). The objective of this paper is to confront beneficial effects of past experience even if the resource to be valued is unfamiliar and never experienced before. Specific to the Quebec context, a major leverage from gold mining is that unlike REEs many people share a good knowledge and experience. Experience is then crucial as project impacts must be inferred long before they are experienced (Fischhoff, 2015). This is even more true for novel and unfamiliar minerals like REEs. The constant evolving mining practices of gold can help guide complex decisions over the risk-cost-benefit tradeoff of REEs.

Data needed about the population's support on mining projects may be in general sparse or absent. To partly handle with the concern of no preference data, this paper opts for the use of the discrete choice experiment (DCE) method to elicit people's responses facing a hypothetical REEs mine's opening. Choice experiment had progressively emerged to study the population preference pattern regarding often complex and unfamiliar resources (Aanesen et al., 2015; Campbell et al., 2008; Sandorf, Aanesen and Navrud, 2016). However, the lack of experience can critically challenge how the elicitation of stated preference is robustly estimated (Boyle, Welsh and Bishop, 1997; Cameron and Englin, 1997) in particular for the validity construct in preference estimates. With this concern in mind, I take advantage of a long history of gold mining in Quebec to estimate the role of past and indirect experience in determining people's preferences for unfamiliar minerals.

The beneficial effects of experience have been explicitly identified by a high number of preference's analysis. It takes on board the experience about living close to the valued resource (Boyle et al., 1993; Dissanayake and Ando, 2014; Ek and Persson, 2014; Lutzeyer, Phaneuf and Taylor, 2018), or about frequently using the resource for recreational and cultural activities (Breffle and Morey, 2000; Hanley et al., 2010; Kosenius and Ollikainen, 2013; Tu and Abildtrup, 2016). Rambonilaza and Brahic (2016) showed that regular use of forest and familiarity with biodiversity positively influence the estimated values of people's preference for forest biodiversity. Ladenburg and Dubgaard (2007) found that the proximity to offshore windfarm can reduce the support for an additional windfarm project.

When people lack or have no previous experience about a valued resource, preference formation at the time of the survey presents a significant DCE methodological challenge in itself. It means that some individuals are likely to poorly perform choice experiment questions (Campbell et al., 2015). In practice by replying to the DCE tasks, respondents can face greater preference uncertainties (Brouwer, 2011), make more error choices that could be inconsistent with their real preferences (Boyle et al., 1997) and last but not least, frequently ignore important characteristics of the resource (Sandorf, Aanesen and Navrud, 2016). These behavioral inconsistencies can dampen the validity of stated preference responses.

Despite that, limited findings in contingent valuation supported that lack of experience is not a crucial issue at all. Boyle et al. (1993) found that the reliability of validity construct can be supported by additional experience with similar resources than those evaluated. McCollum and Boyle (2005) and Voltaire (2015) showed that a direct experience is not absolutely necessary for providing reliable results of preference estimates. To the best of the author's knowledge, choice experiment studies have paid little attention on the benefits of indirect experience. The past experience related to substitute resources can help individuals anticipate and better formulate their preferred tradeoffs for novel resources (Jacobsen and Thorsen, 2010; Rolfe and Bennett, 2002; Whitehead and Bloomquist, 1995). Besides, individual's experience can be strengthened by the peers such when individuals share and exchange knowledge with others (e.g. Confraria et al., 2017; Narayan, Rao and Saunders, 2011; Wichmann, Chen and Adamowicz, 2016).

Mindful of the potential limits from a "no experience", I investigate how population's support can vary with indirect experience in a mining context. We could expect in the discrete choice experiment framework the role of key experience, as highlighted by Carson, Wilks and Imber (1994) in a contingent valuation study linked to an Australian gold's mine. Information was collected by an online choice experiment study concerning preference and experience over the mine's opening of REES. It was anticipated that indirect experience with mining can be translated into a set of experience-related variables such as a) the familiarity with a common mineral as gold in the Quebec context, b) the familiarity with the resource to be valued (i.e., in our study case, REEs), c) past visits of mining sites,

d) a family member or an acquaintance who worked before in the mining industry. I hypothesize that indirect experience with a familiar mineral like gold might be helpful for the stated valuation of a novel REEs mine project.

For testing the proposition, I particularly consider one common source of heterogeneity in stated preference data, which is the error variance (Davis, Burton and Kragt, 2019). The choice experiment literature pointed out that respondents' experience significantly contributes to reduce the error variance across individuals (Czajkowski, Hanley and LaRiviere, 2014) as measured by the variation in the scale factor. The proposition of past experience effects can be tested by the use of the Heteroscedastic Conditional Logit (H-CL) model which accommodates that two groups of people share similar preference pattern but differ in their individual's characteristics (Hensher, Louviere and Swait, 1998).

The General Multinomial Logit (G-MNL) model also accounts for the changes in error variance when estimating simultaneously both preference heterogeneity and scale heterogeneity (Fiebig et al., 2010). The preference's analysis in this paper applied both models for the study of experience effects on the valuation of unfamiliar resources. Estimations models might be relevant to properly identify in what ways mining tradeoffs stemming from indirect experience are different or similar. This is important for the valuation of unfamiliar resources to see how additional past experience might be relevant and beneficial on the validity of preference estimates.

More specifically, this paper proposes to test if people using the experience passed down formulate more refined preferences for the public management of unfamiliar resources. To the best of the author's knowledge, this paper counts among the first attempt to contrast the effects of indirect experience on the stated preference valuation of unfamiliar minerals. This paper also relates to a growing research body in choice experiment studies to evaluate the effects of experience or/and information on the scale of people's preference (Czajkowski et al., 2014; LaRiviere et al., 2014; Rambonilaza and Brahic, 2016).

This paper is organized as follows. Section 2.2 details the econometric strategy. Section 2.3 presents the survey, study area and the related dataset used to value a mining project. I present in section 2.4 the main results across estimation models. Section 2.5, finally, concludes and discusses the findings.

2.2. Econometric models

This section presents the estimation models measuring the effects of experience on people's preferences. I detail how preferences can be modelled and estimated using discrete choice models. Then, I show hypothesis linked to experience and implement them into the estimation models in a consistent way with the choice experiment literature. Based on these estimation models, a later application on the valuation of REEs project allows to test empirically the relationship between indirect experience and people's preference.

2.2.1. Utility models for mining projects

Public support for mining development can be modeled by the use of the random utility model (McFadden, 1974). As far as individuals living near the mining project or further away experience changes in their preferences, we could expect varying conditions in project attributes are linked to the level of individual's utility. Given an additional project, individuals are assumed to support a good mining practice that will procure the highest level of utility.

The individual's utility can be broken down in two distinct parts: a deterministic component and a random component. Equation 2.1 presents this additive functional form of the utility where U_{ijt} is the utility that a mining project procures to an individual i for the project alternative j in the choice set t. The term x_{ijt} is the deterministic part of the utility and can be declined into a linear combination of project attributes as denoted by X_{ijt}. In our specific case, it refers to a range of better mining practices associated with β', a vector of preference-related parameters. The random part of the utility can be captured by the error terms

ε_{ijt} and may include all the relevant factors that the deterministic component fails to capture so far (e.g., potential missing project attributes, individual's experience).

$$U_{ijt} = \lambda_i\left(x_{ijt} + \varepsilon_{ijt}\right) = \lambda_i\left(\beta' X_{ijt} + \varepsilon_{ijt}\right) \quad [2.1]$$

Under the Independence and Irrelevant Alternatives (IIA) assumption, this utility model specifies the error terms ε_{ijt} independently and identically distributed extreme value (Train, 2009). It follows that an individual i has a probability of choosing one alternative j among J project alternatives in the choice set at time t, as given by equation 2.2.

$$P(j) = \frac{exp\left(\lambda_i \beta X_{ijt}\right)}{\sum_{j=1}^{J} exp\left(\lambda_i \beta X_{ijt}\right)} \quad [2.2]$$

The scale of the utility can be captured by a scale parameter λ_i inversely related to the variance of the error terms. To allow parameter identification and simplify the interpretation, the scale parameter is normalized to one in estimation like the Conditional Logit (CL) model. One could consider that the variance of the error terms is subject to changes across individuals (Davis et al., 2019) and these changes are partly driven because of unobserved differences across the population.

$$\lambda_i = exp\ (\delta' k_i) = \frac{\pi}{\sqrt{6} \cdot Var(\varepsilon_{ijt})} \quad [2.3]$$

To identify how unobserved population heterogeneity may affect the variance of the error terms, the scale parameter λ_i can be rewritten as a function of covariates. Equation 2.3 shows the scale function where δ' is a vector of parameters and k_i is a combination of selected covariates. The scale parameter is constrained to be positive by using an exponential transformation (Fiebig et al., 2010) which is important to parameter identification. The scale parameter is an inverted function of the variance in error terms. In this vein, the increase the scale parameter implies a decrease in the variance of error terms.

2.2.2. Estimation of the scale parameter

In this paper, I present and employ two estimation models of the scale parameter. Firstly, I use the Heteroscedastic Conditional logit (HCL) as an extension of the CL model that assumes homogeneous preferences across individuals. Unlike the CL model, individuals only differ in their utility's scale because the normalization of the scale parameter to one is relaxed (Dellaert, Brazell, and Louviere, 1999; Hole, 2006). As population preference is assumed homogeneous, variation in preference parameters can be strictly imputed to differences in scale at the individual level.

Secondly, the General Multinomial Logit (G-MNL) model controls simultaneously both preference heterogeneity and scale heterogeneity. The G-MNL model specifies a scale parameter λ_i that is not the unique source of variation in preference parameters. Equation 2.4 presents the model specification of the G-MNL, where b is a vector of parameter means, η_i detects the presence of observed preference heterogeneity as captured by the deviation from these means.

$$U_{ijt} = [\lambda_i b + \gamma\eta_i + (1-\gamma)\lambda_i\eta_i]\, V_{ijt} + \varepsilon_{ijt} \qquad [2.4]$$

The term γ is a calibration parameter of the G-MNL model. $\gamma = 0$ specifies the G-MNL type 2. The scale parameter enters in the utility's function as a multiplicative term between preference-related parameters and standard deviations given by $\lambda_i(b + \eta_i)$. Otherwise, $\gamma = 1$ specifies the G-MNL type 1. It is assumed that the scale parameter only affects the vector of preference-related parameters as $\lambda_i b + \eta_i$.

Both H-CL and G-MNL models cannot distinctly separate the scale effects from the estimated preference parameters (Hess and Train, 2017) as shown by equation 2.2 and 2.4. The focus of the preference's analysis can be mainly conducted on the result of the scale parameter. A large choice experiment literature empirically investigated the scale effects for several covariates including, without limitation, information, experience, and fatigue that respondents experience during the choice experiment tasks (Hanley et al., 2017; LaRiviere et al., 2014; Lundhede et al., 2009; Tu and Abildtrup, 2016; Zhang and Adamowicz, 2011). The main purpose of the related preference's analysis is to consider potential key factors of unobserved characteristics in the population and contrast them to see the scale on how different groups of people display their preferences (e.g., a group of informed people can show higher scale and thus lower variance compared with the group of uninformed people).

The literature indeed provided different interpretations of the result of the scale parameter. The introduction of a scale heterogeneity permits to highlight potential sources of heterogeneity in error variances. It can define the ability of the preference's analysts to capture unobserved factors, providing reliable insights why utility coefficient can be larger for one group compared with another one (Hess and Train, 2017). Obviously, some cautious are necessary for the identification and the interpretation in estimation of the scale parameter as regards to the role of experience.

Closer to this paper is the research work from Czajkowski et al. (2014) who allowed the scale parameter to be a function of prior experience. The authors proposed both a theoretical model and an empirical study based on the G-MNL model, and they found that the scale parameter increased in experience. They supported that past experience is important for individuals to better refine their preferences such as described by the rational behavior of a Bayesian updater. It implies that an individual who experienced the usage of a resource several times will know better what he likes or dislikes. Such positive effects of experience in real-life could be also present and detectable within the discrete choice experiment framework.

2.2.3. Testing the effects of indirect experience

Based on the two estimation models H-CL and G-MNL, I test hypothesis showing the key role of indirect experience for an unfamiliar resource to be valued.

The main hypothesis emphasized in this paper is that all kind of relevant experience can be positively related to the individual's utility even such experience could be an indirect one. The primary focus of this study is on the valuation of people's support for REEs mining, as one example of an unfamiliar resource. I take advantage of the past experience of gold mining industry within the Quebec province to test if indirect experience provided by gold can help leverage more refined preferences for unfamiliar REEs.

For testing the hypothesis of indirect experience, I estimate the H-CL and G-MNL by implementing in the scale function (as described previously in equation 2.3) a set of indirect experience-related covariates. I assume in particular that the scale parameter increases in individual's experience with gold mining, if any. This hypothesis implicitly considers that larger indirect experience if linked to an unfamiliar resource can contribute to reduce the variance in error terms. The hypothesis below presents how I test the effect of indirect experience with gold mining in the scale function.

$$H_0 : \delta_{gold\_experience} = 0$$
$$H_1 : \delta_{gold\_experience} > 0$$

In the scale function from equation 2.3, I control for indirect experience based on gold mining. $\delta_{gold\_experience}$ corresponds to the covariate parameter identified for indirect experience with gold mining. For testing the hypothesis on indirect experience, there are 2 possible cases according to the estimation model. When assuming homogeneous preferences (H-CL model), if we cannot reject the null hypothesis H_0, it means that the variation in preference parameters cannot be imputed to differences in scale parameter. Oppositely, the alternative hypothesis implies that indirect experience is an increasing function of the scale parameter and then, it decreases the variance in error terms.

Admittedly, considering homogeneous preferences can be a strong assumption in the context of mining development. If we relax the homogeneous preference hypothesis (G-MNL model), and in the meantime, we cannot reject the null hypothesis, it can provide in fact a similar estimation such as in the mixed logit model. Put differently, the differences in error terms cannot be explained by changes in indirect experience. Otherwise, if the null hypothesis can be rejected, it means that the scale parameter increases in indirect experience and thus, the variance of error terms is expected to decrease.

The inclusion of this covariate in the scale function permits to compare the group of individuals familiar with gold mining relative to the reference group of those unfamiliar. I assume that a prior experience with gold mining can positively affect the scale parameter and then reduce the variance in error terms.

By extension, I also considered other indirect experience-related covariates (i.e., familiarity with REEs, visits of mining sites and personal network related to the mining sector) which could potentially affect the scale parameter. To highlight the importance of substitutable experience like the one given by gold mining, it may be appropriate to contrast the effects of "gold experience" on the scale parameter with the inclusions of other relevant covariates. It follows in the next section more details on the conception of the choice experiment study and the measure of the different experience-related covariates.

2.3. Data description

The original dataset used in this paper comes from a discrete choice experiment in August 2017 that took place across the Quebec province, in Canada. The survey valuing both population preference and experience about REEs was administered on-line with a large panel of respondents living within the province. The dataset included 987 respondents for rare earths valuation. The survey presented a hypothetical background of REEs mining followed then by a series of choice experiment questions on the best preferred mining conditions.

2.3.1. The choice experiment study

To evaluate population preferences about REEs mining, respondents completed the process of a discrete choice experiment. First, the survey presented to respondents a mining background where a hypothetical REEs discovery was made and led to the proposition of a mine's opening. The study background proposed to consider a twenty-year project to develop the extraction of REEs in return of a range of beneficial outcomes (i.e., job creation, prioritization of local workforce, investment in local public goods). The proposed project was presented to comply with environmental standards and regulation within the province.

Adding to that, a short description of the REEs was provided to respondents to see the resource itself and the main geological characteristics. Supplementary information there had mentioned that rare earths elements are any of a group of similar oxides of metal or a mixture of such oxides occurring together in widely distributed but relatively scarce minerals.

For each respondent, the choice experiment survey follows the list of project attributes for which mining practices can be improved to develop the hypothetical mine of REEs. Table 2.1 provides a recap of the project attributes to be considered in the survey, and importantly, these attributes were then broken down into various levels for the improvement of mining conditions. The identification beforehand of the key projects attributes and levels were based on an extensive literature review and an in-depth qualitative survey. The qualitative survey helped select the most important determinants of population's support regarding mining development.

From February to May 2016, a series of focus groups and individual interviews were carried out among 63 stakeholders of the Quebec mining industry. Participants including government officers, environmental NGOs managers and mining employees were invited to discuss and debate better mining practices which could leverage wider population's support across the Quebec province. Then, a large list of around thirty project attributes were identified, compared and selected following the findings in the research literature. Consequently, the six project attributes and levels retained in table 2.1 were fruits of these interviews and the back-check from the relevant literature review.

Table 2.1
Attribute description and levels

Project attributes	**Levels**		
	LOW	*MEDIUM*	*HIGH*
a) Mine type	Open-pit mining	Underground mining	
b) Environmental monitoring	Firm	Government	Independent committee
c) Communication campaign	Newspaper advertisement	Mediation	Co-construction
d) Partnership structure	Private partners (only)	Public partners	Regional partners
e) Job creation	200	500	800
f) Annual tax rebate for a 10-year project	\$100 \$400	\$200 \$500	\$300 \$600

Note: All project attributes consider a twenty-year project to develop a REEs mine. Adrien Corneille (2021)

Table 2.1 lists the attributes of a) mine's type, b) environmental monitoring, c) communication campaign, d) partnership structure, e) job creation and f) annual tax rebate. We could expect those improvements in mining conditions (or attributes) from low to high level may affect positively the level of public support for the proposed mining project to develop REEs. For example, the environmental monitoring in project attribute 2 can be more supported by the population if led by the Government as compared with the situation of a Firm-led monitoring. In a similar vein, the population could prefer even an independent committee in charge of the environmental monitoring.

In a second step, the design of hypothetical scenarios was constructed as a varying combination of improvements in mining conditions. There exists a total of 972 possible combinations of project scenarios as calculated by the factorial of the six attributes and their respective levels ($2 \cdot 3^3 \cdot 6 = 972$ scenarios). By the use of an experimental D-efficiency design, as common in the choice experiment literature, I performed both the elimination of dominant strategies and an orthogonal design. The result is to provide a fractional factorial design from 972 to 36 scenarios now, for which scenarios to be considered were broken down into 6 blocks of six scenarios (or choice sets). Accordingly, respondents had only to address one out of the six blocks following a randomized survey process.

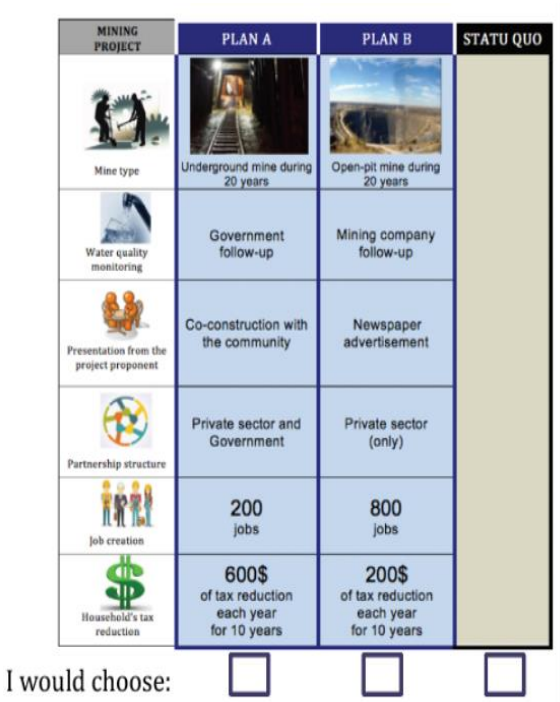

Figure 2.1 Example of a choice set

Adrien Corneille (2020)

The baseline of each choice experiment question is to provide respondents with a sort of mining "dilemma". It presented a tradeoff to be made between two changing options of a REEs mining project and an alternative to decline the two project options (i.e., the *Statu quo* option). For instance, figure 2.1 illustrates how the project was proposed to respondents in one choice set. In the end, the survey collected in a panel data format valuable information on stated preferences.

In this way, we can relate information on the preferred option with the different attributes of the proposed project. For coding variables, I follow an effect coding scheme (see for example Daly et al., 2016). All project improvements are coded 1 in terms of improved level and zero for the lowest level of the project. Hence, the project baseline consisted of a REE's mining project including an open-pit mine, firm-led monitoring, newspaper advertisement, only private partners, and 200 created jobs. Adding to that, the variable Alternative specific constant (ASC) permits to capture the preferences for a Statu quo situation.

2.3.2. Measure of indirect experience

Information on respondent's experience was collected after the choice experiment tasks. It was anticipated that respondents did not share same experience on mining development. Specific to the mining context of Quebec, gold is among traditional minerals for which the extraction of gold dated back to the early 1800's. This mineral had continued to be a cornerstone of the Quebec's mining industry as gold production counted about 42% of the total production (MERN, 2016).

The survey considered the question about respondent's familiarity with gold formulated as "Do you have past experience dealing with gold mining?". Since the central focus of the study is on preference's for REEs, information about gold familiarity permits to better capture an indirect form of experience with mining. Note that past experience with gold mining is not limited to a lived experience of the proximity to a gold's mine but can also covers more general elements such as the familiarity with gold mining impacts, the local knowledge about abandoned mining sites and closed gold's mine.

In addition, the same experience-related question is raised to respondents about the familiarity on REEs. In this particular case, the mining industry of Quebec never produced REEs at the time of the survey. We could expect that the Quebec population and thus the sampled respondents shared a limited knowledge and obviously no direct experience about REEs mining. In the meantime, REEs exploration and prospection highlighted the detections of large REEs deposits across space within the province. It appeals that the mining conditions at the time of the survey can be favorable for the extraction of REEs, in particular because REEs production had become a strategic sector in order to cut down on the dependency on REEs exports.

Survey information on experience also considered lived experiences of the respondents about past visits of mining sites. It is important to mention that the cultural heritage of mining could have been transmitted at school, especially in resource-dependent regions in Quebec. Guided school visits in past and present mining sites could lead people to learn more about the mining development and good/bad practices. Independently, individuals could experience the visits of mining sites by their own through recreational activities in proximity to existing mining sites. Visits of mining sites were formulated such as “Have you ever visited a mine site before?” and we also asked respondents their experienced visit took place in an openpit mine or/and an underground mine.

Another key information about experience with mining can be related to the personal network of the respondents, since we could expect that individuals know someone working in one way or another on mining projects. The question was formulated such as “In your personal network, do you know anyone who works in the mining sector?”. We identified which persons in the network was in close relation with the mining sector such as a family member, a colleague at work or a friend. The intuition is that an individual can enhance her or his level of understanding and knowledge about mining development through the lens of the personal network.

The related-experience variables allow to capture personal experience of the individual with the mining development. In the course of the survey, all respondents had to answer the four questions on mining personal experience about mining. We could expect that among the sampled population, there is a large share of respondents who benefit from a good experience with the mining development. By extension, the survey permits to capture the full absence of knowledge and experience with development. Some respondents can have no experience at all as such they are unfamiliar both with gold and REEs, they never visited a mining site or learnt more about mining development. In the end, the captured experience by the survey can be composed of a mix of good and bad experiences, which in turn can affect their support for the new development of REEs mining.

Table 2.2 presents the share of respondents with prior knowledge about mining. I found that a majority of individuals (around 88%) is closely familiar with gold mining. This result comforts the expectations about a culture heritage since the Quebec province is well-known as a traditional producer of gold. Oppositely, as we might expect, a minority of respondents (less than one third) states to be familiar with rare earths mining. This result is not surprising because REEs are often unfamiliar for the general public and in our context of Quebec, the population never experienced before the extraction of REEs. It is interestingly to note that almost one third of individuals had reported to visit a mining site at least once in their life. Around 22% of the sampled population also expressed to know someone in their network working currently in the mining industry. These variables are important to capture part of the indirect experience with mining.

Table 2.2
Proxies of indirect experience

Variables	Mean	Standard deviations	Min	Max	Number of respondents
Familiar with gold	0.88	0.32	0	1	947
Familiar with REEs	0.31	0.46	0	1	947
Visited a mine	0.35	0.47	0	1	947
Personal network	0.22	0.41	0	1	947

Source: Author's calculation based on the choice experiment study.
Note: These variables are used ad proxies of indirect experience with mining given a Quebec context. For example, *familiar with gold* is our main variable of interest, coded 1 if the individual shared an experience related to gold mining and 0 otherwise.
Adrien Corneille (2021)

Besides, there is few individuals who had no prior experience at all given the different forms of experience with mining considered in the survey. I found only 53 out of the 941 respondents who systematically shared no experience with mining in a general way. In contrast, the rest of sampled population had at least one type of experience with mining. For the preference's analysis, the share of respondents with no experience can potentially influence the sensitivity of preference estimates. While it can be relevant to exclude them from the preference's elicitation for further robustness checks, the small portion of these respondents did not affect the results. Instead, I focused on identifying how experienced individuals gradually react from no to additional experience with mining.

Another key feature of experience concerns the relationship between the different candidates on indirect experience. It is possible that the type of one experience can be highly related with another one and thus, there could be issues of multicollinearity when adding experience's measures in the preference's analysis. For example, we could expect those individuals familiar with REEs mining are in the meantime more familiar with gold mining.

Table 2.3
Correlation matrix about experience

	Familiar with gold	Familiar with REEs	Visited a mine	Personal network
Familiar with gold	1.000			
Familiar with REEs	0.130	1.000		
Visited a mine	0.111	0.201	1.000	
Social network	0.104	0.067	0.244	1.000

Source: Author's calculation based on the choice experiment study.
Note: Coefficients of the Pearson's correlations are reported and all of them are statistically significant at 5% level
Adrien Corneille (2020)

Table 2.3 presents the Pearson's correlations for the plausible candidates of experience's measures. The results systematically show that there is a positive and significant linear relationship between the different measures of experience at the 5% level. The strongest correlations detected was for the familiarity between gold and REEs, but also for the social network and the visit of a mining site. The former finding reports a correlation coefficient of 0.162 such when familiarity with gold mining increases, familiarity with REEs mining tends to increase slightly (or *vice versa*). The latter one indicates a correlation coefficient of 0.172 with a similar positive correlation. The values of these correlations lie however below 0.2 which can be interpreted as showing a weak linear relationship between all the experience's measures.

Because of this weak relationship, one can conclude that the different forms of experiences measured in the survey are closer to being complementary than perfect substitutes. In fact, this implicitly points out one of the study challenges to capture the full extent of individual's experience. This study allows only to identify partly the differences in experience with mining across all respondents.

In addition, the experience captured so far in the survey might not be directly related with the population's preferences for REEs mining. This can be important regarding the potential issues of endogeneity between preference and experience. Experienced individuals can be more likely to support a mining project. Since there is no past experience with REEs mining in the context of Quebec, we could expect no or limited effects of endogeneity problems caused by employing the proxies of experience in the preference's analysis.

2.4. Results

To measure the support of the population for the new development of rare earth mines (REEs), I estimated both the H-CL and G-MNL models as presented in section 2.2. The primary focus of this paper is to highlight the role of indirect experience in a preference's analysis. I take advantage of a Quebec context to investigate the effects of indirect experience in relation to gold mining. Consistently, the two estimation models allow the scale parameter to control for the effects of indirect experience. In the scale function, I considered familiarity with gold mining as a covariate (our proxy of indirect experience) adding to other forms of experience, provided for instance by REEs familiarity, past visits of mining sites, and personal network. The section reports the findings. I also extended the main results of indirect experience by performing a series of additional robustness checks.

2.4.1. Homogeneous preferences

The estimation of the H-CL model implies that preferences are assumed similar (i.e., homogeneous) between individuals. This can be a plausible situation because in our study context, the Quebec province never experienced REEs mining and population could have anticipated similar effects of REEs mining on their well-being. This model assumption is also important to the interpretation of the scale parameter estimated. If scale changes were attributed to experience-related covariates, it follows that changes in preferences could be the result of indirect experience.

Table 2.4 reports the results of the H-CL model. Panel A presents the changes in preferences following the improvement of mining practices. The variable Alternative specific constant (ASC), in the first row, controls for the lack of public support which defines a preferred statu quo situation. Panel B provides the main results of the scale effects in indirect experience. From columns (1) to (4), each covariate for indirect experience is reported separately and column (5) considers these covariates together in scale estimation.

First, I briefly discussed the result of preference parameters from panel A. Then, the major focus of this preference's analysis is to compare the effects of indirect experience in relation to gold mining with other covariates. As expected, I found that individual's utility is positively related to an improvement in mining practices, as can be seen by positive and significant preference parameters. In a general way, the mining project procures a disutility that is shown by a positive and significant coefficient of ASC (in the first row).

Table 2.4
Heteroscedastic conditional logit (HCL) model

	(1)	(3)	(3)	(4)	(5)
Panel A: Preference parameters					
ASC	1.285***	3.528***	3.581***	3.592***	1.293***
	(0.371)	(0.244)	(0.246)	(0.236)	(0.352)
Underground mine	0.135***	0.368***	0.364***	0.369***	0.138***
	(0.0394)	(0.0342)	(0.035)	(0.034)	(0.038)
Government Monitoring	0.218***	0.584***	0.587***	0.587***	0.220***
	(0.0624)	(0.0457)	(0.0467)	(0.046)	(0.0592)
Committee Monitoring	0.199***	0.524***	0.537***	0.531***	0.198***
	(0.057)	(0.0460)	(0.046)	(0.045)	(0.054)
Mediation	0.056***	0.145***	0.143***	0.145***	0.057***
	(0.0206)	(0.0383)	(0.038)	(0.038)	(0.0202)
Co-construction	0.106***	0.290***	0.291***	0.299***	0.109***
	(0.0337)	(0.0449)	(0.0456)	(0.045)	(0.033)
Public partners	0.092***	0.278***	0.289***	0.285***	0.092***
	(0.0312)	(0.0423)	(0.042)	(0.042)	(0.030)
Regional partners	0.092***	0.274***	0.283***	0.281***	0.093***
	(0.031)	(0.041)	(0.041)	(0.041)	(0.029)
Job creation	0.0003***	0.0008***	0.0008***	0.00086***	0.0003***
	(0.00008)	(0.00007)	(0.00007)	(0.000073)	(0.00008)
Tax rebate	0.00028***	0.00078***	0.00079***	0.00078***	0.00028***
	(0.00008)	(0.0001)	(0.0001)	(0.0001)	(0.0000)
Panel B: Experience -related scale parameters					
Familiar with gold	1.159***				1.050***
	(0.282)				(0.269)
Familiar with REEs		0.237***			0.115
		(0.0725)			(0.0737)
Visited a mine			0.189***		0.0554
			(0.0708)		(0.0744)
Personal network				0.273***	0.153*
				(0.0762)	(0.080)
Log-Likelihood	-5 725.4	-5 746.0	-5 747.6	-5 745.3	-5 720.9
Number of observations	16 920	16 920	16 920	16 920	16 920
Number of respondents	941	941	941	941	941

Source: Results are based on the H-CL model and the equations from 2.1 to 2.3.
Note: * p≤0.10; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis. From column (1) to (4), only one experience-related covariate is included within the scale function estimation. Column (5) reports the results for proxies of indirect experience altogether. Adrien Corneille (2020)

The results from panel A indicate that people could be more supportive of the mining project of REEs under the condition of improving mining practices.

Regarding the positive sign of preference parameters from panel A, we can conclude on a series of evidence on population preference for the new development of REEs mining. First, the preferred REEs project is an underground mine as respondents could be able to anticipate larger landscape degradation by openpit mining. Besides, respondents preferred a greater independency in environmental monitoring (e.g., under the control of the government or an independent committee). Information campaign is key for the promotion of a REEs mine and the result shows that a greater involvement of the population is desired (e.g., by the means of mediation sessions, or co-construction). Respondents preferred mining investments to come from the public sector and regional partners, and they adhered more to the project when it created more jobs and allowed compensations of tax rebates.

The preference's analysis focuses on the role of indirect experience. Moving to the panel B, it shows the effects of experience-related covariates on the scale parameter. In the H-CL model, under the assumption of homogeneous preferences across population, I found that different forms of indirect experience alone positively and significantly affect the changes in the scale parameter at the 1% level. A significant higher scale parameter then implies a reduced variance in error terms, as the beneficial result of indirect experience. I reject the null hypothesis of equal scale parameters between unfamiliar individuals and familiar individuals given the different types of indirect experience. When assuming that the scale parameter is a log normal function ($\lambda = \exp\ (\delta_i)$), I found that familiarity with gold mining can strongly reduce the variance in error terms by a scale factor of 3 (calculated by $exp(1.159)$) against 1.2-1.3 after including other covariates alone.

The most interesting result is when we control in the scale estimation for all forms of indirect experience together. It shows that indirect experience leads to an increased scale parameter (and thus a reduced variance in error terms) if this experience comes from gold mining at the 1% level and personal network at the 10% level. Otherwise, experience relative to the familiarity/knowledge with REEs and past visits of a mining site showed no effects on the scale parameter. When these results are interpreted together, it can further suggest that total experience is a kind of multidimensional concept. As an indirect channel, other resource-specific experience, in this case with gold, can help improve the predictability of a preference pattern for unfamiliar REEs mining development.

2.4.2. Heterogeneous preferences

While the estimation of the scale parameter in table 2.4 provides suggestive evidence on the beneficial role of indirect experience, these results could differ by relaxing the assumption of homogeneous preferences. Table 2.5 provides the result of the G-MNL model, which allows this time to control both scale heterogeneity and preference heterogeneity. I report the estimation of both models G-MNL type 1 and type 2, where I suppose the parameters of ASC and tax rebate as nonrandom.

The estimation of these models unlike the H-CL model highlights the potential presence of preference heterogeneity for the development of new REEs mining. I detect a heterogeneous pattern in the way the respondents formulate their preference for better mining practices. As can be shown in columns (2) and (4), preference heterogeneity is captured by significant standard deviations of preference parameters. People's preferences differ for mining practices to be improved and this includes underground mining, environmental monitoring, communication campaign, public/regional partnership, and job creation.

Besides, we allow scale heterogeneity in both G-MNL models as reported by the result in panel B. Again, I can reject the hypothesis of scale equality in indirect experience. I found that the effect of gold-specific experience is significantly positive at the 5% level. When accounting for preference heterogeneity, personal network has no effect anymore on the scale parameter at the 10% level. The result supports that scale heterogeneity is still important. But only indirect experience with gold mining increases the value of the scale parameter, and thus it reduces the variance in error terms.

Table 2.5
General Multinomial Logit (G-MNL) model

	Model G-MNL type 1		Model G-MNL type 2	
Panel A: Preference parameters	(1) b	(2) S.D.	(3) b	(4) S.D.
ASC	4.235*** (0.330)	0 (fixed)	4.732*** (0.323)	0 (fixed)
Underground mine	0.346*** (0.055)	0.992*** (0.074)	0.473*** (0.061)	0.920*** (0.088)
Monitoring Government	0.613*** (0.071)	0.924*** (0.088)	0.781*** (0.077)	0.805*** (0.085)
Monitoring Committee	0.594*** (0.071)	0.809*** (0.0813)	0.724*** (0.077)	0.985*** (0.088)
Mediation	0.232*** (0.048)	0.246** (0.122)	0.283*** (0.056)	0.286*** (0.081)
Co-construction	0.393*** (0.062)	0.416*** (0.099)	0.477*** (0.068)	0.438*** (0.082)
Public partners	0.330*** (0.060)	0.476*** (0.116)	0.432*** (0.068)	0.601*** (0.078)
Regional partners	0.308*** (0.0552)	0.402*** (0.104)	0.406*** (0.062)	0.396*** (0.096)
Job creation	0.0009*** (0.00012)	0.0021*** (0.00018)	0.001*** (0.00013)	0.002*** (0.00018)
Tax rebate	0.0014*** (0.000156	0 (fixed)	0.0015*** (0.00016)	0 (fixed)
Panel B: Experience-related scale parameters				
Familiar with gold	0.240*** (0.079)		0.123** (0.061)	
Familiar with REEs	0.055 (0.044)		0.032 (0.044)	
Visited a mine	-0.011 (0.048)		0.011 (0.046)	
Personal network	0.071 (0.054)		0.082 (0.051)	
Scale variance parameter (τ)	0.335*** (0.047)		0.277*** (0.045)	
Log-Likelihood	-4 809.4		- 4 814.8	
Number of observations	16 920		16 920	
Number of respondents	941		941	

Source: Results are based on the G-MNL model in equation 2.4.
Note: * p≤0.10; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis. The column b is the preference parameters for different improvements in the mining conditions. The column S.D. considers the standard deviation from the mean preference parameter b if assumed to be a random parameter. Adrien Corneille (2020)

The results put together show that the scale parameter increases with indirect experience. These results remain robust if we assume that preferences are homogeneous in table 2.4 or non-homogeneous in table 2.5. They remain consistent with the predictions of a Bayesian agent model, as suggested by Czajkowski et al. (2014). One result of this paper is that indirect experience can help guide respondents even if the resource valuation is completely unfamiliar.

2.4.3. Who is more familiar?

To further investigate the implications of prior results, I propose first to identify who are the respondents with one type of indirect experience. Each measure of indirect experience is regressed in a Probit estimation, to better know the profile of experience across the sampled population in Quebec. Equation 2.5 presents the Probit regression with multiple regressors Z_1, Z_2,…, Z_k, where *Experience* is a binary variable, $\phi(\cdot)$ is the cumulative standard normal distribution. I estimated in table 2.6 the predicted probability that an individual share at least one type of indirect experience according to a range of individual's characteristics, noted as Z_k.

$$P(Experience = 1|Z_1, Z_2, \ldots, Z_k) = \phi(\alpha_0 + \alpha_1 Z_1 + \alpha_1 Z_1 + \cdots + \alpha_k Z_k) \qquad [2.5]$$

The survey collected information (i.e., after respondents completed choice experiment tasks and related-experience questions) about individual's age, income level, degree attained after the bachelor's degree, if the individual lived in a resource region (i.e., specializing mostly in logging and mining), and individual's trust attributed to mining companies. The measure of trust mining is measured using a Likert scale ranging from no trust (scored 1) to total trust (scored 4). I apply a log transformation on the income variable. The related results of preference changes can be only interpreted in terms of signs.

Table 2.6 reports Probit estimations for each form of indirect experience as considered in the survey. The results show that the probability of sharing experience with gold mining increases with individual's age and a high level of education at the 1% threshold. It also increases with individual's income at the 10% threshold. Compared to other proxies for indirect experience, I noted similar positive effects of age and education if individuals shared a good understanding about REEs mining or they had previously experienced the visit of a mining site. Otherwise, no other individual's characteristic appears to have a significant effect on the probability of shared experience with gold mining, as regarding for instance their region of origin and their perceptions on the level of trust. As can be expected, individuals who came from a resource region and perceived higher trust in mining companies were oppositely more likely to relate to someone working in the mining sector. The results together can support the idea that better education can be a significant driver of indirect experience, and this can in turn help determine which mining practices could be best for the development of REEs mining.

Table 2.6
Who holds indirect experience with mining?

	(1) Familiar with gold	(2) Familiar with REEs	(3) Visited a mine	(4) Personal network
Age	0.018***	0.008**	0.006*	0.00170
	(0.004)	(0.003)	(0.0032)	(0.00333)
Log(Income)	0.131*	0.080	0.227***	0.130**
	(0.075)	(0.061)	(0.061)	(0.0665)
Tertiary education	0.393***	0.503***	0.269***	-0.0181
	(0.131)	(0.092)	(0.091)	(0.0981)
Live in a resource region	0.073	0.186	0.093	0.666***
	(0.251)	(0.183)	(0.180)	(0.177)
Trust in mining firms	-0.033	0.052	0.067	0.153***
	(0.061)	(0.047)	(0.047)	(0.052)
Constant	-1.216	-2.134***	-3.478***	-2.790***
	(0.812)	(0.687)	(0.687)	(0.749)
Log-Likelihood	-320.3	-562.2	-589.3	-478.2
R-squared	0.11	0.10	0.09	0.09
Number of respondents	941	941	941	941

Source: Results are based on the equation 2.5.
Note: Standard errors in parenthesis are estimated robustly. The variable age, income and trust in mining firms are continuous while others regressors are dummy coded. Individuals who had a university degree were classified among respondents with tertiary education. Individual's trust is measure by the means of a Likert scale.
Adrien Corneille (2021)

2.4.4. Does the type of experience matter for people's preferences on mining development?

Among respondents who adhere to REEs mining projects, an important matter can arise if indirect experience causes individuals to prioritize differently better mining practices. I thus compare the heterogenous effects of an experience with gold mining and other indirect experience. I suppose that the only source of variability in preferences comes from at least one form of indirect experience. Table 2.7 provides the results of the CL model[12] (i.e., under the assumption of preference homogeneity) and it includes interactions effects between experience-related covariates and some improvements in mining project attributes. In addition, the estimations also considered these interaction effects relative to experience with the variable ASC (i.e., alternative specific constant), as a proxy of no public support.

Additional findings show that as expected, more experienced individuals gain higher utility with better mining practices. If individuals display one type of indirect experience, the result shows positive and significant interaction terms for practices covering underground mining, environmental monitoring, and information campaign. Following a REEs development scenario, indirect experience does not give the same order of preference in the choices of priority improvements. Some project attributes such as employment or partnership structure become of less interest to individuals with prior experience.

The results on the effects of experience on preferences differed between the types of indirect experience. In column 1, individuals with previous experience with gold mining are more in favor of project improvements in terms of landscape impact (i.e., switch to an underground mine) and independent environmental monitoring, as indicated by positive and significant interaction effects at the 1% level. They also prefer more targeted information campaigns (e.g., mediation session) at the 10% level.

[12] RPL model with interaction terms is also presented in appendix 2.A and provides close results compared with the CL model with interaction terms.

Table 2.7
Conditional logit (CL) model and experience effects

	(1) Familiar with gold	(2) Familiar with REEs	(3) Visited a mine	(4) Personal network
ASC	1.018***	1.077***	1.030***	0.995***
	(0.209)	(0.097)	(0.093)	(0.092)
Underground mine	0.111	0.318***	0.390***	0.355***
	(0.108)	(0.044)	(0.041)	(0.041)
Monitoring Government	0.130	0.599***	0.622***	0.619***
	(0.137)	(0.056)	(0.053)	(0.052)
Monitoring Committee	0.125	0.597***	0.529***	0.584***
	(0.138)	(0.056)	(0.053)	(0.052)
Mediation	-0.046	0.106**	0.142***	0.139***
	(0.126)	(0.050)	(0.047)	(0.047)
Co-construction	0.123	0.279***	0.292***	0.270***
	(0.143)	(0.058)	(0.055)	(0.054)
Public partners	0.595***	0.347***	0.277***	0.305***
	(0.136)	(0.054)	(0.051)	(0.051)
Regional partners	0.539***	0.320***	0.276***	0.296***
	(0.135)	(0.053)	(0.049)	(0.049)
Job creation	0.197***	0.310***	0.297***	0.255***
	(0.068)	(0.028)	(0.026)	(0.026)
Tax rebate	0.00086***	0.00085***	0.0008***	0.00085***
	(0.00011)	(0.00011)	(0.0001)	(0.00011)
ASC X Experience	-0.026	-0.265*	-0.179	-0.001
	(0.221)	(0.161)	(0.180)	(0.182)
Undergroundmine X Experience	0.317***	0.226***	-0.002	0.158*
	(0.114)	(0.078)	(0.087)	(0.087)
Government X Experience	0.567***	0.112	0.044	0.066
	(0.145)	(0.100)	(0.110)	(0.112)
Committee X Experience	0.509***	-0.064	0.207*	-0.023
	(0.147)	(0.099)	(0.110)	(0.111)
Mediation X Experience	0.226*	0.149*	0.038	0.064
	(0.134)	(0.088)	(0.098)	(0.099)
Co-construction X Experience	0.214	0.114	0.085	0.194*
	(0.152)	(0.104)	(0.115)	(0.117)
Public partners X Experience	-0.321**	-0.114	0.132	0.010
	(0.144)	(0.096)	(0.107)	(0.107)
Regional partners X Experience	-0.262*	-0.047	0.110	0.030
	(0.142)	(0.093)	(0.103)	(0.104)
Job creation X Experience	0.091	-0.113**	-0.094*	0.097*
	(0.073)	(0.049)	(0.054)	(0.064)
Number of observations	16 920	16 920	16 920	16 920
Number of respondents	941	941	941	941

Source: Results are based on equation 2.2 if the scale parameter is normalized to one.
Note: * p≤0.10; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis.
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Another interesting result from column 1 is about the differences in preference patterns between familiar and unfamiliar individuals. Individuals with no gold mining experience show no preference for improving mining practices that affect the environment and no preference for more effective project communication to the public. In addition, they give a greater weight to the windfall of economic benefits (e.g., job creation, tax rebate) and the project's funding sources.

In comparison, experienced individuals with gold mining place less importance on economic issues, as suggested by negative and significant interaction terms for the variables *Public partners* and *Regional partners* at the 5% and 10% level, respectively. This result can suggest that past experience with gold mining would affect the preferences for new development of REEs, especially concerning the environmental and social concerns at play.

Other forms of indirect experience reported less frequent but still heterogeneous effects on people's preferences. For example, in column 2, I found that a good knowledge about REEs had an influence on the individual's level of support for the mining project. This result is shown by a negative and significant interaction terms between the variables *ASC* and *Experience*. Adding to that, those respondents more familiar with REEs tended to have fewer preferences for job creation compared with those totally unfamiliar. A similar tendency for lower job preference is reported in column 3 when individuals stated to have visited before a mining site. It is also worth noting that respondents who had connections with the mining sector comparably displayed higher preferences for the type of extraction, effective information campaign and local economic benefits (as can be seen by positive and significant interaction terms for the variables *Underground*, *Co-construction* and *Job creation*).

2.5. Conclusion

This paper is interested in uncovering the effects of indirect experience on people's preferences. A common assumption in the literature so far is that direct experience has a beneficial effect on the elicitation of preference estimates, as raised by Czajkowski et al. (2014). These effects provide theoretical predictions about the rational behaviors of economic agents in a consistent way with the Bayes' rule. This model prediction implies that the more the individual experiences a series of events related to a good or resource, the easier it will be for him or her to judge and appreciate trade-off situations with the good/resource to be valued. Put differently, Bayesian individuals continue to update their own preferences with more refined experiences with the resource, and finally adjusts their preferences better.

Although the choice experiment method is enough flexible in measuring stated preferences for a variety of resources, some of these resources could be almost or completely unknown given the study context (e.g., the introduction of a new technology, the preservation of an unfamiliar environmental resource). The choice experiment literature in this case points out the common issue of no experience across respondents and thus potential adverse effects on the accuracy of preference estimates. This concern is even more important because stated preference studies are increasingly interested in the evaluation of resources that are often unfamiliar to the general public. In this paper, I take advantage of a traditional gold mining context within the province of Quebec, to evaluate people's preferences on the mining development of a new, unfamiliar, and often poorly known mineral, i.e., rare earths.

The main objective of this research work is to determine if an indirect experience can be relevant and facilitate arbitrage choices for a never experienced resource (in our case, rare earths mining). To this end, a choice experiment study assessed people's preferences for improved rare earth mining practices, and the survey permitted to collect detailed information about different forms of experience, especially indirect ones. Consistent with the model prediction of a Bayesian agent, such as raised by Czajkowski et al. (2014), I proposed a hypothesis about the effects of indirect experience and measured empirically these effects on preferences by using the H-CL and G-MNL estimation models. This paper highlights what the effects of indirect experience could be for the stated preference valuation of an unfamiliar resource.

Suggestive results provide new empirical evidence to support that indirect experience may have beneficial effects on preference assessment of an unknown resource. I found that indirect experience with gold mining in a Quebec context increases the scaling parameter (i.e., capturing the predictability of preference estimates) and thus reduces the error variance for mining tradeoffs about REEs. The interpretation of the scaling effects further suggests that individuals with indirect experience is likely to formulate preferences consistently, even if the resource to be valued had never been experienced before. The estimated positive effect of indirect experience remains robust, even after adding several other proxies of experience into the scaling function (i.e., familiarity with rare earths, visiting a mining site, or an acquaintance who works in the mining sector), running estimations given the homogeneous versus heterogeneous preferences hypothesis.

By extension to these results, I attempt to qualify the profile of respondents who are more likely to share indirect experience in the study context of mining. I found that age and especially education increased the likelihood of having an indirect experience relative to the mining development. Finally, the results of a CL-model with interaction terms highlighted those individuals with indirect experience weighted their preferences differently especially for the environmental and social issues to be improved.

There may be limitations that this paper does not directly address. First, the choice experiment study format, especially in the case of a previously unknown resource, does not allow for the evaluation of a counterfactual in the real-life. This refers to the common problem well identified in the choice experiment literature, as the projection bias, where a gap may persist between the estimates of stated preferences and real preferences of the individual (Johnston et al., 2017). Nevertheless, this paper contributes to provide a range of preference estimates for the development of rare earths in a mining context where the earths have never been mined before. The results then provided suggestive evidence on what might be the level of public support given a rare earth development scenario.

Another potential limitation is that the amount of total experience for each respondent can be only partially captured by the survey. It is plausible that some individuals collected other relevant information and experience about mining out of the choice experiment framework, through other channels of experience and knowledge, such as the media communication about mining. Notwithstanding other relevant proxies of experience, this paper aims at showing the importance of indirect experience in a preference's analysis. Most results of this paper may be encouraging for the robust evaluation of people's preferences for unfamiliar resources by the means of a choice experiment.

Last but not least, another important caveat to this analysis would be that I cannot clearly identify how people did experience the events related to mining. Consequently, proxies of indirect experience used in this survey did not allow to distinguish good and bad experiences from the perspective of respondents. We could expect that the type of experiences (good versus bad experience) might influence how people could state their preferences for better mining practices. Relevant to our study context, the results may suggest that traditional gold mining is known to have more controlled effects on the environment, with demonstrated economic benefits. Consequently, this may guide some of the respondents to better support the extraction of a new mineral like REEs. While the role of good and bad experiences is beyond the scope of this paper, future research works can investigate their effects on people's preference.

3. INFORMATION EFFECTS IN PREFERENCE'S ANALYSIS: WHY BELIEFS AND CONTEXTS MATTER?

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March 9th, 2021

Abstract

This paper examines the key role of information in determining people's beliefs and preferences as regards to the potential windfall of a mining project. The stated preference literature generally assumes that people share the same interpretation of information, and like Bayesian agents, they tend to revise preferences in the same direction. This study tests this assumption in a mining context and compares the processing effects of two pieces of scientific and persuasive information on people's preferences, in two different contexts where the controversial nature changes with the resource: gold and uranium. I find, consistent with literature findings, little or no effect of information, regardless of the polemical nature of the context, and the information given. When beliefs are crossed with the context, I find that in a more polemical context as embodied by uranium, the same information can cause preferences to change in opposite and divergent directions. These divergent outcomes of information suggest the importance of context, where related beliefs for one polemical context might result in measuring more polarized preferences. I examine the possible implications of information effects in stated preference valuation.

Key words: resource-specific information, Bayesian updating, choice experiment

JEL codes: C93, D83, H43, Q30

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3.1. Introduction

Public opinions had increasingly become divided over good governance and management of natural resources in the past few years. As for instance, in 2017 the Canadian oil pipeline project expansion led the government, NGOs and private sectors to highly discuss on how well the oil pipeline could be maintained and monitored. Under the expansion scenario, one might wonder if a longer oil pipeline may rise greater risk than publicly stated or expected[15]. Others could tolerate such a risk expecting in turn a larger range of economic benefits. This divergence in opinions proved not to be conducive to an emerging public consensus and at the opposite, could create a more polarized environment of public preferences.

This paper studies the role of new information and opinions (as a proxy for beliefs) in changing preferences about multiple scenarios of resource development. In a choice experiment study, I examine the effects of new information on people's preferences. The experimental feature allows both the context and the type of information to vary. The central idea is to capture the underlying effects of information when the contentious nature of the context can change with respect to the resource. In a large-scaled online survey, I elicited people's preferences for implementing better mining practices given two messages (persuasive/scientific information) and two contexts for valuation (gold/uranium mining).

The impact of communication has been so far an early and important concern for the stated preference literature. Theoretically, people are assumed to process new information following the Bayesian updating (BU) rule. The immediate implication is that people interpret information similarly and should thus react in the direction suggested of information (Rabin, 2002). Nevertheless, the effectiveness of communication has been challenged including the provision of persuasive messages and scientific messages (e.g., Yang and Hobbs, 2021; Ajzen,

[15] In fact, because of technology uncertainty, there still exists partial policy answers to uncover the full range of concerns (Fischhoff and Davis, 2014).

Brown and Rosenthal, 1996). Results of the literature are mixed from no effects at all (Boyle et al., 1990; Czajkowski et al., 2016; Hanley and Munro, 1994) to the presence of potential effects (Contu, Strazzera and Mourato, 2016; Hu, Adamowicz, and Veeman, 2009; Morgan, Martin and Huth, 2009; Samples et al., 1986). In addition, few studies have examined the consistency of BU behaviors in the choice experiment framework (Aadland, Caplan and Phillips, 2007; Alberini and Longo, 2009; Czajkowski et al., 2014). This raises the crucial question of why information may appeal the desired effects in some contexts, but it may not in others.

In many economic contexts, the BU rule can be a strong assumption (Rabin, 2002). In fact, the psychology and behavioral economics literatures point out that the BU rule is only one way of combining beliefs with information (Eil and Rao, 2011). Same information can make two people with opposing beliefs strongly agree to disagree (Lord, Ross and Lepper, 1979; Plous, 1991; Sunstein et al., 2016) especially when this information is related to contentious issues (Fryer, Harms and Jackson, 2018; Jern, Chang and Kemp, 2014). Communication about policy outcomes could produce divergent effects in many contexts as documented for climate change (Bujosa et al., 2018), oil spill (León et al., 2014), genetically modified organisms (Yang and Hobbs, 2020). Consequently, not all contexts are emotionally charged the same (Alekseev et al., 2017) and this paper proposes to revisit the implications of the BU hypothesis given a controversial topic.

The primary focus of this work is on a publicly and timely contentious issue given by mining. This choice was made as that is arguably a tangible example of high emotionally charged context (e.g., Carson, Wilks and Imber, 1994). Many empirical studies have long documented the diversity of mining contexts due to the resource heterogeneity (Krautkraemer, 1998). In particular, certain minerals can create more social tensions and anxiety across the population (Berman et al., 2017; Farrer et al., 2016). This paper exploits the contentious nature and variety of the mining environment to elicit the information effects linked to people's beliefs.

The experiment provides exogeneous contexts that vary between minerals across respondents. Two reference contexts presented a mine opening of gold and uranium. In addition, this preference's analysis compares two types of communication that adapts to the specificity of the resource. One scientific information is about the risks inherent to mining. One persuasive information is about the social benefits of final resource uses.

The timing of this choice experiment study is organized as follows. Participants to an online survey were randomly assigned to a mining context between the two minerals of reference. Prior beliefs are elicited against this background, where respondents reported on a Likert-scale format their prior beliefs over the desirability of the mine opening. Then, the survey paid respondents' attention to the changes at play for the valuation exercise and, after, provided two treatment groups (each one a quarter of total respondents) with resource-specific information on final resource uses or risks inherent to mining. Finally, the survey presented a series of choice experiment questions to be answered by all participants.

I find, consistent with previous stated preference studies, that resource-specific information has in average no or small effects on respondents' valuation. When beliefs are crossed with the context, I find that in a more polemical context as embodied by uranium, the same information can cause preferences to change in opposite and divergent directions. This piece of mixed results further suggests that preference polarization can occur according to the nature of the context and the information provided. The good news is that evidence on potential polarized preferences was a puzzling exception in our estimation models rather than the rule.

To the best of the author's knowledge, this study is among the first to identify in a unified framework the influence of exogenous context and further dissociate how people can combine beliefs with information and preferences. By the way, it contributes to the debate about the reliability of Bayesian updating perspective given the large class of policy contexts with different emotional charges. Still considering that people systematically update preferences in the direction of information can expose researchers to misleading policy conclusions.

In the next section, I develop a conceptual framework about information processing in stated preference survey format. It follows the proposition of testable hypotheses to measure the effects of resource-specific information, and the consideration of the BU framework. Next, I detail the experimental procedure, data collect, and composition of split samples used to implement the resource-specific information effects hypothesis. The result section presents the effects of resource-specific information both at the aggregate level and at the group level. The last section of the article comes to conclude on the main challenges raised by information campaigns.

3.2. Communication in contentious social contexts

Over the last decades, a burgeoning stated preference literature put a special emphasis on the communication of policy effects in publicly contentious issues. These studies linked the valuation for controversial social issues to real-life situations such as in events of climate change, oil spill, mining (Carson, Wilks and Imber, 1994; Lundhede et al., 2015; Kling et al., 2012). Applications of stated preference studies provide leverage where revealed preference's data about contentious issues are often sparse and difficult to collect in a more extensive way. Specific features of contentious resource dilemmas are their nature in provoking strong emotions among the population. They are often marked by inconclusive or mixed evidence about the real impacts of the resource involved. In a mining context, Northey et al. (2017) pointed out that long-term impacts of mining are almost impossible to predict.

Effective communication about social contentious issues raises essentially two challenges for the stated preference (SP) discipline. A first challenge is at promoting the most effective scientific communication for a resource dilemma. The design of scientific information should be clear, simplified, and relevant as well to the context under uncertainty. An intense effort should be to provide information on risk-related impacts and scientific uncertainty whenever it is relevant. SP studies have so far considered a deal of outcomes uncertainty by implementing one or more uncertain attributes within valuation scenarios (see for example Faccioli et al., 2019; Tonsor, 2018). Some studies opted to leave unchanged intrinsic risks inherent to the resource (Dorner, Brent and Leroux, 2019) partly because the estimation of real risks is often difficult to quantify accurately. Others implemented in a treatment group new information about how much uncertainty surrounds it (Loomis and duVair, 1993). Relevant risk information can help elicit SP estimates that better reflect welfare changes under uncertainty.

A second challenge is to embellish the relevance of a tenuous context with persuasive communication. Persuasive information is essential for calling respondent's attention on the urgency and importance of the resource dilemma into consideration. For example, Bergstrom, Stoll and Randall (1989) proposed the provision of new information about the end resource usages for the public benefits of respondents. Ajzen et al. (1996) employed varying quality of arguments with the aim of motivating the needed policy intervention. Johnston et al. (2016) insisted on establishing clear and transparent links between the proposed changes of the resource and their policy impacts on climate change. Persuasive messages are effective when they can "convince people to behave in ways that someone else has chosen" (Fischhoff and Davis, 2014).

Both types of communication are commonly used in the environmental valuation literature. Researchers should define clear prior expectations about the directional effects of information provided in the survey. These expectations provide hypotheses on testing empirically the effects of information and are in general based on a normative standard for reasoning under uncertainty, namely the Bayesian updating rule. Being close to a Bayesian updater implies that individuals should revise their preferences in the direction suggested of information. For instance, they could not show an increased preference for no-policy actions when more additional scientific/persuasive information highlights the pressing needs for policy interventions.

In a general way, both scientific and persuasive information are framed in a neutral or positive way. The literature review focus is hence on the directional effects of positive/neutral information in two different stated preference approaches: contingent valuation and choice experiment. Across a large class of economic contexts, information effects on stated preferences were mainly mixed.

Munro and Hanley (2002), Boyle et al. (1990) and Samples et al. (1986) tested in contingent valuation the effects of positive information finding no effects against some substantial effects on the valuation. Where the information effects dominate, individuals show an increased preference in the direction of positive information or/and a decreased variance in their preference estimates. Besides, Tienhaara et al. (2019) found that more additional scientific and neutral information does not affect preference estimates and their variance. Ajzen et al. (1996) showed that the quality of persuasive (positive) arguments can increase preferences only for individuals considering the resource change as desirable.

Fragmented and mixed findings were also reported in choice experiment studies. In a GMO context, Yang and Hobbs (2020) compared the framing effects of positive information between logical-scientific and narrative style. They found that for a portion of individuals, persuasive communication (from narrative style) can be more effective than for scientific communication.

In a preservation context of endangered bird species, Czajkowski et al. (2016) evidenced that persuasive information about the urgency for policy intervention does not affect preference estimates in average but can positively influence the estimated scale parameter (i.e., which reduces the variance in preference estimates). Together, the range of evidence suggests further that the direction intended of information can mismatch with measured effects of information; one may wonder why individuals seem to deviate in average from the BU perspective?

While the literature on stated preferences frequently uses scientific or persuasive information, it is unclear why we do observe no aggregate effects of information in some economic contexts. SP studies are essentially constructed on a neoclassical perspective (Green and Tunstall, 1999), but the discipline marked a progressive shift in recognizing the importance of cognitive bias which might affect the validity construct. It is well admitted that respondents can poorly process information because of cognitive burden (Campbell et al., 2015; Czajkowski, Giergiczny and Greene, 2014) and complexity of information (Hoyos, 2010) as well.

In this paper, I advocate that there is another source of heterogeneous effects of information which can be the result of how people combine prior beliefs with the direction of information. Linking psychological behaviors with the stated preference literature may help to better understand the mixed results of information effects.

Against the normative standard of Bayesian updating, the phenomenon of belief polarization was pointed out in the past by psychology and behavioral economics. The seminal paper of Lord, Ross and Lepper (1979) showed that two people with opposing prior beliefs update the same evidence in opposite and divergent directions. In their experiment, subjects were provided a series of scientific evidences about the positive and negative influence of death penalty on crime deterrent. Belief polarization was present in other social contentious contexts where same scientific information reinforces the prior beliefs of opponents and supporters about climate change (Sunstein et al., 2016), safety of nuclear centrals (Plous, 1991), nanotechnology (Kahan et al., 2009). The phenomenon of belief polarization is also associated with the provision of persuasive information (Burnstein and Vinokur, 1977).

It is well served by the stated preference literature that people's preferences are closely related to their beliefs, and in particular their opinions about the desirability of the resource change. Beliefs can affect policy attitudes for many resource dilemmas, such as their supports for adopting nuclear energy (Contu, Strazzera and Mourato, 2016), their views on forest conservation (Meyerhoff and Liebe, 2009), their supports for the preservation of endangered species (Kotchen and Reiling, 2000) or their expectations on water quality improvement (Zhang and Adamowicz, 2011).

People's beliefs can in turn influence the revision of their policy preferences, as reflecting the heterogeneity in people's preferences (Ajzen et al., 1996). These beliefs motivate why opponents are more prone to choose a "no-policy change" (i.e., statu quo) or why supporters are more reluctant to do so (Meyerhoff and Liebe, 2009).

Although SP studies explored the effects of heterogeneous beliefs up to a large class of resource dilemma, the combination of various beliefs with information has been so far overlooked. Few studies attempted to provide empirical background to the normative standard of Bayesian updating. Alberini and Longo (2009) and Czajkowski et al. (2014) found that the BU perspective seem to be consistent with the way respondents proceeded with new information.

Findings were however limited to a unique context of valuation and characterized by low emotional charges (i.e., cultural good, water quality of beach). Only a few papers were interested in relating information effects with beliefs relevant to higher contentious issues. In a genetically modified bread context, Wuepper et al. (2018) tested the effects of resource-specific information on people's preferences with opposing prior beliefs. Results suggest no patterns of preference polarization driven by strong beliefs. Furthermore, LaRiviere et al. (2014) proposed to measure the individual's knowledge in a quiz and provided respondents their test score. Authors found that this information increased the mean preference only for the groups of familiar individuals, but no effects at the aggregate level neither on the variance.

3.3. Protocol of the experiment and hypothesis

In 2017, a choice experiment was conducted in the Canadian province of Quebec collecting detailed information about stated preferences for better mining practices. The survey was distributed on-line by a Canadian survey company. Sponsors of the study were included in a consent formula. Figure 3.1 shows the number of respondents according to the mining context and information treatments provided in the survey. For a total of 2 020 respondents, the survey randomly assigned two contexts of mining (i.e., gold or uranium) and two additional information (i.e., persuasive information or scientific information) only for treated groups of respondents.

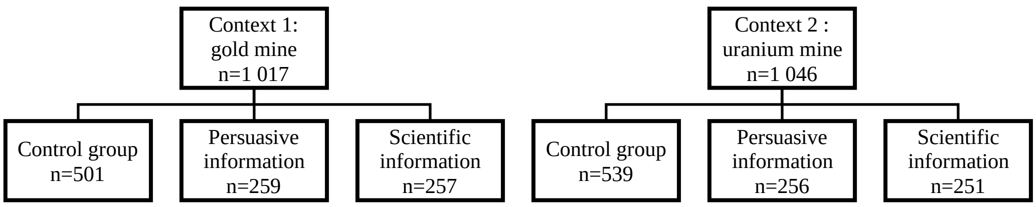

Figure 3.1 Allocation of information treatments

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3.3.1. Mining contexts and prior beliefs

All respondents faced a random context of mining which differs by its resource type: namely gold (context 1) or uranium (context 2). The general description of the context presented a twenty-year mine, with important economic benefits within the region. While survey participants faced a specific-resource context, they were unaware of the other mineral provided in the experiment. Providing two or more mineral-specific contexts to the same individual might be valuable with two inconveniences at least. One issue can arrive with the increase in respondent’s cognitive burden, which could affect the accuracy of preference estimates. Another related issue is about the credibility and the realism of hypothetical scenarios provided in the survey. The two mineral discovery is unlikely at the same time in the same place. Then, the survey focus only considered a between-subject variation.

Given the two random contexts, respondents were asked to report their own prior beliefs over the desirability of mining. The question is formulated such as "Is the new mining project more preferable than the current situation with no mine?" and all respondents were forced to choose one response among the three statements:

- Statement 1: I am certain that costs would exceed the benefits of the new mine.
- Statement 2: I am uncertain that benefits and costs would be more or less the same.
- Statement 3: I am certain that benefits would exceed the costs of the new mine.

It was mentioned there "*no right or wrong answers about the likely outcomes of the proposed mining project*". When respondents chose either statement 1 or 3, they reported on an 8-point scale how sure they are for the desirability of mining. The exact wording for the second question is "Please indicate how sure you are on a scale from 1 to 8, where 1 means weakly certain and 8 means strongly certain". If a respondent put a high score like 7 at this question, she or he shares stronger prior beliefs than someone weighing a 4. After having completed this question, respondents continued the next steps of the experiment, with no possible coming back to previous screens. This implies that respondents do not know the proposed changes of mining while answering the belief-related question. They only expressed their ex-ante anticipations for the desirability of mining given the resource-specific context.

3.3.2. Information provision

All respondents received background information for the valuation exercise into consideration as it is common in choice experiment surveys. They were informed that the proposed mining project can be better off by improving one or more attributes of the project considered. Besides, the on-line survey randomly assigned information treatments to respondents. Half of the respondents did not receive new information. The other half received one of the two versions of resource-specific information including a persuasive message or a scientific message.

- Persuasive message describes the clear links between the resource of interest and the social benefits of the end resource usages.
- Scientific message shows that mining can have negative environmental externalities, but the use of current technology permits to limit them to the minimum.

Table 3.1
Resource specific information

Context 1: gold mine	
Persuasive information	Gold is used to manufacture electronic circuits and luxury items such as jewels. Dentists use gold for filling and crown.
Scientific information	Gold extraction needs to use chemical products such as arsenic and cyanide. During the process, current technology is able to control and monitor mining wastes the minimum.
Context 2: uranium mine	
Persuasive information	Uranium is used in medical and nuclear medicine for cancer treatment. It contributes to generating nuclear power, which reduces the emission of greenhouse gas.
Scientific information	Uranium extraction may lead to the rejection of radioactive gas called radon. Current technology is able to control and monitor the mining wastes the minimum.

Note: The contents and type of information were constructed based on an extensive qualitative survey among stakeholders of the mining industry. Key messages for communication campaign about a mining project were identified according two types: one addressing the technology risks and related environmental issues, as noted by Scientific information, and one highlighting the usefulness of minerals in everyday life, noted Persuasive information.
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Table 3.1 shows the exact contents of persuasive and scientific information provided randomly into split samples. Similar wording for each information type is applied to the contexts of gold and uranium. The direction of two pieces of information was anticipated being positive. On one hand, persuasive information pays respondents' attention on the social benefits of mining; on the other hand, scientific information makes clear the reduced environmental consequences of mining.

Drawing on the results from the stated preference literature, I propose two hypotheses about the effects of resource-specific information.

> Hypothesis 1: new information can affect preference changes for mining improvements regardless of the type of information (persuasive versus scientific) and the context presented.

> Hypothesis 2: individuals with opposing prior beliefs (i.e., opponents and supporters) and neutral individuals experience preference changes in the same direction.

There is a series of comments to underline for the analysis of the information effects. First, the suggested direction of information was carefully considered based on extensive discussions with stakeholders of the mining industry. Second, there are no clear-cut expectations about the usefulness between persuasive and scientific information. Both messages can influence positively the consideration of project improvements. Third, the content of information remains specific to the resource. For example, environmental consequences of mining are different between gold and uranium. Finally, the experimental protocol permits to identify prior beliefs according to the given context without being linked to the provision of additional information.

3.4. Data

3.4.1. Classifying individuals with opposing prior beliefs

Given a mining context, people can share a variety of prior beliefs: negative, neutral, or positive. Table 3.2 classifies respondents by the direction of their prior beliefs in the contexts 1 and 2. Opponents belong to the group of individuals choosing the statement A (costs would exceed the benefits of the new mine), indifferents selected the statement B, supporters are those who chose the statement C (benefits would exceed the costs of the new mine). Context 2 shows a higher share of opponents about 38% of individuals while in context 1, there is a lower share of opponents about 20%.

Table 3.2
Prior beliefs in the sampled population

Beliefs	Context 1: gold mine	Context 2: uranium mine
Neutral groups	42%	36%
Belief-based groups		
- Opponents	20%	38%
- Supporters	38%	26%

Source: Author's calculation based on the choice experiment survey provided in Appendix 4.
Note: Respondents' shares in percent are split by belief status. Prior beliefs were measured based on a Likert scale from 0 (neutral beliefs) to 8 (belief-based groups) during the survey presentation of the (hypothetical) mining background. The sum of values in a same column equals to 100%.
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3.4.2. Comparing socio-demographic information

Table 3.3 presents the comparison of participants' sociodemographic characteristics across sub-samples between contexts 1 and 2, and the general Quebec population. Columns report the average of values, and the last column provides characteristics of the general population based on the 2016 Quebec Census. There are two key issues to discuss from this table. One issue is that respondents are older, better educated, and more often owners compared with the general population, as usually the case for online surveys. It is hence difficult claiming that sub-samples are fully representative of the general population.

Table 3.3
Sociodemographic statistics

	Context 1: gold mine			Context 2: uranium mine			Quebec population
	NI	PI	SI	NI	PI	SI	
Female	50.0	50.0	50.0	50.0	50.0	40.0	50.0
Age	54.3	53.2	53.6	53.0	53.0	53.6	49.2
Education	14.5	14.4	14.7	14.5	14.4	14.6	13.2
Income	64 404	68 753	67 694	63 478	62 226	63 147	63 744
Sample	501	259	257	539	256	251	-

Source: Author's calculation based on the choice experiment survey provided in Appendix 4 and the 2016 Census by Statistic Canada
Note: Columns NI, PI and SI denote No information, Persuasive information, Scientific information, respectively. The variable Female indicates the respondent's share of women in percent across split samples given valuation contexts 1 and 2. Mean age for people living in Quebec aged 18+. Education includes the number of education years. Income is labelled in Canadian dollars (1 CAD = 0.68€). Last row indicates the number of respondents for each split sample. Last column shows the statistic information on the Quebec population based on the 2016 Census by Statistic Canada.
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3.4.3. Valuation exercise

The valuation tasks are designed from an extensive qualitative study made in the field where 63 stakeholders provided key project attributes relevant to many mining contexts[16]. Table 3.4 presents the six attributes retained including a) mine types, b) water quality monitoring, c) presentation by the promoter, d) partnership structure, e) job creation and f) tax rebate. For the valuation exercise, all respondents faced a series of six choice experiment tasks presented as a resource dilemma between three alternatives. Figure 3.2 presents an example of mining trade-off provided in the survey. There are three different alternatives: two project options against an option of Statu quo (i.e., the mining project being abandoned).

[16] At this time, the pilot survey emphasized to put the distance-to-the mine in the valuation context, instead of including it as a key attribute in the choice task. Mainly, this alternative design was motivated by the invariant location of a resource deposit and the fact that credibility of choice tasks would decrease with varying distance-to-the mine within the same project.

Table 3.4
Definition of attributes and levels

Attributes	Levels
a) Mine types	From an open pit mine to - Underground mine
b) Water quality monitoring	From a mining company to - Government - Independent committee
c) Presentation by the promoter	From a newspaper advertisement to - Mediation - Co-construction
d) Partnership structure	From private sector (only) to - Public and private partners - Regional and private partners
e) Job creation	From 200 jobs to - 500 jobs - 800 jobs
f) Household's tax rebate for the next ten years	$100, $200, $300, $400, $500, $600 each year for 10 years

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In the survey, there were six versions of a series of choice sets generated by using SAS and considering the D-efficiency criterion (Louviere et al., 2002). The total of full factorial designs (2*3*3*3*3*6=972) was reduced to a partial design simplified to 36 choice tasks blocked into 6 series of 6 choice tasks. Respondents were individually assigned to one of the six randomized blocks. The final design allows us to identify the information effects and the variations in mining contexts as well, since treatments of information and resources are both randomized in the experiment.

Figure 3.2 Example of a choice experiment task

Note: The choice card in French is translated.
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3.5. Econometric model

Typically, the individual's utility function can be modelled by applying the random utility theory (McFadden, 1974) in a Lancastrian style. This involves in our study case about mining that a) individuals can derive an indirect utility from changes over project attributes[17], b) they would opt for the mining option which procures the highest level of utility. I suppose that the individual's utility is additively separable between a deterministic term and a random term. Equation 3.1 shows the basic form of the individual's utility and its two components.

$$U_{njt} = V_{njt} + e_{njt} \quad [3.1]$$

Subscripts index the individual $n \in \{1, \dots, N\}$, the option $j \in \{1, \dots, J\}$ related to a mining scenario, on the occasion of a choice experiment task $t = \{1, \dots, T\}$. The deterministic term V_{njt} is assumed to be a linear function of project attribute and possibly, it includes the variable Alternative specific constant (ASC). The latter term allows to capture people's preference on average under a statu quo scenario (i.e., without the mining project). The random term e_{njt} represents in a general way all unobserved factors to the econometrician, which may have a potential influence on the individual's utility.

When assuming individuals share heterogeneous preferences, the utility is then given by $U_{njt} = \beta_n' X_{njt} + \varepsilon_{njt}$, where β_n is defined as a vector of random parameters. The random term is supposed to be an independently and identically distributed extreme value. This is the Random parameter logit (RPL) model, which allows to account for preference heterogeneity across respondents. In all regression estimations of this paper, I will employ the RPL model to investigate the effects of new information on respondent's preference.

[17]The value of a good can be defined by the sum of values of each attribute (Lancaster, 1966).

It follows the elicitation of willingness-to-accept compensation, as an Hicksian welfare's measure. Basically, the WTA compensations can be derived in average at the attribute level, by dividing the estimated preference parameters of one project attributes by the preference parameter of a non-random monetary attribute (in our case, it is captured by the inclusion of a tax rebate within the mining scenario). Equation 3.2. below presents the calculation of the average WTA compensation given one project attribute level k.

$$\overline{WTA} = \frac{\beta_k}{\beta_{tax}} \qquad [3.2]$$

As a complementary approach, one can be interested in comparing variations in WTA compensations at the individual level. Hensher (2006) noted that the measure of individual welfare estimates cannot be computed directly, instead it should be addressed indirectly and estimated by comparing a portion of individuals who made similar choices and then derive their individual-specific preference estimates. I applied this methodology as developed by Revelt and Train (2000) to measure WTA compensations at the individual level.

Lastly, I take advantage of the two preference's measures of WTA compensations both at the sample mean (i.e., mean WTA) and at the individual level to consider the key role of information. WTA compensation estimates are robustly obtained by the use of the Krinsky Robb procedure. The main purpose of this preference's analysis is to investigate more in depth the potential effects of additional information on the process of preference formulation. I considered in particular the the potential interaction between information and prior beliefs.

3.6. Results

This section presents new evidence about the effects of new information in a preference's analysis as linked to an improved scenario of mining development within the Quebec province. Intuitively, I compare the aggregate effect of new information on people's preference and their specific effects at the groups level, as identified by the belief status. When assuming heterogenous preferences across the sampled population, I estimated the effects of new information using the Random parameter logit (RPL) model.

Starting with context 1 of gold mining, I evaluated the effects of two types of information: persuasive versus scientific messages on the global structure of people's preference. Based on a Likelihood ratio test procedure, I empirically tested the hypothesis of preference parameter equality between informed respondents and a control group (i.e., respondents who received no additional information). Results were reported at the aggregate level, but also split into the neutral group (i.e., respondents who were indifferent on a risk-cost-benefit tradeoff of a new mine) and belief-based groups among opponents and supporters. It follows in a second step the measure of willingness-to-accept (WTA) compensations and the variation in mean WTA compensations with and without new information.

Moving to context 2 of uranium mining, I addressed a more contentious valuation issues than in context 1. The proportion of the belief-based group changed from 54% to 62% of the sampled population. This approach in particular can be relevant to uncover the potential interactions between prior beliefs and information provided in the survey. Again, I compare and contrast the overall effects of persuasive/scientific information and their decomposed group effects according to various prior beliefs. Last parts of the results propose to perform a series of additional robustness checks about the role of prior beliefs.

3.6.1. Context 1: gold mining

I start to measure individuals' preferences by separate Random parameter Logit (RPL) models, where I compare groups of individuals who randomly received new (persuasive/scientific) information with others receiving no information. Following the Likelihood ratio test procedure (Louviere et al., 2000) in table 3.5, I test the null hypothesis of equal preference parameters across groups. Under the null hypothesis, independent treatments of information can be pooled because both informed and uninformed groups would display similar preference's patterns.

As a result, I systematically rejected the null hypothesis such that informed and uninformed groups share common preference structures at the 5% significance level. The results then suggest that both types of information may influence how people could anticipate their needs to change mining practices.

Table 3.5
Comparison of preference structure in context 1: gold mining

	Persuasive information			Scientific information		
	N	LL	p-value	N	LL	p-value
1) All individuals						
Groups with no information	501	-2 539.56		501	-2 539.56	
Groups with new information	257	-1 307.57		259	-1 318.18	
Both groups	758	-3 863.61		760	-3 883.24	
H0: Pooling two groups is okay			**0.046** (32.94)			**0.001** (37.23)
2) Neutral groups						
Neutral groups with no information	230	-1 176.11		230	-1 176.11	
Neutral groups with new information	113	-570.79		125	-664.30	
Both neutral groups	343	-1 761.93		355	-1 861.38	
H0: Pooling two neutral groups is okay			**0.090** (30.05)			**0.035** (34.11)
3) Belief-based groups						
Belief-based groups with no information	271	-1 354.59		271	-1 354.59	
Belief-based groups with new information	144	-719.17		134	-624.77	
Both belief-based groups	415	-2 079.02		405	-1 992.71	
H0: Pooling two belief-based groups is okay			0.971 (10.50)			0.309 (23.67)

Source: Results are based on the equation 3.1.
Note: N corresponds to the number of respondents for each sub-sample. LL refers to estimated Log-Likelihood of Random parameter logit models for each sub-sample considered. P-values are noted in bold if the null hypothesis (H0) is rejected at the 10% significance level. In the column of p-values, Khi2 statistic is reported in parenthesis.
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Furthermore, I emphasize whether information effects still have an effect among individuals with different prior beliefs. These beliefs were stated by respondents when they were aware of the hypothetical context (in this case, context

1 of gold mining), before they completed the series of mining tradeoffs tasks. I split individuals in two groups: respondents sharing neutral beliefs (i.e., neutral groups) and those sharing strong positive or negative opinions about mining (i.e., belief-based groups).

Recall that new information was randomly allocated across all respondents. Accordingly, a change in preferences can be mainly attributed to the effect of an information treatment. I found interestingly that the null hypothesis of equal preference parameter is rejected among neutral groups who received persuasive information at the 10% significance level and those who received scientific information at the 5% level.

More surprisingly, the results highlighted that new information did not have any effect on people's preference with non-neutral beliefs (i.e., including both opponents and supporters). Regardless of the type of information, the null hypothesis of equal preference parameters cannot be rejected at the 10% significance level (p-value $= 0.971$) for this group of individuals.

Taken together, it further suggests that the global changes in people's preferences could have been driven by the responses from individuals neutral to mining development. In a like manner, this result partly joins with the mixed findings of the choice experiment literature (e.g., Johnston et al., 2017), about the effects of new information. Besides, this result can also be interpreted with the model prediction of a Bayesian agent. In this case, individuals should react to same information along or close to the same "preference" line. In contrast, I found suggestive evidence about an asymmetric response between individuals with different prior beliefs, despite of the same message provided in the survey.

Fairly, table 3.5 is limited to explain in which direction the preference change occurs. Some effects of information can be masked following the global changes in preference's patterns. The measure of a no change in the preference pattern does not mean necessarily that additional information can be ineffective. Table 3.6 presents the elicitation of preferences parameters employing the RPL model, splitting respondents given the information provided and the belief status previously identified in the survey.

The result shows that in a general way, people's preferences are positively associated with the improvements of mining conditions regardless of the information type or/and the respondent's belief status. It is indicated by a significantly positive sign of preference parameters as regards to the main changes in mining conditions. Besides, I found a strong pattern of observed preference heterogeneity, as reported by significant standard deviations in preference parameters. The statu quo (SQ) effects were captured by the inclusion of the variable Alternative specific constant (ASC_{SQ}), and these effects significantly vary between individuals, as shown by the standard deviation.

Table 3.6
Random parameter logit (RPL) models in context 1: gold mining

	All individuals			Neutral groups		
	(1) No information	**(2) Persuasive information**	**(3) Scientific information**	**(4) No information**	**(5) Persuasive information**	**(6) Scientific information**
Preference parameters						
ASC_{SQ}	4.303*** (0.471)	4.458*** (0.646)	3.465*** (0.623)	4.407*** (0.688)	6.017*** (1.071)	4.964*** (0.889)
Underground mine	0.441*** (0.0772)	0.530*** (0.110)	0.542*** (0.102)	0.441*** (0.116)	0.765*** (0.179)	0.793*** (0.150)
Government monitoring	0.737*** (0.0846)	0.987*** (0.123)	0.611*** (0.112)	0.630*** (0.137)	1.269*** (0.197)	0.602*** (0.173)
Committee monitoring	0.875*** (0.0841)	0.767*** (0.121)	0.601*** (0.125)	0.927*** (0.134)	1.014*** (0.222)	0.298 (0.182)
Mediation	0.0948 (0.0719)	0.201** (0.101)	0.284*** (0.100)	-0.0344 (0.115)	0.410** (0.163)	0.0706 (0.147)
Co-building	0.272*** (0.0857)	0.395*** (0.118)	0.369*** (0.115)	0.16 (0.137)	0.515** (0.212)	0.121 (0.243)
Public partners	0.369*** (0.0817)	0.422*** (0.111)	0.368*** (0.113)	0.433*** (0.134)	0.556*** (0.187)	0.590*** (0.158)
Regional partners	0.432*** (0.0801)	0.324*** (0.110)	0.443*** (0.103)	0.650*** (0.123)	0.281 (0.173)	0.579*** (0.171)
500 jobs	0.434*** (0.0775)	0.416*** (0.113)	0.359*** (0.110)	0.338*** (0.123)	0.118 (0.175)	0.475*** (0.170)
800 jobs	0.788*** (0.0927)	0.812*** (0.120)	0.530*** (0.121)	0.652*** (0.153)	0.604*** (0.206)	0.692*** (0.158)
Tax rebate	0.0012*** (0.0002)	0.00093*** (0.0003)	0.00096*** (0.0003)	0.0014*** (0.0003)	0.0012** (0.0005)	0.00077* (0.0004)
Standard deviations						
ASC	2.683*** (0.228)	2.587*** (0.364)	2.928*** (0.331)	0.956*** (0.308)	2.602*** (0.505)	1.787*** (0.389)
Underground mine	0.922*** (0.100)	0.934*** (0.139)	0.730*** (0.114)	0.758*** (0.155)	1.040*** (0.180)	0.442*** (0.168)
Government monitoring	0.633*** (0.104)	0.738*** (0.134)	0.484*** (0.122)	0.888*** (0.141)	0.456* (0.272)	0.744*** (0.188)
Committee monitoring	0.505*** (0.112)	0.761*** (0.182)	0.890*** (0.123)	0.744*** (0.144)	1.056*** (0.279)	0.633** (0.265)
Mediation	0.117 (0.111)	0.305** (0.147)	0.228* (0.126)	0.280* (0.162)	0.0378 (0.196)	0.177 (0.164)
Co-building	0.288** (0.118)	0.140 (0.289)	0.00459 (0.195)	0.461*** (0.169)	0.709*** (0.258)	0.0981 (0.424)
Public partners	0.188* (0.109)	0.212 (0.141)	0.386** (0.154)	0.376** (0.190)	0.227 (0.174)	0.0311 (0.292)
Regional partners	0.489*** (0.120)	0.495*** (0.175)	0.103 (0.142)	0.116 (0.144)	0.117 (0.181)	0.771*** (0.182)
500 jobs	0.098 (0.106)	0.194 (0.159)	0.511*** (0.122)	0.435*** (0.120)	0.248 (0.155)	0.704*** (0.201)
800 jobs	1.014*** (0.112)	0.665*** (0.157)	0.881*** (0.151)	1.270***(0.194)	1.171*** (0.246)	0.276 (0.317)
Log-Likelihood	-2 541.9	-1 315.1	-1 318.3	-1 183.0	-571.5	-665.0
Number of observations	9 018	4 626	4 662	4 140	2 034	2 250
Number of respondents	501	257	259	230	113	125

Source: Results are based on the equation 3.1.

Note: The variable ASC_{SQ} represents the Alternative specific constant used as a proxy of statu quo effects. Standard deviations measure the potential in unobserved heterogeneity among different project attributes and SQ preferences (as noted by ASC_{SQ}). Observations are presented in panel data format and the number of observations is calculated by multiplying the number of respondents by six choice sets of a mining project and 3 project alternatives. Standard errors are in parentheses. Asterisks ***, **, * denote significance at the 1%, 5% and 10% levels, respectively. Adrien Corneille (2021)

Table 3.6
Continued

	Belief-based groups		
	(7) No information	(8) Persuasive information	(9) Scientific information
Preference parameters			
ASC	4.494*** (0.643)	3.971*** (0.874)	2.551*** (0.938)
Underground mine	0.375*** (0.110)	0.405*** (0.134)	0.225 (0.190)
Government monitoring	0.894*** (0.121)	0.881*** (0.168)	0.771*** (0.178)
Committee monitoring	0.906*** (0.115)	0.675*** (0.145)	0.910*** (0.226)
Mediation	0.172* (0.100)	0.113 (0.135)	0.596*** (0.168)
Co-building	0.258** (0.121)	0.284* (0.164)	0.600*** (0.190)
Public partners	0.372*** (0.112)	0.356** (0.143)	0.124 (0.182)
Regional partners	0.286** (0.118)	0.390*** (0.145)	0.275* (0.162)
500 jobs	0.498*** (0.110)	0.658*** (0.149)	0.268 (0.164)
800 jobs	0.906*** (0.132)	0.914*** (0.157)	0.479** (0.210)
Tax rebate	0.00118*** (0.0003)	0.00088** (0.00036)	0.0014*** (0.00045)
Standard deviations			
ASC	2.335*** (0.285)	2.459*** (0.373)	1.857*** (0.307)
Underground mine	1.030*** (0.124)	0.811*** (0.166)	1.517*** (0.235)
Government	0.578*** (0.136)	0.898*** (0.152)	0.511** (0.212)
Independent	0.348* (0.190)	0.341 (0.229)	1.526*** (0.251)
Mediation	0.171 (0.186)	0.539*** (0.189)	0.365 (0.242)
Co-construction	0.439*** (0.149)	0.562** (0.226)	0.495*** (0.171)
Public partners	0.185 (0.176)	0.306 (0.265)	0.404** (0.178)
Regional partners	0.781*** (0.152)	0.334 (0.231)	0.471** (0.214)
500 jobs	0.302** (0.153)	0.0229 (0.263)	0.0896 (0.266)
800 jobs	1.086*** (0.168)	0.361 (0.341)	1.333*** (0.234)
Log-Likelihood	-1 354.8	-725.9	-622.7
Number of observations	4 878	2 592	2 412
Number of respondents	271	144	134

From the RPL model results, I calculated average WTA compensations that an individual could claim, to measure the preference change from new information. Importantly, the t-test procedure is not appropriate for a mean comparison between different groups of respondents (e.g., the variation in preferences between the control group and an informed group). The WTA compensations are obtained as a ratio of preference parameter that are usually non-normally distributed (see Mariel et al., 2021 for a valuable discussion on this point). Consequently, I applied the two-step combinational test procedure from Poe, Giraud and Loomis (2005), and elicited the significance of WTA changes for respondents with and without new information.

The Poe's test consists of a one-side test, for which I hypothesize that the group of informed respondents can show higher preferences compared with those uninformed (i.e., the control group). This can be shown by a p-value inferior to 0.10. Otherwise, when superior to 0.90, this test can provide the exact opposite interpretation. Informed individuals share lower preferences after receiving new information. Results of WTA compensations for the range of improved mining practices are reported in table 3.7 and it includes the p-values of the Poe's test to evaluate the effects of the new information in a choice experiment study.

New information has a limited effect on people's preferences, as can be seen by only one significant difference out of the 9 project improvements. A scientific information about gold increases the needs for mediation ($p\text{-}value = 0.0313$) while a persuasive information significantly increases the preferences for closer government monitoring ($p\text{-}value = 0.0456$). Consistently with findings in table 3.5, absent effects of information overall can mask in fact a larger variability across individuals.

Table 3.7
Willingness-to-accept compensations in context 1: gold mining

	Underground mine	Government monitoring	Committee monitoring	Mediation	Co-building	Public partners	Regional partners	+500 jobs	+800 jobs
1) All individuals									
Persuasive information (PI)	570***	**1061*** **	825***	216**	425***	454***	348***	447***	873***
No information (NI)	368***	**614*** **	729***	79***	227***	308***	360***	362***	657***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.1171	**0.0456**	0.3272	0.1289	0.1118	0.1984	0.5124	0.3014	0.1887
Scientific information (SI)	565***	636***	626***	**296*** **	384***	383***	461***	374***	552***
No information (NI)	368***	614***	729***	**79*** **	227***	308***	360***	362***	657***
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.1110	0.4212	0.6199	**0.0313**	0.1522	0.3126	0.2637	0.4442	0.6273
2) Neutral groups									
Persuasive information (PI)	**638*** **	**1058*** **	845***	**342** **	**429** **	463***	234	98	503***
No information (NI)	**315*** **	**450*** **	662***	**-25**	**114**	309***	464***	241***	466***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	**0.0902**	**0.0400**	0.2958	**0.0172**	**0.0846**	0.2646	0.8068	0.7536	0.4390
Scientific information (SI)	**1030*** **	782***	387	22	157	766***	752***	617***	899***
No information (NI)	**315*** **	450***	662***	-25	114	309***	464***	241***	466***
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	**0.0433**	0.2168	0.7759	0.2924	0.4542	0.1202	0.2648	0.1352	0.1616
3) Belief-based groups									
Persuasive information (PI)	458***	997***	764***	128	321*	403**	441***	744***	1034***
No information (NI)	318***	758***	768*	146**	219***	315**	242***	422***	768***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.2831	0.2993	0.5133	0.5479	0.3433	0.3778	0.2238	0.1540	0.2755
Scientific information (SI)	161	551***	650***	**426*** **	429***	89	196*	191	**342** **
No information (NI)	318***	758***	768*	**146** **	219***	315**	242***	422***	**768*** **
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.8108	0.7760	0.6650	**0.0481**	0.1679	0.8823	0.6125	0.8790	**0.928**

Source: Author's calculation based on the equation 3.2 and the results of RPL model estimations in table 3.6.
Note: P-values≥0.90 indicate that mean WTA compensations of an informed group are significantly lower. Asterisks ***, **, * denote WTA values which are statistically different from zero at the 1%, 5% and 10% levels, respectively. All WTA compensations are labelled in Canadian dollars (CAD).
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The preference's analysis highlighted that respondent with different prior beliefs could have formulated preferences in different ways. The mean values of preference estimates could swap a larger variation of information effects happening across groups with different prior beliefs. This result is consistent with prior finding of Munro and Hanley (2002) in contingent evaluations and Tonsor and Shupp (2011) in the discrete choice experiment framework. Individuals neutral to gold mining were found to move more frequently their preference at the upper bound (for 4 out of the 9 project improvements). In total contrast, individuals who are either supporters or opponents expressed less preference changes. Only a scientific information about gold lead them to show decreased preferences in jobs and higher preferences in mediation.

3.6.2. Context 2: uranium mining

One can conclude that information could have only positive effects of preferences. As an extension, I augmented this preference's analysis by considering the contentious nature of the mineral and conducted similar preference's analysis as before. Note that a larger share of respondents displays opposing prior beliefs, about 62% of the sampled population against 54% of similar respondents in context 1 of gold mining. Information about uranium were adapted in content to the specificity of the resource, in a similar way as for gold. Both types of information (scientific/persuasive information) suggest a positive message on the windfall of mining.

I found similar findings about the effects of information over the global structure of information. Individuals with different prior beliefs react differently. Table 3.8 reported changes in global preferences with and without new information. I rejected the null hypothesis of preference equality across all individuals at the 10% significance level. Individuals neutral to a uranium mine are more reactive to new information. Again, neutral groups are responsive to persuasive information (p-value=0.010) and scientific information (p-value=0.067), while there is a more limited effect among the belief-based group.

I cannot reject the null hypothesis of preference equality for the belief-based group who randomly received persuasive information about uranium (p-value=0.957). At the opposite, providing them scientific information results in different structures of preferences at the 10% significance level.

Table 3.8
Comparison of preference structure in context 2: uranium mining

	Persuasive information			Scientific information		
	N	LL	p-value	N	LL	p-value
1) All individuals						
Groups with no information	539	-2 680.63		539	-2 680.63	
Groups with new information	251	-1 190.30		256	-1 223.34	
Both groups	790	-3 895.70		795	-3 922.83	
H0: Pooling two groups is okay			**0.000**			**0.013**
			(49.54)			(37.72)
2) Neutral groups						
Neutral groups with no information	201	-998.22		201	-998.22	
Neutral groups with new information	111	-534.59		95	-446.20	
Both neutral groups	312	-1 552.3		296	-1 468.25	
			0.010			**0.067**
			(38.95)			(31.65)
3) Belief-based groups						
Belief-based groups with no information	338	-1 676.98		338	-1 676.98	
Belief-based groups with new information	140	-648.93		161	-765.12	
Both belief-based groups	478	-2 331.54		499	-2 470.69	
			0.957			**0.076**
			(11.26)			(30.84)

Source: Results are based on the equation 3.1.
Note: N corresponds to the number of respondents for each sub-sample. LL refers to estimated Log-Likelihood of Random parameter logit models for each sub-sample considered. P-values are noted in bold if the null hypothesis (H0) is rejected at the 10% significance level. In the column of p-values, Khi2 statistic is reported in parenthesis.
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In table 3.9, I tested the effects of new information given a mining context of mining. A surprising result highlights no overall effect of information on people's preference. The null hypothesis of equal WTA compensations cannot be rejected across information treatments.

In contrast with context 1, a different valuation context provides no result of information effects regardless of the type of information. This is an important finding because it suggests that given similar content of information, the valuation context matters for the interpretation of information. Again, respondents with neutral beliefs appear more responsive to new information than belief-based group can do. The context 2 however differs from gold, as neutral individuals show reduced preferences for improved mining practices.

This finding can suggest two further caveats. First, even though I did not detect any aggregate effects of new information, that is not to say there was no impact here. Many stated preference studies tested the effects of new information in less controversial topics (e.g., Tonsor and Shupp, 2011; Yang and Hobbs, 2020). In strong contrast, uranium mining (as valued in context 2) raised intensive and timely debates about the desirability of mining conditions, especially in a Quebec context. It is plausible that no matter how the mining project was improved, the provision of new information could only act on the Statu quo (SQ) effects. This can in turn increase the number of protest responses (i.e., in the case where the respondent systematically chose the SQ option across choice sets).

A second and related caveat is that aggregate results are masking important sources of heterogeneity in information effects. The null hypothesis of equality in WTA estimates is likely to be rejected with larger variations and confidence intervals (Mariel et al., 2021). On this matter, Munro and Hanley (2002) argued that the almost absence of an effect can be reasonably led by a strong pattern of heterogeneous prior beliefs. In such a case, if individuals share strong opposing prior beliefs, they could respond to the same information in the exact opposite, which could partially mute the overall effect of information and consequently, increase the variability in people's reactions.

Table 3.9
Willingness-to-accept compensations in context 2: uranium mining

	Underground mine	Government monitoring	Committee monitoring	Mediation	Co-building	Public partners	Regional partners	+500 jobs	+800 jobs
1) All individuals									
Persuasive information (PI)	357***	472***	456***	83	222***	387***	235***	260***	512***
No information (NI)	420***	567***	586***	144***	191***	232***	169***	277***	374***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.7317	0.7836	0.8492	0.7824	0.4100	0.1071	0.2833	0.5958	0.1944
Scientific information (SI)	498***	483***	554***	139**	143*	138*	172**	208***	379***
No information (NI)	420***	567***	586***	144***	191***	232***	169***	277***	374***
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.3226	0.7475	0.6242	0.5495	0.6892	0.8135	0.5204	0.7527	0.5192
2) Neutral groups									
Persuasive information (PI)	**285****	444***	**300*****	81	238**	349***	305***	296***	563***
No information (NI)	**701*****	679***	**892*****	94	179	371***	206*	280**	421***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.9511	0.8076	0.9823	0.5322	0.3745	0.5342	0.3022	0.467	0.2983
Scientific information (SI)	**279*****	**306*****	**458*****	258***	131	252***	169**	285***	306***
No information (NI)	**701*****	**679*****	**892*****	94	179	371***	206*	280**	421***
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.9652	0.9376	0.9401	0.1432	0.6053	0.7113	0.5737	0.4915	0.6948
3) Belief-based groups									
Persuasive information (PI)	245**	407***	538***	**110***	155*	286**	153*	158*	342***
No information (NI)	311***	501***	454***	**135*****	169***	163***	158***	260***	346***
H0: $\overline{WTA}_{PI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.6873	0.7242	0.3072	0.9189	0.5532	0.2005	0.5261	0.7903	0.5132
Scientific information (SI)	**737*****	550***	702***	46	182	-61	152	174***	361***
No information (NI)	**311*****	501***	454***	135***	169***	163***	158***	260***	346***
H0: $\overline{WTA}_{SI}^{k} - \overline{WTA}_{NI}^{k} = 0$	0.0103	0.4044	0.1022	0.7944	0.4727	0.9045	0.5280	0.7199	0.4684

Source: Author's calculation based on the equation 3.2 and the results of RPL model estimations in Appendix 3.A.
Note: P-values≥0.90 indicate that mean WTA compensations of an informed group are significantly lower. Asterisks ***, **, * denote WTA values which are statistically different from zero at the 1%, 5% and 10% levels, respectively. All WTA compensations are labelled in Canadian dollars (CAD).
Adrien Corneille (2021)

3.6.3. Do opponents and supporters respond to information the same?

Previous section reported that belief-based groups can diverge over the common interpretation of same information and this regardless of the studied context. First, they appeared less responsive to new information compared with neutral groups. Second and most importantly, they occasionally revised their preferences in an opposite direction of neutral groups.

For example, belief-based groups had expressed lower job preferences in the face of scientific information in context 1, although neutral groups displayed similar job preferences. Alternatively, context 2 reported under scientific information that the belief-based group claimed increased WTA compensations for the mine's status, while the neutral group tended to understate such project improvement.

From a Bayesian updating perspective, these two divergent cases can be challenging if we assume that all individuals respond to information in the same direction. I propose as a simple extension of previous findings to empirically investigate behaviors of belief-based groups split into directional beliefs: a) opponents who share negative priors about mining and b) supporters who share positive priors. Again, I considered the effects of both persuasive and scientific information in the two contexts of mining: gold and uranium.

3.6.3.A. Information effects on SQ effects

First, I propose to study how opponents and supporters discriminate project options from the Statu quo (SQ) situation. As noted by Zhang and Adamowicz (2011) and Meyerhoff and Liebe (2009), SQ effects can reveal a pattern of polarized preferences between two individuals with opposing prior beliefs. The basic idea in what follows is to examine how same information can affect SQ effects across opponents and supporters.

Figure 3.3 reports and contrasts the tendency of preferring the statu quo option (i.e., a situation without the proposed gold mine) between opponents and supporters. The results were based on the RPL models for opponents and supporters. It includes interaction effects between Statu quo (SQ) preferences and the random provision of new information (see the appendix 3.B). Interaction effects are statistically significant at the 5% level, where upper and lower limits of the vertical line represent the confidence intervals. Statu quo effects are captured by the ratio of estimated ASC values and the value of tax rebate, labelled in Canadian dollars (CAD).

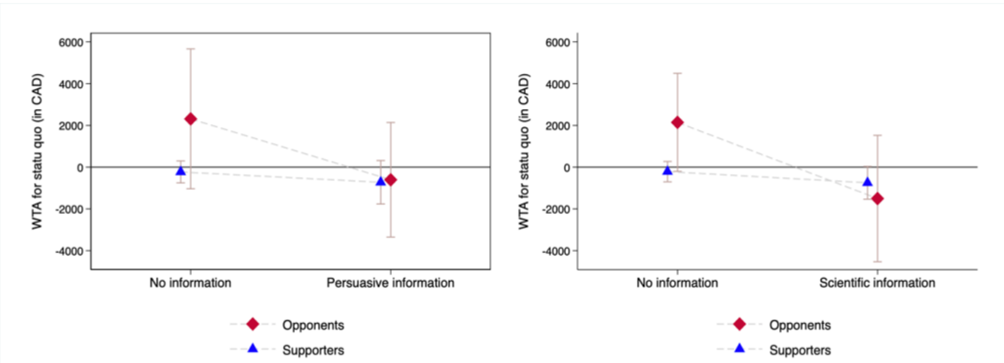

Figure 3.3 Statu quo effects in context 1: gold mining

Source: The results are estimated based on the estimations RPL models with interaction effects of information as presented in Appendix 3.B.
Note: Belief-based groups include opponents and supporters. Y-axis reports the willingness-to-accept (WTA) values relative to the preferred statu quo situation, labelled in Canadian dollars (CAD).
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As expected, I found that opponents without receiving new information generally preferred a SQ situation. It is indicated by a positive SQ value in terms of WTA compensations. Oppositely, supporters felt a gold mine as a desirable project, as their ASC values were nearly zero. In addition, if individuals with opposing prior beliefs received new information, there were significant changes in SQ preferences for both opponents and supporters. New information led opponents and supporters to align their SQ preference in a same way. I did not identify a specific effect between persuasive and scientific information.

Findings about SQ preference and information effects differ with context 2 of uranium mining. Strikingly, figure 3.4 shows that same information can produced opposite and divergent preference changes in SQ. A persuasive information led opponents to increase their SQ preference, while it affects supporters' preference, such as in the opposite direction. This result suggests importantly, that when moving from context 1 to context 2, the measured effects of persuasive information totally changed in the interpretation of the SQ effects.

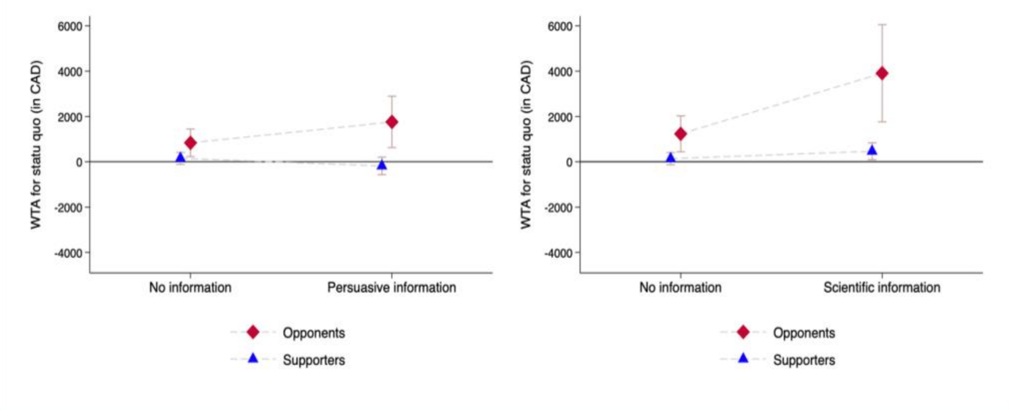

Figure 3.4 Statu quo effects in context 2: uranium mining

Source: The results are estimated based on the estimations RPL models with interaction effects of information as presented in Appendix 3.B.
Note: Belief-based groups include opponents and supporters. These figures are based on the estimations RPL models with interaction effects of information. Y-axis reports the willingness-to-accept (WTA) values relative to the preferred statu quo situation, labelled in Canadian dollars (CAD).
Adrien Corneille (2020)

Although same persuasive information about gold was interpreted similarly among opponents and supporters (i.e., *their SQ preference moved in the same direction*), the results as given by a context of uranium mining uncover a strong divergence in interpretation and reactions to the Statu quo situation. Besides, a scientific information about uranium led opponents to strongly increase their SQ preferences, and supporters increased them slightly. Again, if we refer to the prior result, the gap in SQ preference appeared graphically larger in the context of uranium mining.

This further suggests that the type of information does not seem to have a strong influence over the SQ effects, while the context of the resource might have. Certainly, we could expect those individuals with negative prior beliefs (as opponents do have) were more likely to prefer the SQ situation, but in the meantime, new information sounds like non-neutral in the mind of opponents. Furthermore, figures 3.4 pointed out that new information could trigger in certain conditions more polarized SQ preferences between opponents and supporters, as it can be shown graphically with and without persuasive information about uranium. Appendix 3.E and 3.F also reported the changes in average WTA compensations following a range of project improvements for a gold's mine and a uranium's mine, respectively. I found similar result of polarized preferences in a context of uranium mining.

3.6.3.B. Information effects on WTA compensations about project improvements

I also propose to study the direction of preference changes relative to the mining project, and I focus this preference's analysis on the improvements for the highest job creation (from 200 to 800 jobs) in context 1 (the result from 200 to 500 jobs is also presented in Appendix 3.D*)* and the lower degradation in landscape (under underground mining) in context 2. While all other attributes of the mining project are equally important, the basic idea is to compare how preferences for both opponents and supporters could move with and without new information. For these two attribute levels, tables revealed that the differences in WTA compensation were statistically significant.

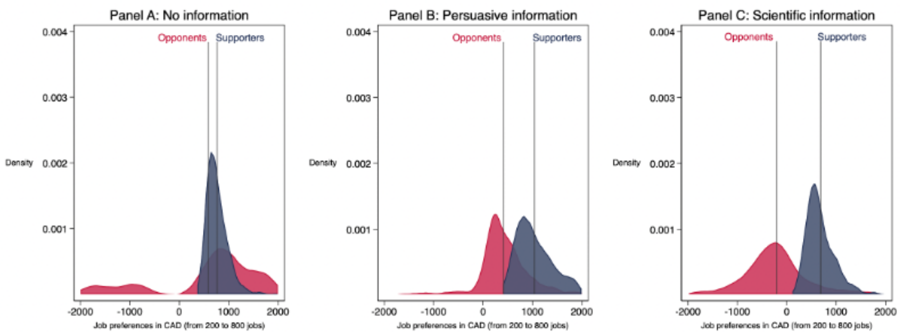

Figure 3.5 Job preferences in context 1: gold mining

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Based on the RPL model regressions, I applied the Revelt and Train's procedure to derive the preference parameters at the individual level. I calculated the WTA compensations for each project improvement considered and plotted them in a Kernel density functions[18]. These density functions are colored in red for opponents and in blue for supporters and I systematically compared respondents with opposing prior beliefs according to (panel A) no information, (panel B) persuasive information and (panel C) scientific information. The two vertical lines indicate the mean in preference for opponents and supporters.

As we could expect, supporters shared higher job preferences than opponents and inversely, opponents were more concerned about changes in landscapes than supporters were. Opponents and supporters still differed in their responses to information, and as suggestive evidence, figure 3.5 illustrates graphically a larger preference gap from no information to new information, as can be seen by the two vertical lines moving in the opposite direction. I still found a similar pattern of preference changes between scientific and persuasive information. Figure 3.6 further suggests a change in preferences for underground mining when opponents and supporters randomly received a scientific information.

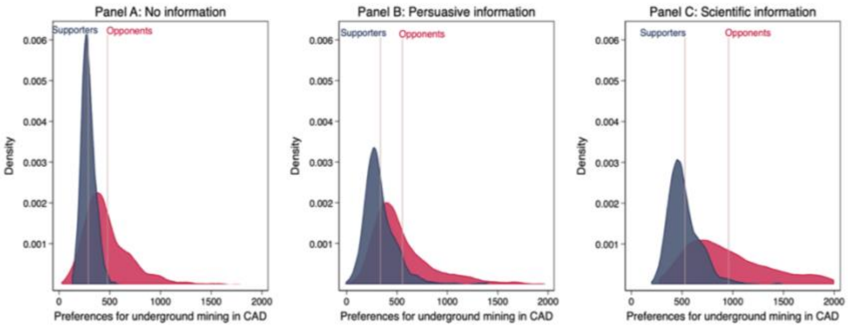

Figure 3.6 Preferences for mine's status in context 2: uranium mining

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[18] The Kernel functions are based on the estimation of separate Mixed logit models for both opponents and supporters. Individual estimates of job preference were converted in a second step as in terms of willingness-to-accept (WTA) compensations.

3.7. Discussion and conclusion

The goal of this paper is to empirically measure the effects of information on people's preferences. One standard assumption in the choice experiment literature is that respondents behave like Bayesian agents. Therefore, any information relevant to the resource's valuation should be used in the same way by most respondents. For instance, the provision of a positive information on one resource at risk would be likely to increase people's preferences for any new policy that protect such a resource and mitigate the related risks.

Although new information helps narrow the potential knowledge gap, the results of information effects are generally mixed in the choice experiment literature including but not limited to a no-effect, positive or negative effects. As Munro and Hanley (2002) noted, absent effects of information may mask significant variability between individuals, and one of these major sources of heterogeneity could be related with the presence of prior beliefs (Ajzen et al., 1996). The main idea of the paper is to clarify in which direction preferences could move with information. More specifically, when two people have different prior beliefs, do they share both similar interpretations and reactions to information?

In this paper, I exploited a rich framework of choice experiment study to study the effects of new information in a mining context. The experimental design controlled for prior beliefs over mining development. The survey randomly provided the valuation contexts between a gold's mine or a uranium's mine. Respondents learnt the context and reported their own beliefs about the windfall of a new (hypothetical) mining project.

Then, new information was randomly assigned to half of the respondents, and the other half served as a control group. This design allows a between-subject variation. Among the informed groups of respondents, information randomly differed between a persuasive information and a scientific information. Based on this experimental design, I can identify the effects of information type on individuals' preferences in two different contexts and I can also decompose these effects on preferences among respondents with different prior beliefs.

The results showed that a type of information had heterogeneous effects on people's preference for different project improvements (e.g., as table 3.7, a scientific information about gold affects WTA for mediation, as indicated in bold and a persuasive information can affect WTA for monitoring). I also found small or no effects of new information when considering the mining contexts of gold and uranium, respectively. These results are not new in the choice experiment literature as regards to the mixed findings of information effects. Interestingly, it further shows given similar project changes, both contexts affected the attribute tradeoff of respondents differently.

To highlight the potential presence of belief heterogeneity, I decomposed and compared the effects of information between respondents with different prior beliefs. I found that respondents neutral to the mining project were more likely to vary their preferences, unlike the group of respondents with opposing prior beliefs. I interpret this finding as the partial sign of an asymmetry in information's interpretation. Typically, this preference's analysis almost failed to detect overall effect of new information.

One central result of this paper is that same information can lead individuals with opposing beliefs to move their Statu quo preferences in an opposite and divergent direction. Such result is consistent with a large psychology and behavioral economic literature suggesting that people do not always update beliefs and preferences in a Bayesian style (see Rabin, 2002 for an extensive and valuable discussion on this research body). Interestingly, I also found that a less social contentious context such as gold mining provided results of information effects consistent with the predictions of a Bayesian behavior. I deduce that both contexts and beliefs matter for the effects of new information on preference estimates.

How information affects preferences is still a timely and open discussion. So far, the stated preference literature reported mixed evidence. This can be good news for consistency as different survey information would not alter the scope of policy recommendations (Munro and Hanley, 2002). This paper contrasts by shedding lights on possible preference divergence due to same information. This finding could even suggest the occurrence of a social polarization. Future research works could extend this finding to other emotional-charged contexts and underline the possible interactions between beliefs and information.

CONCLUSION GÉNÉRALE

Mesurer le bien-être général de la population peut occulter une partie importante de la variabilité de cet indicateur au sein même de la population. La thèse propose d'utiliser le cadre riche d'étude de la province minière du Québec pour identifier et couvrir trois sources majeures d'hétérogénéité au sein de la population, qui sont susceptibles d'affecter les changements des préférences.

Un premier facteur d'hétérogénéité est incarné par la distance relative entre le lieu d'habitation de la personne interrogée dans l'enquête et la localisation du projet minier. Pour une large classe de biens et services environnementaux en évaluation non marchande, la valeur estimée des préférences est prédite diminuée avec la distance. Dans le contexte minier, nous testons la prédiction de cette relation pour différentes ressources minières évaluées à travers une enquête en ligne au Québec. L'idée est de comparer entre plusieurs minerais les effets de la distance de la mine.

Nos résultats en particulier mettent en évidence que la distance à la mine peut affecter les préférences des populations éloignées. La plupart des attributs du projet considérés dans notre enquête semblent en général insensibles aux effets de la distance. Seulement pour certains attributs du projet, les populations éloignées semblent exprimer des préférences plus élevées et ces effets peuvent varier d'un minerai à un autre. Les évidences empiriques suggèrent de ce fait que le type de ressource est une dimension importante à considérer pour évaluer de façon plus robuste l'importance du contexte géographique en analyse des préférences.

Un second facteur d'hétérogénéité mis en lumière est lié aux différences d'expériences entre les individus d'une même population. L'enquête porte sur l'évaluation d'un minerai souvent méconnu par le grand public, i.e. les terres rares. L'analyse vise à vérifier si dans le contexte du Québec une expérience indirecte avec un minerai alternatif (l'or) influence positivement l'adhésion des individus à un projet hypothétique d'extraction des terres rares.

Le questionnaire en ligne interroge les répondants sur différents niveaux d'expérience incluant les liens avec un réseau personnel dans le secteur minier, la visite de sites miniers, le niveau de familiarité avec l'or. L'analyse des préférences capture les effets de l'expérience et trouve en particulier qu'une meilleure familiarité avec une ressource connexe (l'or) peut contribuer à atténuer les effets persistants de réponses aléatoires souvent reportés dans les questionnaires distribués en ligne. Ce résultat suggère que même une expérience indirecte avec une ressource alternative peut contribuer à une estimation plus robuste des préférences.

Un dernier facteur mis en évidence est l'hétérogénéité des croyances au sein de la population. L'analyse des préférences propose d'une part d'évaluer les effets du type de l'information sur la valeur des préférences, d'autre part de tester ces effets selon les croyances des individus sur l'aubaine de la mine. Le travail de recherche considère deux types de messages : une information persuasive et une information scientifique. L'analyse des préférences étudie les effets de l'information dans deux contextes miniers (l'or versus l'uranium) afin de comparer les effets de l'information selon les croyances.

Similaire à la littérature des préférences déclarées, les résultats mettent en évidence de faibles effets ou des effets nuls de l'information sur la valeur moyenne de tous les individus. Plus intéressant, les effets de l'information génèrent plus de variabilité entre les groupes d'individus avec différentes croyances. Contrairement à l'hypothèse d'agent Bayésien souvent postulée dans la littérature, une même information peut entraîner des réactions différentes et opposées lorsque deux individus partagent des croyances opposées (opposants et supporters). L'étude des préférences montre notamment que le contexte d'évaluation compte dans la formulation et les interactions des croyances avec la nouvelle information. L'analyse empirique met ainsi en évidence qu'un contexte plus polémique comme dans le cas d'une mine d'uranium peut conduire à polariser les effets de l'information sur les préférences.

L'analyse des préférences moyennes peut masquer une part importante de la variabilité des préférences. En particulier, la thèse met en évidence des effets contrastés des préférences selon la proximité avec la mine, le niveau d'expérience et l'interaction des croyances avec l'information. Il en ressort que les populations locales expriment une perte de bien-être plus importante dans le cas d'une dégradation des conditions du projet minier. Les populations éloignées peuvent aussi être sensibles à des changements similaires mais considèrent un nombre plus restreint d'attributs. Les personnes plus familières et expérimentées avec les opérations minières accordent en moyenne plus de valeur aux aménagements favorables du projet. Tandis que l'information semble avoir un effet limité sur les préférences en moyenne, cette tendance masque en fait des effets plus différenciés entre les groupes d'individus avec différentes croyances.

L'analyse plus fine des préférences révèle que le critère de distance n'explique que partiellement les variations des préférences. Par exemple, certains minerais peuvent soulever des préoccupations plus globales chez la population. Bien que suggéré implicitement par une comparaison entre les ressources, la perception de l'individu sur la dangerosité d'un minerai pourrait être un élément explicatif de l'absence d'effet de la distance. L'analyse met en lumière aussi le rôle de l'expérience indirecte pour juger et mieux apprécier la valorisation d'un minerai méconnu. L'analyse des effets de l'information est enfin plus complexe au regard de l'importance des croyances. L'interaction des croyances avec l'information peut montrer que deux individus avec des croyances opposées réagissent dans des directions opposées sur leur niveau d'adhésion au projet minier.

Bien que la thèse vise à améliorer notre compréhension de la réceptivité des populations aux grands projets miniers, une série de limites peuvent être soulignée. L'emploi de la méthode des choix expérimentaux est sujet au biais hypothétique, situation dans laquelle est observée un écart entre les vraies préférences et les préférences déclarées par le répondant. La question de biais hypothétique est centrale avec cette méthode d'évaluation, et est particulièrement présente lorsque les individus disposent d'information insuffisantes sur la ressource évaluée. La thèse a contribué à pointer des sources importantes d'hétérogénéité des préférences, mais le focus de l'analyse des préférences ne porte pas sur la mesure des effets du biais hypothétique dus à l'utilisation de la méthode des choix expérimentaux. Les estimés obtenus des préférences dans la thèse peuvent être exposés à la présence potentielle de biais hypothétique, tandis que ces évidences empiriques donnent un aperçu de la potentielle variation des préférences.

Par ailleurs, l'analyse des préférences porte essentiellement sur trois sources principales d'hétérogénéité et laisse inexplorée les effets d'autres sources potentielles d'hétérogénéité. Par exemple, le format de présentation du questionnaire peut influencer la robustesse des résultats empiriques. Faire varier le nombre d'attributs, de niveaux, d'alternatives dans un scénario minier peut entraîner des variations dans les résultats des estimés de préférences. Enfin, le cadre d'étude ne permet pas de s'assurer de la validité externe des résultats dans d'autres provinces canadiennes ou d'autres pays. Une comparaison intra-individuelle permettrait d'enrichir la pertinence de l'analyse de l'hétérogénéité des préférences en renforçant la robustesse des résultats.

En conduisant l'analyse de l'hétérogénéité des préférences, cette thèse peut déboucher sur une série d'implications quant au design et à l'évaluation des politiques de gestion des ressources naturelles. Premièrement, la distance est un critère clé dans l'évaluation de l'adhésion de la population. Il est important que les politiques adaptées au milieu considèrent l'importance de l'hétérogénéité des ressources. Sans quoi, un projet peut être jugé socialement acceptable dans un contexte local sans pour autant emporter l'adhésion de la population générale. Deuxièmement, l'expérience est souvent considérée par les parties prenantes comme un facteur de légitimation dans le processus décisionnel. Les personnes les plus familières et les mieux expérimentées seraient donc plus légitimes pour se prononcer sur l'adhésion à un nouveau projet minier. Néanmoins, les évidences de la thèse mentionnent que les citoyens sont en mesure de se prononcer sur l'adhésion pour des minerais méconnus en se basant sur l'expérience avec minerai plus familier.

Enfin, la thèse peut donner des pistes de recommandation pour la conception de campagnes d'information plus efficaces sur les grands projets miniers. Il est important pour les promoteurs miniers et les décideurs publics de considérer qu'une même information peut avoir des effets dissonants au sein de la population. Les effets d'une campagne de communication peuvent avoir des effets plus complexes sur l'adhésion de la population. Ni les décideurs publics, ni les promoteurs miniers observent parfaitement les croyances/opinions des individus. Une clé de la communication est de contenir le climat de polarisation sociale au sein de la population. Des messages ciblés pour certaines catégories de la population (opposant/supporters) peuvent contribuer à ne pas aggraver la polarisation sociale.

La thèse conclut sur l'importance de l'hétérogénéité des préférences dans le contexte minier. Si les sources d'hétérogénéité ne sont pas prises en compte, l'analyse des préférences est limitée pour expliquer l'adhésion des projets miniers. Un certain nombre de limites au-delà de cette thèse peuvent donner matières à la poursuite de travaux de recherche plus approfondis. Une extension pourrait être par exemple de comparer les sestimés des préférences obtenues avec des scénarios hypothétiques avec des situations réelles. Dans cette perspective, les effets de la distance pourraient être détectés avec plus de précision en comparant un projet réel avec un projet hypothétique. Une autre dimension du travail de recherche peut se focaliser à évaluer comment l'information et l'expérience permettent de réduire les effets de biais hypothétiques, qui sont souvent présents dans les études de préférences déclarées.

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Appendix 1. Article 1

Appendix 1.A Quiz test about mining

1. Quand le Québec a-t-il exploité les premiers minerais ?
   - ☐ à partir de 1800
   - ☐ à partir de 1900
   - ☐ à partir de 1950
   - ☐ à partir de 2000
   - ☐ Je ne sais pas

2. Quand un gisement de minerai est découvert au Québec, qui est propriétaire du gisement en sous-sol ?
   - ☐ Entreprise minière
   - ☐ Habitant à proximité
   - ☐ État
   - ☐ Région
   - ☐ Je ne sais pas

3. Parmi les minerais suivants, lesquels ont des composantes radioactives :
   - ☐ Argent
   - ☐ Marbre
   - ☐ Uranium
   - ☐ Or
   - ☐ Je ne sais pas

4. Parmi les affirmations suivantes, une affirmation est fausse, laquelle ?
   - ☐ Les minerais proviennent des météorites.
   - ☐ L'argile est un minerai utilisé pour faire de la poterie.
   - ☐ Le gouvernement oblige les minières à restaurer le site après la fermeture de la mine.
   - ☐ Le fluor contenu dans le dentifrice est un minerai.
   - ☐ Je ne sais pas

5. Parmi ces objets du quotidien (*images pour aider*), cochez celui qui n'est pas constitué de(s) minerai(s) :
   - ☐ Bague en or
   - ☐ Voiture électrique
   - ☐ Feuille de papier
   - ☐ Ordinateur
   - ☐ Je ne sais pas

6. Parmi ces impacts sur l'environnement, cochez l'impact qui n'est pas dû à un projet minier ?
   - ☐ Pollution des eaux
   - ☐ Oiseaux tués
   - ☐ Émission de carbone
   - ☐ Érosion
   - ☐ Je ne sais pas

7. Lequel de ces éléments n'est pas un minerai ?
   - ☐ Terres rares
   - ☐ Graviers
   - ☐ Corail
   - ☐ Fer
   - ☐ Je ne sais pas

8. Parmi les villes suivantes, notez celles qui sont des villes minières ?
   - ☐ Schefferville
   - ☐ Montréal
   - ☐ Sherbrooke
   - ☐ Val d'Or
   - ☐ Je ne sais pas

Appendix 1.B RPL model: exclusion of respondents in big cities

	1) GOLD				2) URANIUM				3) RARE EARTHS			
	Main effects		**Interaction effects**		**Main effects**		**Interaction effects**		**Main effects**		**Interaction effects**	
	0-20km	**S.D.**	**20-100km**	**+100km**	**0-20km**	**S.D.**	**20-100km**	**+100km**	**0-20km**	**S.D.**	**20-100km**	**+100km**
ASC	-3.879***	-2.42***	-0.913	-1.019	-4.700***	-2.22***	0.511	0.879	-5.388***	-2.61***	1.942**	0.606
	(0.665)	(0.225)	(0.890)	(0.887)	(0.666)	(0.296)	(0.925)	(0.903)	(0.711)	(0.223)	(0.948)	(0.950)
Openpit mine	-0.854***	0.978***	-0.0175	0.402**	-1.047***	1.531***	-0.119	0.0959	-0.882***	1.260***	0.251	0.237
	(0.130)	(0.0869)	(0.174)	(0.171)	(0.156)	(0.111)	(0.220)	(0.210)	(0.147)	(0.0952)	(0.198)	(0.198)
Government monitoring	0.234*	0.624***	-0.191	-0.261	-0.0822	0.882***	0.0784	-0.0358	-0.207	0.694***	0.414**	0.248
	(0.132)	(0.122)	(0.179)	(0.179)	(0.142)	(0.122)	(0.200)	(0.196)	(0.142)	(0.103)	(0.193)	(0.192)
Firm monitoring	-0.662***	0.485***	-0.174	-0.147	-1.127***	0.814***	0.277	0.0498	-1.061***	0.598***	0.235	0.180
	(0.137)	(0.158)	(0.184)	(0.182)	(0.157)	(0.139)	(0.207)	(0.204)	(0.155)	(0.135)	(0.199)	(0.197)
Mediation	-0.126	0.106	-0.191	-0.0730	-0.0935	0.214*	0.0759	0.172	-0.355**	-0.125	0.245	0.317*
	(0.133)	(0.123)	(0.183)	(0.181)	(0.138)	(0.114)	(0.194)	(0.190)	(0.138)	(0.132)	(0.193)	(0.190)
Newspaper advertisement	-0.418***	0.0863	-0.0789	0.0119	-0.455***	0.467***	0.102	0.318	-0.513***	-0.368***	0.145	-0.00197
	(0.143)	(0.196)	(0.196)	(0.192)	(0.153)	(0.133)	(0.211)	(0.208)	(0.148)	(0.138)	(0.206)	(0.204)
Public partners	0.0831	-0.0346	-0.151	-0.241	-0.0573	0.252*	0.180	0.100	0.0780	0.550***	-0.164	-0.153
	(0.124)	(0.120)	(0.171)	(0.168)	(0.131)	(0.133)	(0.186)	(0.181)	(0.138)	(0.123)	(0.191)	(0.191)
Private partners	-0.386***	-0.68***	-0.244	-0.235	-0.438***	0.588***	0.126	0.255	-0.581***	0.549***	0.0977	0.0393
	(0.137)	(0.117)	(0.186)	(0.185)	(0.138)	(0.145)	(0.193)	(0.190)	(0.140)	(0.0981)	(0.192)	(0.192)
Job creation	0.0014***	-0.0021***	0.000198	-0.000159	0.00134***	0.00129***	-0.000319	-0.0000580	0.0009***	0.00159***	0.00068*	0.000018
	(0.000268)	(0.000199)	(0.000364)	(0.000364)	(0.000245)	(0.000277)	(0.000342)	(0.000334)	(0.000252)	(0.000217)	(0.0003)	(0.0003)
Tax rebate	0.00082**		0.000808*	0.000284	0.00130***		0.000338	0.000629	0.0015***		0.000168	-0.00009
	(0.00032)		(0.000440)	(0.000436)	(0.000338)		(0.000476)	(0.000468)	(0.000336)		(0.0004)	(0.0004)
# observations	11232				11016				10512			
# respondents	624				612				594			
Log-Likelihood	-3173.6				-3039.8				-2938.2			

Note: *i*) * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. S.D. give standard deviations for mean preference parameters supposed as random. Standard errors are in parenthesis.
ii) For each resource estimation model, the baseline is the mining area 0-20 kilometers, and the two following columns are interaction effects from 20-100km and more than 100km.
iii) ASC (Alternative specific constant) captures the Statu quo (SQ) effects. *iv*) Individual's preference is measured following a degradation in mining condition. The project baseline is an underground mine, monitored by an independent committee, partly supported by regional partners and co-constructed with the population. Adrien Corneille (202

Appendix 2. Article 2

Appendix 2.A Mixed logit model: interaction effects with experience

	1) Familiar with REEs	2) Familiar with gold	Visited a mine	Personal network
ASC	0.216 (0.424)	-0.088 (0.197)	-0.193 (0.189)	-0.297 (0.190)
SD ASC	3.305*** (0.172)	3.325*** (0.173)	3.321*** (0.172)	3.331*** (0.174)
Underground mine	0.159 (0.114)	0.369*** (0.046)	0.435*** (0.043)	0.398*** (0.043)
Monitoring Government	0.158 (0.144)	0.651*** (0.058)	0.678*** (0.055)	0.667*** (0.054)
Monitoring Committee	0.157 (0.148)	0.669*** (0.058)	0.598*** (0.055)	0.645*** (0.054)
Mediation	-0.040 (0.132)	0.133** (0.053)	0.166*** (0.049)	0.158*** (0.049)
Co-construction	0.134 (0.153)	0.315*** (0.062)	0.326*** (0.058)	0.289*** (0.057)
Public partners	0.646*** (0.143)	0.389*** (0.057)	0.323*** (0.053)	0.348*** (0.053)
Regional partners	0.577*** (0.139)	0.343*** (0.055)	0.294*** (0.051)	0.313*** (0.051)
Job creation	0.235*** (0.072)	0.355*** (0.029)	0.335*** (0.027)	0.287*** (0.027)
Tax rebate	0.00099*** (0.00012)	0.00099*** (0.00012)	0.00097*** (0.00011)	0.00098*** (0.00011)
ASC X experience	-0.573 (0.449)	-0.689** (0.326)	-0.570 (0.367)	-0.041 (0.363)
Underground X experience	0.317*** (0.121)	0.216*** (0.081)	0.011 (0.091)	0.178* (0.092)
Government X experience	0.591*** (0.153)	0.107 (0.104)	0.026 (0.114)	0.083 (0.116)
Committee X experience	0.541*** (0.156)	-0.085 (0.103)	0.188* (0.114)	-0.005 (0.116)
Mediation X experience	0.249* (0.140)	0.152* (0.091)	0.050 (0.102)	0.096 (0.103)
Co-construction X experience	0.234 (0.163)	0.101 (0.110)	0.073 (0.121)	0.243* (0.125)
Public partners X experience	-0.331** (0.152)	-0.107 (0.101)	0.113 (0.111)	0.009 (0.112)
Regional partners X experience	-0.285* (0.147)	-0.059 (0.096)	0.105 (0.106)	0.031 (0.108)
Job creation X experience	0.089 (0.077)	-0.140*** (0.051)	-0.104* (0.057)	0.110* (0.059)
# of observations	16 920	16 920	16 920	16 920

Appendix 3. Article 3

Appendix 3.A RPL models in context 2: uranium mining

	Pooling			Neutral groups		
	No information (control group)	Persuasive information	Scientific information	No information (control group)	Persuasive information	Scientific information
Coefficients						
ASC	4.241*** (0.458)	4.862*** (0.798)	5.769*** (0.740)	3.439*** (0.777)	5.978*** (1.086)	6.752*** (1.322)
Underground	0.588*** (0.0777)	0.582*** (0.134)	0.841*** (0.145)	0.708*** (0.126)	0.550** (0.226)	0.723*** (0.253)
Government	0.794*** (0.0824)	0.770*** (0.121)	0.818*** (0.138)	0.686*** (0.146)	0.856*** (0.197)	0.792*** (0.255)
Independent	0.820*** (0.0811)	0.744*** (0.125)	0.937*** (0.148)	0.901*** (0.152)	0.579*** (0.199)	1.187*** (0.262)
Mediation	0.201*** (0.0682)	0.136 (0.114)	0.235** (0.117)	0.0945 (0.123)	0.157 (0.170)	0.668*** (0.209)
Co-construction	0.267*** (0.0804)	0.362*** (0.127)	0.242* (0.143)	0.181 (0.140)	0.459** (0.198)	0.338 (0.256)
Public partners	0.325*** (0.0756)	0.631*** (0.119)	0.234* (0.139)	0.375*** (0.136)	0.674*** (0.189)	0.652*** (0.247)
Regional partners	0.237*** (0.0730)	0.383*** (0.114)	0.290** (0.123)	0.208* (0.124)	0.588*** (0.182)	0.439** (0.219)
500 jobs	0.388*** (0.0759)	0.424*** (0.128)	0.352*** (0.131)	0.283** (0.133)	0.572*** (0.192)	0.738*** (0.250)
800 jobs	0.523*** (0.0815)	0.835*** (0.138)	0.641*** (0.144)	0.425*** (0.140)	1.086*** (0.195)	0.793*** (0.253)
Tax rebate	0.0014*** (0.0002)	0.0016*** (0.0002)	0.0016*** (0.0003)	0.0010*** (0.0003)	0.0019*** (0.0004)	0.0026*** (0.0006)
Standard deviations						
ASC	3.685*** (0.281)	3.987*** (0.672)	3.679*** (0.324)	2.429*** (0.547)	3.288*** (0.516)	4.402*** (0.634)
Underground	1.030*** (0.0955)	1.369*** (0.198)	1.493*** (0.158)	0.901*** (0.170)	1.844*** (0.284)	1.767*** (0.287)
Government	0.591*** (0.100)	0.445* (0.242)	0.622*** (0.134)	0.902*** (0.160)	0.680*** (0.228)	1.042*** (0.227)
Independent	0.455*** (0.155)	0.582 (0.387)	0.962*** (0.180)	0.949*** (0.154)	0.690*** (0.246)	0.776*** (0.208)
Mediation	0.153 (0.132)	0.0706 (0.245)	0.216 (0.142)	0.356 (0.227)	0.337* (0.190)	0.0543 (0.243)
Co-construction	0.0160 (0.135)	0.482 (0.387)	0.445*** (0.167)	0.152 (0.154)	0.353 (0.277)	0.314 (0.234)
Public partners	0.296** (0.142)	0.180 (0.228)	0.493*** (0.145)	0.362 (0.327)	0.370* (0.213)	0.766*** (0.248)
Regional partners	0.210** (0.102)	0.179 (0.175)	0.0962 (0.130)	0.171 (0.257)	0.124 (0.237)	0.427** (0.167)
500 jobs	0.156 (0.217)	0.239 (0.246)	0.509*** (0.133)	0.497*** (0.173)	0.311 (0.215)	0.612** (0.268)
800 jobs	0.621*** (0.154)	0.530 (0.587)	1.055*** (0.167)	0.629*** (0.179)	0.444** (0.208)	1.068*** (0.297)
Log-Likelihood	-2703.3	-1203.0	-1232.6	-1006.1	-540.1	-446.5
Number of observations	9702	4518	4608	3618	1998	1710
Number of respondents	539	251	256	201	111	95

Appendix 3.A Continued

	Belief-based groups		
	No information (control group)	**Persuasive information**	**Scientific information**
Coefficients			
ASC	4.607***(0.619)	4.138***(1.039)	4.880***(0.929)
Underground	0.551***(0.102)	0.502**(0.209)	1.068***(0.198)
Government	0.887***(0.109)	0.835***(0.193)	0.797***(0.180)
Independent	0.804***(0.111)	1.102***(0.216)	1.018***(0.180)
Mediation	0.239***(0.0917)	0.00217(0.165)	0.0665(0.146)
Co-construction	0.300***(0.109)	0.317*(0.190)	0.264(0.178)
Public partners	0.289***(0.101)	0.587**(0.232)	-0.0886(0.220)
Regional partners	0.280***(0.0983)	0.314*(0.172)	0.220(0.156)
500 jobs	0.460***(0.0991)	0.324*(0.185)	0.252(0.163)
800 jobs	0.612***(0.117)	0.702***(0.211)	0.523***(0.197)
Tax rebate	0.00177***(0.00026)	0.00205***(0.00049)	0.00145***(0.00041)
Standard deviations			
ASC	3.038***(0.390)	3.253***(0.476)	3.050***(0.621)
Underground mine	1.117***(0.134)	1.834***(0.314)	1.337***(0.238)
Government	0.581***(0.170)	0.890**(0.384)	0.540**(0.265)
Independent	0.668***(0.136)	0.966***(0.227)	0.490**(0.228)
Mediation	0.197(0.192)	0.118(0.321)	0.125(0.176)
Co-construction	0.419***(0.141)	0.460 (0.284)	0.275(0.232)
Public partners	0.257(0.198)	1.086***(0.394)	1.076***(0.247)
Regional partners	0.219(0.200)	0.0811(0.211)	0.324*(0.170)
500 jobs	0.0382(0.169)	0.0967(0.284)	0.186(0.165)
800 jobs	0.991***(0.181)	1.129***(0.257)	1.248***(0.196)
Log-Likelihood	-1684.9	-644.3	-768.2
Number of observations	6084	2520	2898
Number of respondents	338	140	161

Note: * p≤0.1; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis.
Adrien Corneille (2020)

Appendix 3.B Information effects among opponents and supporters

	1) Opponents		2) Supporters		3) Opponents		4) Supporters	
	Main effect	Persuasive information	Main effect	Persuasive information	Main effect	Scientific information	Main effect	Scientific information
ASC	4.240***	-1.978	3.622***	0.719	4.233***	-0.253	3.971***	-1.847
	(1.070)	(1.684)	(0.706)	(1.144)	(1.048)	(1.729)	(0.755)	(1.236)
Undergr. mining	0.370**	-0.137	0.557***	-0.0258	0.290	0.0220	0.560***	-0.249
	(0.164)	(0.275)	(0.128)	(0.210)	(0.180)	(0.278)	(0.141)	(0.267)
Gov. monitoring	0.572**	0.202	1.033***	0.0253	0.589***	0.432	1.054***	-0.560**
	(0.232)	(0.374)	(0.148)	(0.233)	(0.206)	(0.335)	(0.143)	(0.239)
Com. monitoring	0.728***	-0.216	0.912***	-0.0945	0.797***	0.600*	0.965***	-0.495*
	(0.219)	(0.364)	(0.132)	(0.212)	(0.190)	(0.319)	(0.154)	(0.274)
Mediation	0.147	-0.129	0.290**	-0.0624	0.0900	0.258	0.328**	0.331
	(0.186)	(0.306)	(0.123)	(0.199)	(0.177)	(0.281)	(0.128)	(0.228)
Co-construction	0.208	-0.473	0.341**	0.345	0.260	0.181	0.395**	0.389
	(0.243)	(0.398)	(0.147)	(0.248)	(0.209)	(0.334)	(0.154)	(0.271)
Public partners	0.293	0.143	0.462***	-0.208	0.264	0.392	0.455***	-0.515**
	(0.195)	(0.331)	(0.136)	(0.221)	(0.184)	(0.303)	(0.143)	(0.255)
Regional partners	0.537***	-0.219	0.262**	0.224	0.501***	-0.00253	0.278**	-0.0159
	(0.205)	(0.347)	(0.131)	(0.218)	(0.184)	(0.295)	(0.129)	(0.230)
Job creation	0.0010***	-0.000185	0.002***	0.0000242	0.0011***	-0.0013***	0.002***	-0.000663
	(0.00037)	(0.000607)	(0.000295)	(0.000474)	(0.000327)	(0.000511)	(0.000321)	(0.000567)
Tax rebate	0.000626		0.0013***		0.000343		0.0017***	
	(0.000417)		(0.000269)		(0.000361)		(0.000295)	
Preference heterogeneity	YES		YES		YES		YES	
# of observations	2484		4986		2664		4626	
Log-Likelihood	-698.6		-1318.6		-717.4		-1208.4	

Note: * p≤0.1; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis. Adrien Corneille (2020)

Appendix 3.B Continued

	5) Opponents		6) Supporters		7) Opponents		8) Supporters	
	Main effect	Persuasive information	Main effect	Persuasive information	Main effect	Scientific information	Main effect	Scientific information
ASC	4.765*** (0.804)	1.359 (1.455)	3.566*** (0.781)	-2.054 (1.350)	5.294*** (0.824)	-0.437 (1.387)	3.994*** (0.792)	1.436 (1.390)
Undergr. mining	0.514*** (0.144)	0.0779 (0.257)	0.770*** (0.138)	-0.0862 (0.258)	0.422*** (0.151)	0.368 (0.267)	0.823*** (0.142)	0.113 (0.259)
Gov. monitoring	1.084*** (0.161)	-0.187 (0.278)	0.948*** (0.158)	-0.366 (0.275)	1.039*** (0.160)	-0.123 (0.291)	0.940*** (0.152)	-0.214 (0.268)
Com.monitoring	0.896*** (0.154)	0.219 (0.273)	0.846*** (0.151)	-0.182 (0.276)	0.932*** (0.168)	0.353 (0.291)	0.844*** (0.158)	-0.223 (0.284)
Mediation	0.408*** (0.131)	-0.287 (0.237)	0.235* (0.134)	-0.167 (0.242)	0.384*** (0.134)	-0.484** (0.243)	0.225* (0.132)	0.199 (0.238)
Co-construction	0.324** (0.159)	0.215 (0.302)	0.385** (0.156)	-0.277 (0.286)	0.360** (0.157)	-0.435 (0.289)	0.430*** (0.166)	0.328 (0.315)
Public partners	0.469*** (0.154)	0.224 (0.278)	0.166 (0.145)	0.265 (0.265)	0.420** (0.166)	-0.649** (0.293)	0.175 (0.152)	0.0321 (0.285)
Regional partners	0.340** (0.140)	-0.143 (0.258)	0.307** (0.138)	-0.0723 (0.253)	0.370*** (0.140)	-0.297 (0.264)	0.354*** (0.137)	-0.0618 (0.252)
Job creation	0.000409 (0.000272)	0.000864* (0.000496)	0.00174*** (0.000310)	-0.000664 (0.000569)	0.000300 (0.000289)	0.000680 (0.000529)	0.00173*** (0.000319)	-0.000616 (0.000594)
Tax rebate	0.00124*** (0.000311)		0.00237*** (0.000319)		0.00109*** (0.000309)		0.00256*** (0.000336)	
Pref. heterogeneity	YES		YES		YES		YES	
# of observations	4788		3816		5022		3960	
Log-Likelihood	-1271.3		-996.2		-1326.4		-1065.4	

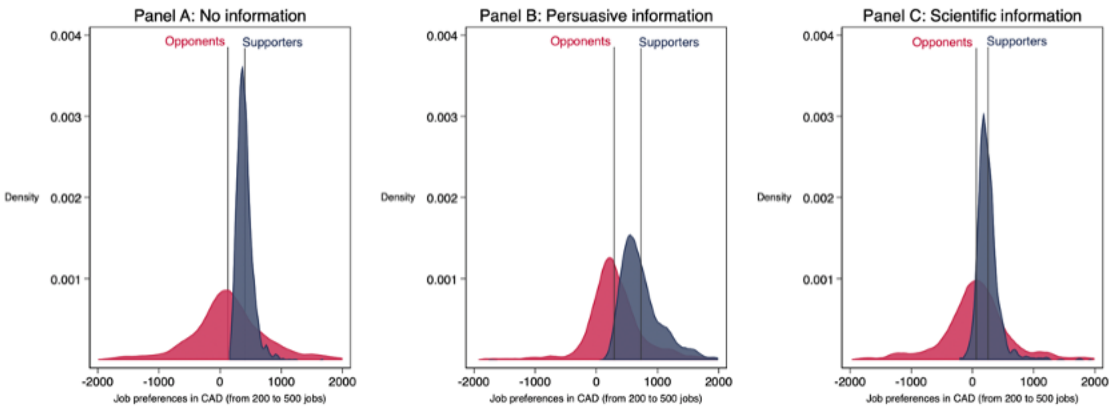
Note: * p≤0.1; ** p≤0.5; *** p≤0.01. Standard errors are in parenthesis.
Adrien Corneille (2020)

Appendix 3.C G-MNL model type 2: scale effects

	(1) Gold		(2) Uranium		(3) Rare earths	
Panel A: Preference coefficients						
ASC	0.0947	(0.170)	0.649***	(0.185)	0.512***	(0.176)
T	0.0011***	(0.0001)	0.0016***	(0.0002)	0.0015***	(0.0002)
X_1 (underground mining)	0.506***	(0.0593)	0.713***	(0.0769)	0.552***	(0.0683)
X_{21} (gov. monitoring)	0.761***	(0.0705)	0.733***	(0.0784)	0.804***	(0.0793)
X_{22} (indep. committee)	0.762***	(0.0713)	0.816***	(0.0834)	0.840***	(0.0818)
X_{31} (info. session)	0.192***	(0.0470)	0.212***	(0.0493)	0.262***	(0.0555)
X_{32}(co-construction)	0.360***	(0.0586)	0.299***	(0.0591)	0.478***	(0.0683)
X_{41} (public-private partners)	0.340***	(0.0561)	0.380***	(0.0622)	0.443***	(0.0673)
X_{42} (regional partners)	0.375***	(0.0558)	0.297***	(0.0558)	0.386***	(0.0624)
X_{51} (500 jobs)	0.441***	(0.0568)	0.443***	(0.0625)	0.571***	(0.0678)
X_{52} (800 jobs)	0.768***	(0.0732)	0.688***	(0.0741)	0.775***	(0.0765)
Panel B: Standard deviations						
η_{ASC}	2.958***	(0.154)	3.367***	(0.165)	3.193***	(0.178)
η_1	0.968***	(0.0889)	1.208***	(0.115)	1.155***	(0.110)
η_{21}	0.626***	(0.102)	0.619***	(0.110)	-0.719***	(0.106)
η_{22}	-0.598***	(0.104)	0.434***	(0.114)	0.661***	(0.126)
η_{31}	-0.213*	(0.117)	0.13	(0.0839)	0.195*	(0.108)
η_{32}	0.243**	(0.122)	0.104	(0.229)	0.313***	(0.110)
η_{41}	0.0144	(0.184)	0.337***	(0.117)	0.518***	(0.112)
η_{42}	0.224	(0.143)	0.124	(0.0990)	0.251	(0.159)
η_{51}	0.0581	(0.122)	-0.193*	(0.103)	0.307**	(0.123)
η_{52}	-0.825***	(0.0933)	-0.582***	(0.117)	0.719***	(0.123)
Panel C: Scale function						
T2	0.160	(0.111)	0.352***	(0.133)	0.0138	(0.104)
T3	0.203	(0.126)	0.293**	(0.134)	0.00979	(0.128)
Opponents	-0.0761***	(0.0262)	0.0323	(0.0222)	-0.0784***	(0.0221)
Supporters	0.0719***	(0.0142)	0.0857***	(0.0181)	0.0380**	(0.0178)
T2 X Opponents	-0.027	(0.046)	-0.052	(0.037)	0.0009	(0.03)
T2 X Supporters	-0.0435*	(0.023)	-0.033	(0.033)	0.051*	(0.028)
T3 X Opponents	0.099**	(0.047)	-0.071*	(0.039)	-0.009	(0.03)
T3 X Supporters	-0.013	(0.028)	-0.092**	(0.036)	0.009	(0.029)
τ (scale heterogeneity)	0.00429	(0.0829)	0.541***	(0.106)	0.360***	(0.0532)
Log-likelihood		-5437.6		-5435.3		-4962.3
Pseudo-R^2		0.145		0.153		0.151
AIC/n		0.60		0.58		0.59
Observations		18.306		18.828		16.938
Number of respondents		1017		1046		941

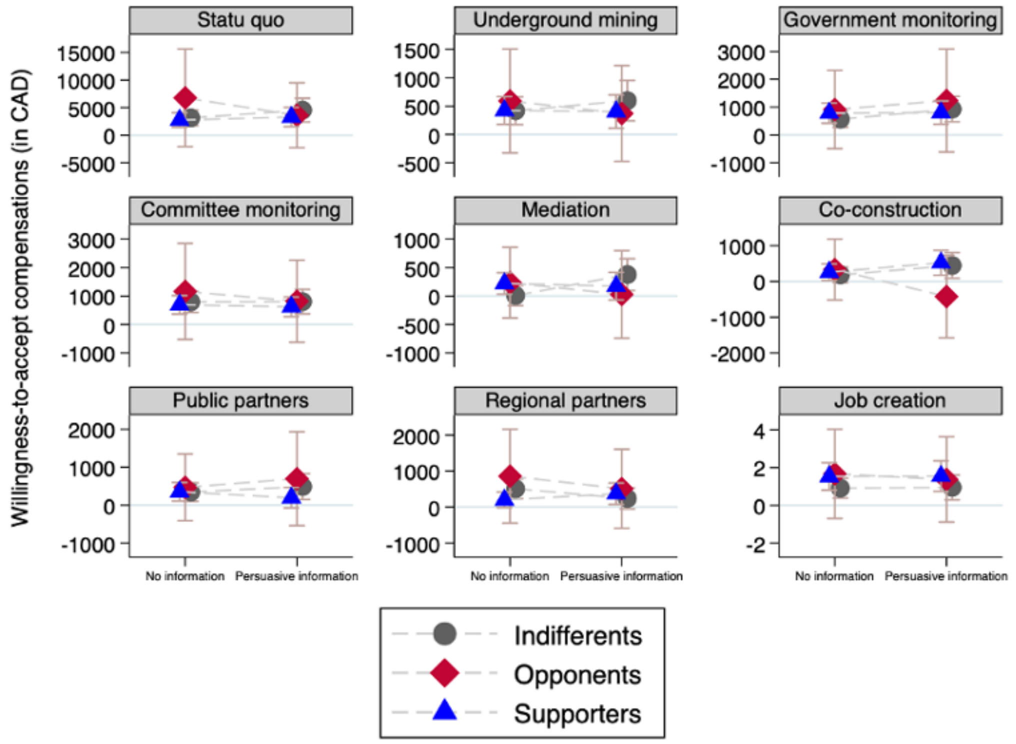
Note: * p ≤ 0.10 ; ** p ≤ 0.5 ; *** p ≤ 0.01. Standard errors in parenthesis.

Appendix 3.D Job preferences in context 1 of gold mining

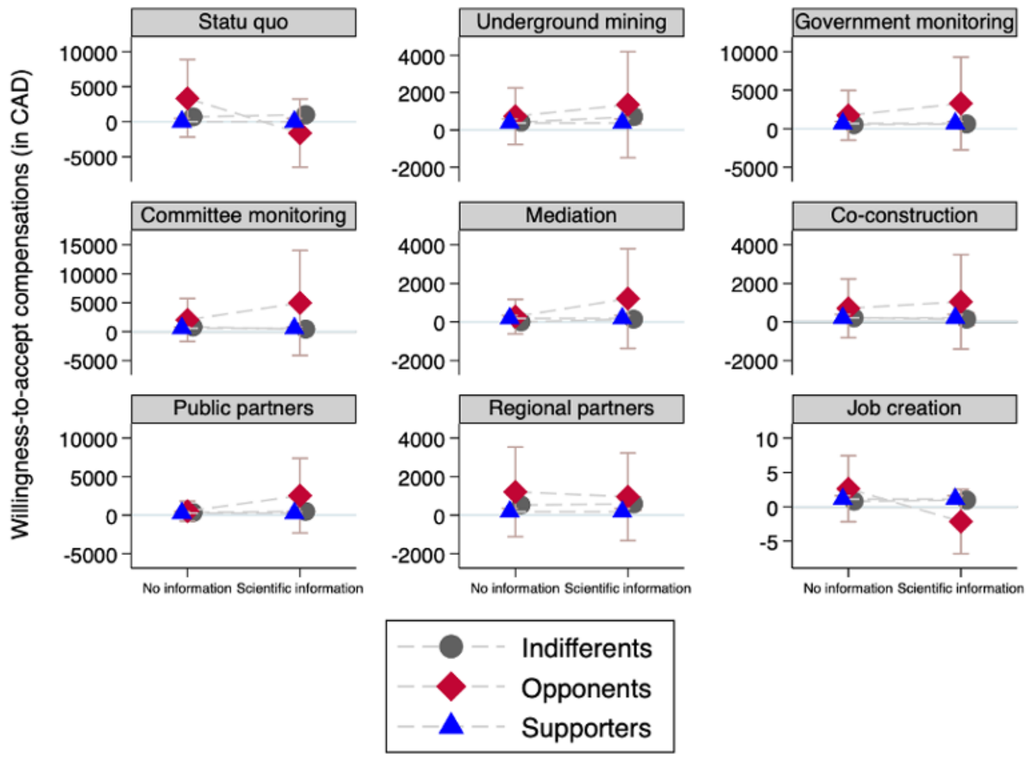


Appendix 3.E Effects of information on average WTA: context 1

Panel A: the effects of persuasive information

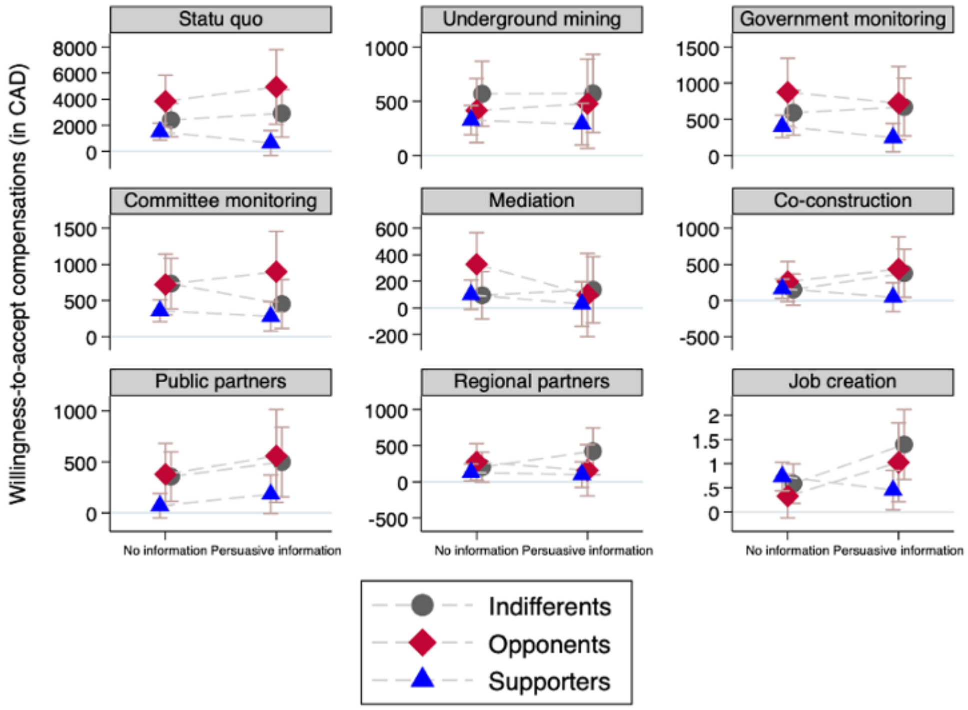


Panel B: the effects of scientific information

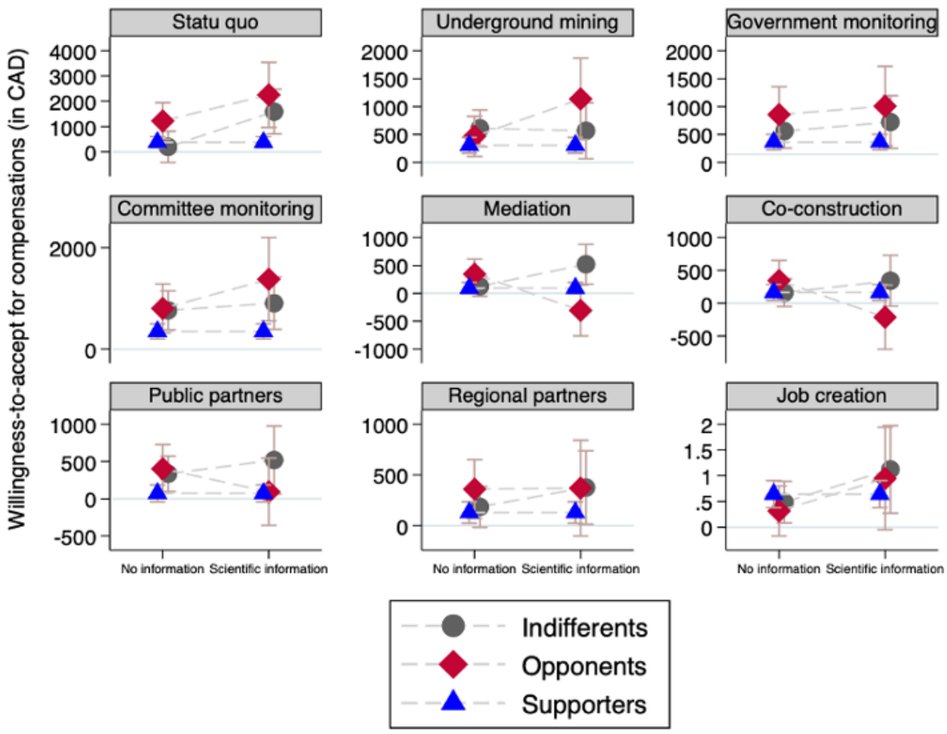


Appendix 3.F Effects of information on average WTA: context 2

Panel A: the effects of persuasive information



Panel B: the effects of scientific information



fAppendix 4. Survey questionnaire

Enquête sur l'acceptabilité sociale de nouveaux
projets miniers au Québec

Chercheure principale : Jie He, Professeure titulaire, Département d'économique, Université de Sherbrooke

OBJECTIF DE L'ENQUÊTE

Notre enquête vise à sonder les attentes de la population quand de nouveaux projets miniers se mettent en place au Québec.

L'idée est d'identifier quels sont les points d'accord et de désaccord entre le promoteur minier et la population.

Les résultats de l'enquête permettront de valoriser les principaux déterminants de l'acceptabilité sociale et pourront aider les minières à aller dans le sens des attentes de la population.

FINANCEMENT DU PROJET DE RECHERCHE

Le chercheur a reçu des fonds du Fonds de recherche du Québec – Nature et technologies (FRQNT) et le Ministère de l'énergie et des ressources naturelles (MERN) pour mener à bien ce projet. Le projet recevra également le support technique et financier de l'entreprise ArcelorMittal dans la réalisation de certaines activités du projet (conception des scénarios de projets miniers, stage pour étudiant). Les fonds reçus couvrent les frais reliés à ce projet de recherche.

VOTRE PARTICIPATION

Le questionnaire consiste à remplir 46 questions pour une durée approximative de 20-30 minutes. Les questions portent sur des informations socio-économiques, vos connaissances et votre opinion sur le secteur minier, ainsi que vos choix parmi différentes options de projets miniers.

Sachez qu'il n'y a pas de bonnes ou de mauvaises réponses. Nous souhaitons valoriser votre opinion et votre expérience avant tout.

Le questionnaire se présente en quatre parties :

Section A : Votre opinion sur le secteur minier
Section B : Quiz sur la connaissance des minerais
Section C : Propositions de projets miniers
Section D : Informations socio-économiques

ANONYMAT ET CONSERVATION DES DONNÉES

La participation au questionnaire est totalement anonyme. Il ne sera donc pas possible de vous identifier après avoir participé à l'enquête. Les données recueillies seront conservées pour une période n'excédant pas 10 ans. Après cette période, les données seront détruites. Aucun renseignement permettant d'identifier les personnes participant à l'étude n'apparaître dans aucune documentation.

ATTESTATION DE CONSENTEMENT

Le simple retour du questionnaire rempli est considéré comme l'expression implicite de votre consentement à participer à l'enquête.

POUR TOUS RENSEIGNEMENTS SUPPLÉMENTAIRES

Veuillez nous contacter au 1-819-821-8000, au numéro sans frais 1-800-267-8337 poste 62360 ou par courriel :

- Adrien Corneille (Adrien.Corneille@USherbrooke.ca)
- Jie He (Jie.He@USherbrooke.ca)

Le Comité d'éthique de la recherche Lettres et sciences humaines de l'Université de Sherbrooke a approuvé ce projet de recherche et en assure le suivi. De plus, il approuvera au préalable toute révision et toute modification apportée au formulaire d'information et de consentement, ainsi qu'au protocole de recherche.

Vous pouvez parler de tout problème éthique concernant les conditions dans lesquelles se déroule votre participation à ce projet avec la responsable du projet ou expliquer vos préoccupations à M. Olivier Laverdière, président du Comité d'éthique de la recherche Lettres et sciences humaines, en communiquant par l'intermédiaire de son secrétariat au numéro suivant : 1-800-267-8337 poste 62644, ou par courriel à: cer_lsh@USherbrooke.ca.

SECTION A – VOTRE OPINION SUR LE SECTEUR MINIER

1. **Sur les propositions suivantes, indiquez à quel point vous êtes en accord ou en désaccord :**

1.1 L'indépendance énergétique du Québec passe par :...					
le développement des énergies solaires	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
l'exploitation du gaz de schiste	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
le développement des énergies éoliennes	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
l'exploitation du charbon	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
le développement nucléaire	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
la construction de barrages hydroélectriques	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐

1.2 Habiter à proximité d'une mine augmente les risques de ...					
maladie respiratoire	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
cancer	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
maladie cardiovasculaire	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐
maladie de la peau	Totalement en désaccord ☐	Désaccord ☐	Pas d'avis ☐	D'accord ☐	Totalement d'accord ☐

2. Indiquez votre niveau de confiance pour chacune des propositions suivantes :

2.1 Aujourd'hui, les entreprises minières au Québec réussissent à mieux contrôler leurs impacts sur :					
Eau	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Air	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Faune et Flore	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Vibrations du sol	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Poussières	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Bruit	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐

2.2. Quand un nouveau projet minier s'implante au Québec, votre niveau de confiance pour les acteurs suivants sont :					
Gouvernement fédéral	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Gouvernement provincial	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Municipalité régionale de comté	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Municipalité	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Industrie minière	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Compagnie minière québécoise	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Compagnie minière canadienne	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Compagnie minière étrangère	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐
Association pour l'environnement	Très confiant ☐	Confiant ☐	Peu confiant ☐	Aucune confiance ☐	Ne sais pas ☐

SECTION B. QUIZ SUR LA CONNAISSANCE DES MINERAIS

9. Quand le Québec a-t-il exploité ses premiers minerais ?

- ☐ à partir de 1800
- ☐ à partir de 1900
- ☐ à partir de 1950
- ☐ à partir de 2000
- ☐ Je ne sais pas

10. Quand un gisement de minerai est découvert au Québec, qui est propriétaire du gisement en sous-sol ?

- ☐ Entreprise minière
- ☐ Habitant à proximité
- ☐ État
- ☐ Région
- ☐ Je ne sais pas

11. Parmi les minerais suivants, lesquels ont des composantes radioactives :

- ☐ Argent
- ☐ Marbre
- ☐ Uranium
- ☐ Or
- ☐ Je ne sais pas

12. Parmi les affirmations suivantes, une affirmation est fausse, laquelle ?

- ☐ Une compagnie titulaire d'un titre minier peut faire une demande d'expropriation d'un propriétaire terrien auprès de l'État.
- ☐ Au Québec, une zone tampon oblige une mine à être localisée dans un rayon de 6km.
- ☐ L'exploration minière est interdite dans les parcs naturels et les aires protégées.
- ☐ Le gouvernement oblige les minières à restaurer le site après la fermeture de la mine.
- ☐ Je ne sais pas

13. Parmi ces objets du quotidien, cochez celui qui n'est pas constitué de(s) minerai(s) :

- ☐ Bague en or
- ☐ Voiture électrique
- ☐ Feuille de papier
- ☐ Ordinateur
- ☐ Je ne sais pas

14. Parmi ces impacts sur l'environnement, cochez l'impact qui est le moins probable d'arriver à cause d'un projet minier ?

- ☐ Pollution des eaux
- ☐ Oiseaux tués
- ☐ Émission de carbone
- ☐ Érosion du sol
- ☐ Je ne sais pas

15. Lequel de ces éléments n'est pas un minerai ?

- ☐ Terres rares
- ☐ Graviers
- ☐ Corail
- ☐ Fer
- ☐ Je ne sais pas

16. Parmi les villes suivantes, notez celles qui sont des villes minières ?

NB : *Une ville minière se définit comme une ville construite en partie par une entreprise minière qui exploite un gisement.*

- ☐ Schefferville
- ☐ Montréal
- ☐ Sherbrooke
- ☐ Val d'Or
- ☐ Je ne sais pas

17. Avez-vous consulté un moteur de recherche comme par exemple Google pour répondre aux questions du quiz ?

- ☐ Oui
- ☐ Non

17.1. (Si oui) Parmi les huit questions, combien de fois avez-vous utilisé le moteur de recherche ?

18. Avez-vous demandé à une personne de votre entourage pour vous aider à répondre aux questions du quiz ?

- ☐ Oui
- ☐ Non

18.1. (Si oui) Parmi les huit questions, combien de fois avez-vous sollicité une personne de votre entourage ?

SECTION C. NOUVEAUX PROJETS MINIERS

Cette section vise à sonder les attentes de la population. Plusieurs projets miniers hypothétiques vous seront proposés. En fonction de vos choix, nous pourrons mieux comprendre les préoccupations de la population.

Dans quelle région habitez-vous ?

1. Mise en contexte :

Un promoteur souhaite développer un nouveau projet minier d' **[or ; uranium ; terres rares]** situé **[entre 0 et 20km ; entre 20km et 100 km ; plus de 100 km]** de votre lieu d'habitation. Le projet sera en opération pour une période de 20 ans. Le promoteur veut s'assurer que son projet puisse convenir à la population. Après avoir identifié des gisements avec une rentabilité suffisante, le promoteur hésite encore entre deux plans de projet.

D'après le promoteur, chacun des deux plans de projet contribuera largement au développement de l'économie locale et régionale (ex : *contrat prioritaire avec les entreprises locales, embauche prioritaire d'employés locaux, construction d'aréna, d'écoles*).

Les retombées économiques du projet seront les mêmes pour les deux plans de projet.

Du point de vue du Gouvernement, chacun des deux plans de projet minier respecte les normes environnementales sur la faune, la flore, la qualité de l'air et la qualité de l'eau. Le promoteur prévoit un plan de réhabilitation du site après la fermeture de la mine.

2. Votre opinion sur la mine

2.1. L'ouverture de la nouvelle mine est-elle préférable à la situation actuelle (c'est-à-dire *pas de mine*) ?

Je suis certain(e) que la nouvelle mine présente plus d'inconvénients.								Je ne suis pas certain(e) que la nouvelle mine présente plus d'inconvénients ni plus d'avantages	Je suis certain(e) que la nouvelle mine présente plus d'avantages.							
8	7	6	5	4	3	2	1	0								
								☐								

Note : Les niveaux 8 et -8 marquent le degré de certitude le plus fort. Les niveaux 1 et -1 indiquent le degré de certitude le plus faible. Le niveau 0 indique aucune certitude.

3. Description des caractéristiques du nouveau projet minier

Le promoteur prend en compte 6 caractéristiques pour concevoir un plan de projet minier. Veuillez prendre connaissance des caractéristiques suivantes.

Note : les logos et les photos de type de mine ont été obtenus à partir de Google Image en accès public.

Questionnaire – Minerai “Or

3.1. Savez-vous que : (Version 2 – or)	L’extraction de l’or nécessite des procédés chimiques polluants à base de cyanure et d’arsenic. Durant l’extraction, la technologie actuelle permet de contrôler et de surveiller en permanence les impacts miniers sur l’eau.

OU

3.1. Savez-vous que : (Version 3 – or)	L’or est utilisé pour la fabrication de biens de luxe comme les bijoux, de circuits électroniques. Les dentistes utilisent l’or dans les couronnes et les plombages.

Questionnaire – Minerai “uranium“

3.1. Savez-vous que : (Version 2 – uranium)	L’extraction de l’uranium peut libérer un gaz radioactif appelé le radon. La technologie actuelle permet de contrôler et de surveiller en permanence les émissions du radon.

OU

3.1. Savez-vous que : (Version 3 – uranium)	L’uranium est utilisé en radiologie et dans les traitements du cancer. L’uranium est aussi utilisé dans les centrales nucléaires pour produire de l’électricité contribuant à réduire les émissions de gaz à effet de serre.

Questionnaire – Minerai “terres rares“

3.1. Savez-vous que : (Version 2 – terres rares)	Dans certains cas, l’extraction des terres rares peut conduire à libérer des éléments radioactifs. Une nouvelle technologie est développée pour limiter les dommages sur l’environnement au minimum.

OU

3.1. Savez-vous que : (Version 3 – terres rares)	Les terres rares sont utilisées dans la fabrication des éoliennes, des batteries de voitures électriques ainsi que les téléphones intelligents (IPhone).

Plusieurs projets vous seront proposés. Pour chaque projet, vous êtes invité(e) à indiquer le plan de projet que vous préférez. Si aucun de ces plans ne vous convient, vous avez la possibilité **de ne pas accepter le projet** du promoteur en choisissant l'option « *statu quo* ».

3.1. Quel plan de projet préférez-vous ? Si aucun plan ne vous convient, vous pouvez choisir l'option statu quo.

Série de 6 ensembles de choix à remplir par le répondant.

3.2. Avez-vous ignoré une ou plusieurs caractéristiques du projet ?

☐ Oui
☐ Non

3.2.1.(Si oui) Quelles sont la ou les caractéristiques que vous avez ignorées dans vos choix de plans de projet ?

☐ Type de mine
☐ Suivi de la qualité de l'eau
☐ Attitude du promoteur
☐ Structure du partenariat
☐ Création d'emplois
☐ Diminution des taxes par an dans les 10 ans à venir

3.3. Si vous avez choisi l'option « *Statu quo* » une ou plusieurs fois, cochez le(s) case(s) qui peu(ven)t expliquer le mieux vos choix.

Le promoteur ne prend pas en compte mon attachement au territoire.	☐
Le promoteur n'a pas inclus la transformation du minerai dans les plans de projet.	☐
La technologie utilisée pour extraire le minerai est trop risquée.	☐
Selon moi, les bénéfices économiques du projet ne sont pas suffisants pour compenser les coûts associés au projet.	☐
Il existe d'autres projets industriels plus intéressants que des projets miniers.	☐
Un nouveau projet minier n'est pas compatible avec ma tranquillité de vie.	☐
Je ne veux pas que le nouveau projet minier dégrade l'environnement.	☐
Je suis contre le développement minier.	☐
Je suis contre l'extraction du minerai présenté.	☐
Les plans de projet n'avaient pas de sens pour moi d'où l'option statu quo.	☐
Autre raison (*expliquez brièvement ci-dessous svp)*	☐

Maintenant nous allons vous poser des questions sur le futur. Nous vous demanderons le % de chance qu'un événement se produise. Des réponses comme par exemple 2% ou 5% signifie que l'événement aura presque aucune chance de se réaliser ; 20% signifie très peu de chance ; 45% ou 55% signifie quasiment une chance égale ; 80 % signifie de très bonne chance ; 95% ou 98% signifie quasiment certain que l'événement se réalise.

Pour répondre aux questions (3.6.) à (3.9.), vous pouvez indiquer le % de chance de l'événement en valeur précise OU donner un intervalle en %.

3.4. D'après vous, quelle est le % de chance que les impacts miniers de l'OR soient similaires aux impacts miniers de l'URANIUM ?
Note : Vous pouvez indiquez la valeur précise en % OU donner un intervalle en %.

☐ Entre 0% et 10% ☐ Entre 50% et 60% ☐ Entre 90% et 100%
☐ Entre 10% et 20% ☐ Entre 60% et 70%
☐ Entre 20% et 30% ☐ Entre 70% et 80%
☐ Entre 40% et 50% ☐ Entre 80% et 90%

3.5. D'après vous, quel est le % de chance que les impacts miniers de l'OR soient similaires aux impacts miniers de TERRES RARES ?

☐ Entre 0% et 10% ☐ Entre 50% et 60% ☐ Entre 90% et 100%
☐ Entre 10% et 20% ☐ Entre 60% et 70%
☐ Entre 20% et 30% ☐ Entre 70% et 80%
☐ Entre 40% et 50% ☐ Entre 80% et 90%

3.6. Durant les 10 prochaines années, quelle est le % de chance que l'ouverture de la mine d' [OR ; URANIUM ; TERRES RARES] conduise à la construction d'une [FONDERIE ; CENTRALE NUCLÉAIRE ; CONSTRUCTION D'UN PARC AUTOMOBILE DE VOITURE ÉLECTRIQUE] au Québec?

☐ Entre 0% et 10% ☐ Entre 50% et 60% ☐ Entre 90% et 100%
☐ Entre 10% et 20% ☐ Entre 60% et 70%
☐ Entre 20% et 30% ☐ Entre 70% et 80%
☐ Entre 40% et 50% ☐ Entre 80% et 90%

3.7. Dans les 12 prochains mois, une offre d'emploi minier se présente à vous avec un salaire égal ou supérieur à votre dernier emploi. La minière située [entre 0 et 20 km ; entre 20km et 100km ; plus de 100km] vous propose de vous payer les coûts de transport ou de déménagement. Quelle est la probabilité que vous travaillez pour la minière d' [OR / URANIUM / TERRES RARES] ?

☐ Entre 0% et 10% ☐ Entre 50% et 60% ☐ Entre 90% et 100%
☐ Entre 10% et 20% ☐ Entre 60% et 70%
☐ Entre 20% et 30% ☐ Entre 70% et 80%
☐ Entre 40% et 50% ☐ Entre 80% et 90%

Quelle est le % de chance que les impacts miniers de la nouvelle miner située [entre 0 et 20 km ; entre 20km et 100km ; plus de 100km] contaminent la fourniture en eau dans votre district ?

☐ Entre 0% et 10% ☐ Entre 50% et 60% ☐ Entre 90% et 100%
☐ Entre 10% et 20% ☐ Entre 60% et 70%
☐ Entre 20% et 30% ☐ Entre 70% et 80%
☐ Entre 40% et 50% ☐ Entre 80% etSECTION D – INFORMATIONS

Section. SOCIO-ÉCONOMIQUES

1. Vous êtes :
   - ☐ Une femme
   - ☐ Un homme

2. Votre statut matrimonial :
   - ☐ Marié(e)
   - ☐ Divorcé(e)
   - ☐ Célibataire
   - ☐ Conjoint(e) de fait
   - ☐ Veuf(ve)

3. Quel est votre âge :
   - ☐ Entre 18 et 24 ans
   - ☐ Entre 25 et 34 ans
   - ☐ Entre 35 et 44 ans
   - ☐ Entre 45 et 54 ans
   - ☐ Entre 55 et 64 ans
   - ☐ Entre 65 et 74 ans
   - ☐ 75 ans ou plus

4. Combien d'enfants avez-vous à charge dans votre foyer ?

5. Indiquez le code postal de votre résidence principale (ex. j1j4b6) :

5.1. Depuis quand résidez-vous à cette adresse ?
- ☐ Entre 1 mois et 6 mois
- ☐ Plus de 6 mois à 12 mois
- ☐ Entre 13 mois et 24 mois
- ☐ Entre 3 ans et 5 ans
- ☐ Plus de 6 ans

6. La fourniture de l'eau dans votre logement provient de :
- ☐ la municipalité
- ☐ un puits privé

7. Êtes-vous :
- ☐ Locataire
- ☐ Propriétaire

8. Vivez-vous à proximité d'une mine (dans un rayon de 10 km)?
- ☐ Oui, proche d'une mine en activité
- ☐ Oui, proche d'une mine fermée
- ☐ Non
- ☐ Je ne sais pas

9. Avez-vous une résidence secondaire (par exemple, chalet) ?
- ☐ Oui
- ☐ Non

9.1. Si oui, quel est le code postal de votre résidence secondaire ?

9.2. La fourniture de l'eau de votre seconde résidence provient de:
- ☐ la ville
- ☐ un puits privé

10. À quel niveau se situe la dernière année de scolarité que vous avez terminée?
- ☐ Primaire
- ☐ Secondaire
- ☐ DEP
- ☐ Collégial
- ☐ Universitaire
- ☐ Je préfère ne pas répondre

11. Avez-vous déjà travaillé dans le secteur minier ?
- ☐ Oui
- ☐ Non

12. Parmi votre entourage proche, connaissez-vous une (des) personne(s) ayant travaillé dans les mines ?
    - ☐ Oui
    - ☐ Non

    12.1. Si oui,

☐ Famille	☐ Ami(e)s
☐ Collègue(s)	☐ Autres – Précisez .....

13. Avez-vous déjà visité une mine ?
    - ☐ Oui, une mine souterraine
    - ☐ Oui, une mine à ciel ouvert
    - ☐ Non
14. Cochez la case du domaine d'emploi qui correspond le mieux à votre emploi actuel. Si aucune case ne correspond à votre catégorie, vous pouvez le noter dans la case autre.
    - ☐ Association environnementale
    - ☐ Autre type d'association : Précisez ....
    - ☐ Gouvernement
    - ☐ Mines
    - ☐ Au foyer
    - ☐ Statut étudiant
    - ☐ Retraite (pré-retraite, rentier)
    - ☐ Sans emploi (Assurance-emploi, assisté social,...)
    - ☐ Catégorie d'emploi autre - spécifiez
15. Parmi les catégories suivantes, laquelle reflète le mieux le REVENU total de votre ménage avant impôt pour l'année 2016 ?
    - ☐ 9 999$ et moins
    - ☐ Entre 10 000$ et 29 999$
    - ☐ Entre 30 000$ et 49 999$
    - ☐ Entre 50 000$ et 74 999$
    - ☐ Entre 75 000$ et 99 999$
    - ☐ Entre $100 000 et $149 999
    - ☐ $150 000 et plus
16. (Si propriétaire à la question 7) La valeur marchande de votre logement au prix actuel du marché est environ :
    - ☐ Moins de 50 000$
    - ☐ Entre 50 000$ et 99 999$
    - ☐ Entre 100 000$ et 199 999$
    - ☐ Entre 200 000$ et 299 999$
    - ☐ Entre 300 000$ ou plus
17. Avez-vous déjà fait des dons pour des causes environnementales dans les douze derniers mois?
    - ☐ Oui
    - ☐ Non