Social preference for new mining projects in Québec, Canada: An Analysis Based on Discrete Choice Experiment Method

Adrien Corneille[1,2], Jie He[2] and Thomas Poder[3]

March 7th, 2018

Abstract:

In this paper, we investigate the social preference patterns for the production of three non-renewable resources i.e. gold, uranium and rare earth elements. Using discrete choice experiment method, we show that heterogeneous social preferences for mining projects are mainly driven by the mineral, the proximity to mine as well as the basic knowledge about mineral world. Our findings suggest that institutions should design resource policies that include heterogeneous preferences for non-renewable resources. Otherwise, institutions assuming homogeneous preference for mining projects could misunderstand citizens' expectations and face unpredictable social tensions.

Keywords: Social acceptability, choice experiment, heterogeneous risks, willingness to accept

[1] CERDI (Centre d'Etudes et de Recherches sur le Développement International), UMR 6587 CNRS Université d'Auvergne, 65 Boulevard François Mitterrand, 63009 Clermont Ferrand, France

[2] Département d'Économique, Faculté d'Administration, Université de Sherbrooke, 2500 Boulevard de l'université, Sherbrooke, QC, Canada J1K2R1

[3] CRC-Chus

1. INTRODUCTION

Our contribution

We investigate to what extent the design of mining projects may affect the social preferences of citizens. We look at things from the point of view of population to address the best compensation scheme for mining operations. Our paper examines the heterogeneity of social preferences for mining projects across multiple minerals in a resource-rich province of Canada, in Québec.

Of particular note is that the Social Licence to Operate (SLO) does not identify the mineral effect on the preference tastes of citizens. We think on the contrary it is an important matter for decision-makers in mining companies to better discern the different public perceptions of minerals. Scope of public debates over different minerals could be broader than exclusively the local context.

We estimate sources of heterogeneity across citizens and between minerals in a random utility framework: using the estimators (*i*) Mixed Logit model and (*ii*) Latent class model. Distribution of preference parameters are continuous for the former estimator while the latter estimator is based on a discrete distribution.
Our preferred estimator is the latent class model as public debates over mineral-led development are very often polarized between classes of opponents, supporters and indifferent people (***).

We find that the total willingness to accept (WTA) for new mining projects vary significantly between $** and $**. Our results stress on a strong heterogeneity of preference patterns for the production of non-renewable resources. For all the three minerals, contests for the opening of new mine are mainly motivated by …
The technologies used to extract the mineral are of importance for citizens' perceptions.

Our paper finds some evidences of conflicting perceptions between mining communities and general population. Both local and general populations could be subject to welfare loss, but in different ways.

We hope to provide useful guidelines for the mineral-led development to improve good corporate governance of mining companies in accordance with social preferences of citizens.

Our paper explores social concerns of mining operations in a developed country, Canada, and could be easily replicated in developing countries.

2. LITERATURE REVIEW

Opposition to mineral resource projects

The relationship between social conflicts and mineral resource development have been extensively highlighted (Collier and Hoeffler, 2004; Ross, 2006; Brunnschweiler and Bulte, 2008; Aragon and Rud, 2013; Berman et al., 2017). Community activism and opposition are more significant regarding the failure of mining projects to address unanticipated environmental concerns (Northey, Mudd and Werner, 2017). Historical accidents and disasters raise great challenges for mining industries to restore confidence with public opinion. Examples of project failures are the collapse of the tailings dam at the Samarco mine in Brazil in 2015 (Kemp, Worden and Owen, 2016) or the Deepwater Horizon in the Gulf of Mexico (Franks et al., 2014).

From the point of view of mining companies, social conflicts affect significantly mining operations through delay, interruption and shut down of projects (Prno and Slocombe, 2012; Browne et al., 2011;). For large scale mining projects, Franks et al. (2014) document high costs of social conflict due to opposition and civil protest. The authors conclude that earlier identification of needs and improved analysis and management of social and environmental issues may prevent unwanted costs and disruption. In order to ensure the viability of the mining sector, companies are increasingly aware about the social, environmental and economic issues.

Social licence to operate (SLO)

Social licence to operate (SLO)[4] is an attempt by mining industry to reconcile the needs and expectations of stakeholders (Owen and Kemp, 2013). This concept appeared in the 1950s as a response of mining industry to mitigate social risks (Boutilier and Thomson, 2011). Regardless of the sector, global standards for good corporate governance influenced the SLO in mining industries. The International Standards Organisation (ISO) Guidance on Social Responsibility (ISO 26000) was a first step in this sense.

[4] As Moffat and Zhang (2014) mentioned, SLO is common to a large range of industries including pulp and paper manufacturing, alternative energy generation as well as agriculture.

Guiding Principles on Business and Human Rights in the United Nations report (2012) highlight the unequal distribution of impacts from industrial development.

Additionally, specific initiatives for mining sector led mining companies to be more and more aware of social and environmental citizens' concerns. Environmental and social performance standards launched by World Bank and International Finance Corporation (IFC) give important guidelines for the global mining industry. Implemented in 51 resource-rich countries, Extractive Industries Transparency Initiative (EITI) provides global standards for the good governance of mining industry by improving transparency and accountability in extractive industries.

Concerns for SLO about the mineral-led development cofound local community perceptions as well as societal perceptions. Owen and Kemp (2013) stress on conflicting interests between local communities and general population faced to the development of mineral resource projects. Lack of contests does not induce that the mining companies totally succeed in obtaining SLO as community actors may spend time to organise themselves and take the opportune moment to voice opposition (Owen and Kemp, 2013).

Compensation scheme for mining operations could be a mismatch with the perceptions of local communities and general population. The non-market valuation of resource projects is an interesting tool to capture ex-ante the social preferences before the mining projects being under the way.

Stated CE method for energy projects and resource projects

Henceforth, an abundant literature covers the non-market valuation of social acceptance over new projects related to renewable or/and non-renewable resources. Stated choice experiments is a common method to elicit the willingness to accept for new windfarms (Ek et Persson, 2014; Strazzera, Mura et Contu, 2012), for compensation programs (Kermogaret et al., 2016), for energy projects (Contu, Strazzera and Mourato, 2016) as well as for mining projects (Rolfe and Windle, 2015; Ivanova and Rolfe, 2010; Spyce, Weber and Adamowiz, 2012; Garrod and Willis, 2000).

Contingent evaluation and CE for mining projects

In this paper, we investigate the social preferences of mining projects that generate a wide range of externalities. Non-market valuation literature focuses on positive and negative externalities associated to one particular non-renewable resource. In contingent evaluation, Pemberton et al. (2010) investigate environmental resources preservations faced to copper extraction. Mendoza and Tilton (2000) study the willingness to pay for environmental programs to mitigate mining impacts from iron ore. Damigos et al. (2016) estimate the willingness to pay for landfill mining plans without pointing out what minerals are.

Using stated choice experiments Garrod and Willis (2000) assessed the social preferences from new quarry projects. Ivanova and Rolfe (2010) asked local population for their expectations from a town development program in order to compensate the costs from a new coalmine[5]. Rolfe and Windle (2015) analyzed the impact of mining expansion for current mines extracting coal and coal seam gas. Spyce, Weber and Adamowiz (2012) estimated the wellbeing from aboriginal and non-aboriginal land use faced to cumulative effects of regional development including mining development.

Distance effects on the preference parameters

Distance is an important component of social acceptance of new projects over renewable resources (Jones and Eiser, 2010; Van der Horst, 2007; Devin-Wright, 2005) and non-renewable resources [6] (Contu, Strazzera and Mourato, 2016) commonly known as Not in my backyard (NIMB) syndrome. Environmental impacts and economic benefits from mining development are a decreasing function of the distance[7] (Aragon and Rud, 2014; Aragon and Rud, 2013; Dell, 2010). Citizens would be subjects to NIBY syndrome when the new hypothetical mine was closer to their house.

---

[5] Gillespie and Kragt (2010) studied the local wellbeing faced to a new underground coalmine.

[6] Proponents have some flexibility over the localisation of projects with renewable resources such as wind farms (Brennen et VanRensburg, 2016) and nuclear energy (Contu, Strazzera and Mourato, 2016). But mining proponents have less flexibility in relocating the new mine as conditional due to the specific localisation of mineral deposits.

[7] Within a 0 to 20 km radius from the mine, Aragon and Rud (2014) find 40% of agricultural productivities' decrease over 1997-2005. Dell (2010) shows that consumption strongly increases within a 25km radius. Following gold mine's expansion, Aragon and Rud (2013) show increases in real income and nominal income until it becomes insignificant beyond 100km.

3. Non-market valuation of mining projects

Social preferences of mining projects

We investigate the social preferences for mining projects in Québec, Canada. In summer 2017, we collect web-survey questionnaires from 1500 respondents belonging both to mining communities and non-mining communities. In our experiment, the new hypothetical mines may vary across minerals and distances between respondents' houses and mining sites. We aim at capturing a large extent of mining contexts. Patterns of social preferences for mineral resource development may vary between mining projects. Some variations in the characteristics of mining projects could result in variations of social welfare. For instance, mining proponents using different technology to extract the resource would affect risk perceptions for citizens[8]. See for example Farrer et al. (2017) that document changes in risk perceptions from vertical wells to horizontal hydrofracturing.

- **Social preferences across minerals**

In Québec, there are 30 operating minerals including precious metals, ferrous metals and industrial minerals. Our approach focuses on the study of social preferences for precious minerals and ferrous excluding industrial minerals. Alone, ferrous metals and precious metals concentrated in 2016 94.6% of expenditures for mineral development in Québec (Institut de la statistique du Québec, 2017). We investigate the production of three minerals: gold, uranium and rare earth elements[9].

In Québec gold is well accepted regarding the historical context of mining extraction[10] while exploration and production for uranium were subject to several oppositions[11] in 2015 (BAPE, 2015) falling the mining project of uranium. The production of rare earth elements raises current environmental and social issues in

[8] Indeed, use of different pollutants to extract the resource would result in different environmental burdens between mining deposits.

[9] In Québec in 2016, gold represents 52.7% of expenditures for mineral development. Rare earth element and uranium represent 4.1% and **% of exploration expenses (Institut de la statistique du Québec, 2017).

[10] Gold had been traditionally exploited in Québec since 1800 while mining deposits of uranium and rare earth elements have been identified through mining exploration.

[11] Bjorst (2016) reports intensive debate about new mining projects of uranium in Greenland.

China (Ali, 2014) and had been currently discussed in Québec during public debates (BAPE, 2016).

Section of the questionnaire

The survey is divided into four parts. The first part evaluates the general perceptions about mining industry related to trust in mining stakeholders, environmental and health risks as well as preferences for renewable and non-renewable sources of energy. The second part tests the basic knowledge of respondents with mineral world in terms of history, norms, geology and impacts. The third part provides some details about the opening of the new mine such as the mineral, the distance from the dwelling, the operating period, the local economic spinoff in accordance of environmental standards. Short descriptions of the new mineral (including a picture of the mineral) and the characteristics of the mining project are also provided. The final part includes the sociodemographic information.

Hypothetical mines

From May to November 2016, we conducted an in-depth qualitative study among 63 stakeholders belonging to the mining sector. We obtained thirty different factors of social preferences related to mining projects and we ranked them each time one factor was mentioned by a stakeholder. Expert judgements from a multidisciplinary research team sum up the final output of our qualitative study into six main attributes. Table 1 mentioned attributes and levels of new hypothetical mines. Project plans vary across six attributes related to environmental, social and economic factors.

The opening of hypothetical mines proposes two alternatives of project plans and the option “statu quo” being described as the current situation without a new mine. By not imposing the acceptance of project plans, respondents could express their protest against the new mines. Mining development raises environmental, social and economic concerns in the society that may slow or prevent the development of a mineral resource project (Northey, Mudd and Werner, 2017).

Table 1 – Attributes and levels

Attributes	Levels
(i) Mine types	Open-pit mine (baseline) Underground mine
(ii) Water quality monitoring	Mining company (baseline) Government Independent committee
(iii) Presentation from the project proponent	Newspaper advertisement (baseline) Information session with a mediator Co-construction with the community
(iv) Partnership structure	Private sector (baseline) Private sector and Government Private sector and Region
(v) Job creation	200 jobs (baseline) 500 jobs 800 jobs
(vi) Household's tax rebate for the next ten years	100$, 200$, 300$, 400$, 500$, 600$ each year for 10 years

i. Mine types

Non-renewable resources occur in deposits of various grades (Krautkraemer, 1998). Technical constraints of mining sites may impose the technologies used to extract the minerals: open-pit mining for lower quality of mineral deposits and underground mining for higher quality of mineral deposits. In the view of citizens, open-pit mining raises stronger concerns than underground mining and leads to more social conflicts (Mining Watch, 2014). Environmental consequences are stronger during open-pit exploitation regards to the huge amounts of extracted rock [12] (Bergeron et al., 2015). Underground mining implies less aesthetic differences of landscape than open-pit mining (***). If the respondents are

[12] Aesthetically viewed, underground mining is less visible than open-pit mining (Bergeron et al., 2015).

unfamiliar with mining operations, we provide pictures about underground and open-pit mining as well as a short description.

ii. Water quality monitoring

In Québec, Bergeron et al. (2015) note that mining impacts on sources of drinking water are one of the major issues for mining communities[13]. In USA, Muehlenback, Spiller and Timmins (2015) find similar evidences of stronger negative impacts for groundwater houses. Institutions are important safeguards to ensure that mining operations are conformed to environmental standards. Standard environmental monitoring depends mainly on the mining companies' duties in many resource-rich countries such as Québec, Australia, United States, South Africa, *etc*. The current system in Québec let the mining companies to be in charge of taking samples[14] of liquid effluents, record data on an information system platform of the government website (MERN, 201*). During this process, several NGOs are worried about the transparency of data (MiningWatch Canada, 2014) reflecting that citizens want more reassurance concerning the collect of data[15].

iii. Presentation from the mining proponent

Mining proponents play a great part in the communication and the promotion of their project[16] (***). Different models of communication are applied in the mining context with variable outcomes (***). Arnstein (1979) describes three levels of commitment for social actors: (*i*) lack of participation, (*ii*) symbolic participation and (*iii*) citizen power. In our design of project, we consider these three levels of commitment in the context of mining operations. Mining companies are not restricted in the way they prefer to announce their project to the population. Institutional norms require minimum corporate commitments if the production levels of resource extraction exceed ** of ton by day. We assume that mining

---

[13] Results from our qualitative study support the observations of Bergeron et al. (2015).

[14] An analytical laboratory is accredited to analyze the accuracy of data.

[15] Some mining companies decided to be more transparent by involving the community in the monitoring process. For instance, the Raglan mine in the north of Québec involved some citizens of Innu community to collect water data nearby the mine.

[16] The government may give some advices to the mining proponent if requested, but this is mainly the matter of the mining proponent.

companies are under this level production and are free to fix their commitment degrees.

iv. Partnership structure

Amounts of billions need to be invested to undertake a mining project. The private sector through shareholders could get together to invest in the project. Sometimes the Government invests in the project to complement the rest of needed money. Foreign proponents through a partnership with the government could more easily implement their projects in the communities. In Québec, partnership with regional actors and institutions appeared more and more within the last years.

v. Job creation

Opportunities for job creation is a keen argument for the proponents when implementing their mining projects. Most of the mining projects are implemented in remote regions or mono-industrial regions strengthening the impact of local economic spinoff. Communities facing high level of unemployment and local economic crisis would be more sensitive to job creation's argument[17].

vi. Tax rebates

Tax rebates for households is the monetary attribute. We assume that the government will decide to transfer a part of the mining royalty to households through the financial vehicle of tax reduction. From the point of view of citizens in Québec, this financial vehicle is likely to be credible as political elections took place in October 2017, two months after the field study was conducted.

Distance treatment

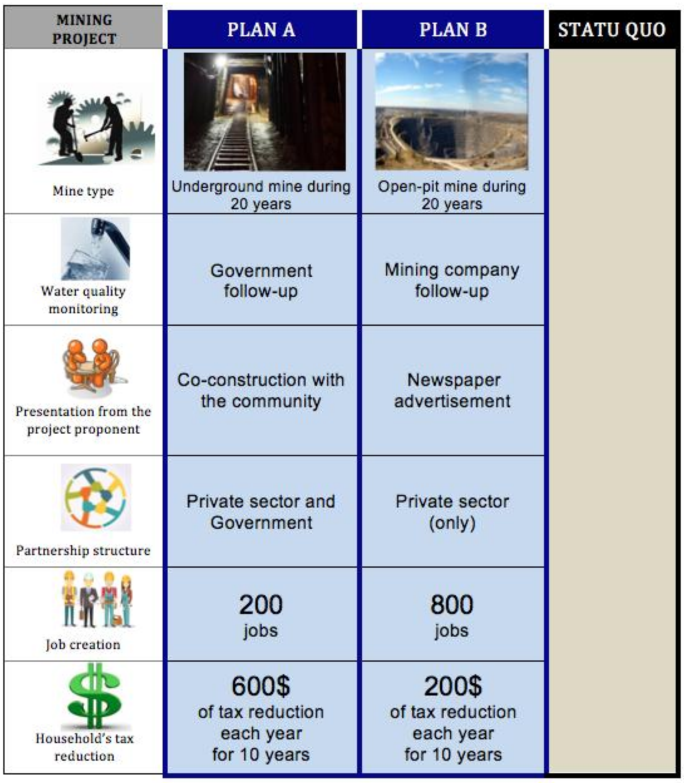
[17] In order to be realistic as possible, the highest and lowest levels of job creation are compatible with the mine type. In most cases, open-pit mines are more intensive in labor force than underground exploitation for the same size of mineral deposit.

We capture the phenomenon of NIMB by randomly assigning different ranges of radius[18] from the mine: (*i*) between 0-20km, (*ii*) between 20-100 km, (*iii*) more than 100km. This approach contributes to distinguish the social preferences between mining communities close to the mine and non-mining communities far away.

CE design

The full factorial design of our experiment is composed of 972 choice pairs. We applied the partial factorial design to finally obtain 36 choice pairs. Our design of choice sets used the D-efficiency criteria to obtain an orthogonal design and eliminate any dominant strategies. We divided the choice pairs into 6 blocks of 6 choice sets such that each questionnaire presented six choice sets. For each choice set, the respondents have to choose between two alternatives of project plans and the "no-choice option".

Figure 1 – Example of choice card



18 Hypothetical mines would be unrealistic when proposing to the same respondent different minerals at the same time and location. Otherwise, mineral deposits of gold, uranium and rare earth elements shall be unlikely at the same place.

4. Models for resource preferences

We model preferences for mineral resource projects in a random utility model (McFadden, 1974). We explore two sources of heterogeneity in this random utility model framework within sample and between sample.

In choice situations t, choices between j alternatives of projects reflect utility derived from the characteristics of resource projects such as:

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \left(\sum_{k=1}^{K} x_{ijtk} + ASC_j \right) + \varepsilon_{ijt}$$

The utility of agents (U_{ik}) includes (i) a systematic component (V_{ik}), which is composed of a linear combination of attributes and (ii) a random component (ε_{ik}). In our case, the deterministic component of utility is composed of the six characteristics of the mining projects presented in table 1. β represents a vector of preference parameters which are constant across alternatives. An alternative specific constant (ASC_j) affords the advantage of capturing the preference over *statu quo*.

We use two models specification to elicit the willingness to accept related to mineral resource projects: multinomial logit and mixed logit models. Multinomial logit is a common estimator assuming homogeneous preferences across the population. The strong assumption in this model is that the random component depends on the independence from irrelevant alternatives following extreme value distribution $(0, \mu)$. Otherwise, alternatives of mining projects are independent and identically distributed with type I extreme value distribution.

Interactions between attributes of mining projects and individual socioeconomic characteristics of decision-makers contribute to capture a part of the individual heterogeneity across the population. We explore heterogeneity sources between resources by using not only socioeconomic characteristics, but also by estimating the random utility model with Mixed logit specification.

In a second specification, we assess the welfare estimates of mining projects thanks to a mixed logit model, also called random parameter logit model. Mixed logit model overcomes the IIA problem of multinomial logit by allowing for unobserved heterogeneity in the slope preference parameters. In others words, the marginal utilities associated to project characteristics are allowed to vary between individuals.

Utility is now defined as:

$$U_{ijt} = \beta_i x'_{ijt} + \epsilon_{ijt}$$

where β_i represents a vector of preference parameters which follow normal distributions. ϵ_{ijt} follows a Gumbel distribution of type I which is independently and identically distributed. σ_k represents … v_{ik} is …

$$\beta_{ik} = \beta_k + \sigma_k \cdot v_{ik}$$

The logit probability of the observed choice for citizens i in choice situation t is given by:

$$P_i = \prod_{t=1}^{6} P_{it}(j_{it})$$

In the specification of latent class model,

5. RESULTS

We implement the alternative specific constant (ASC) in the econometric specification of multinomial logit and mixed multinomial logit. The variable ASC captures the *statu quo* option described as the situation without the opening of a mine. This is the result of the influence on choice of unobserved attributes relative to specific attributes (Hensher et al., 2009; Rolfe et al., 2000).

Implementing ASC is relevant for environmental and public goods (Dissanayake and Ando, 2015, Blaej et al, 2007) as some respondents could not be necessarily in favour of environmental and public policy changes. For instance, windfarms raised strong contests in Québec. A positive parameter for ASC indicates that respondents who have chosen the *statu quo* option increase their indirect utility independently from the alternative mining projects. Being forced to choose between policies and goods alternatives could bias welfare estimates (Blaej et al., 2007). Incorporating *statu quo* option is particularly relevant for the development of mineral resource projects regarding strong opposition faced to mining industry (***).

For all the three minerals, respondents are averse to the opening of a new mine confirming that proposed changes in the mining projects do not fully compensate the respondents' disutility. Respondents have a positive and significant welfare estimate of ASC indicating a strong preference for the current situation without a new mine. For uranium and rare earth elements, proportions of respondents that have chosen the *statu quo* option at least once are higher (respectively 24.2% and 22.1%). This means that we find stronger opposition for the development of these resource projects compared to the opening of a new gold mine (20.1%).

MNL models

Table 2 presents MNL model specifications including the alternative specific constant (ASC). For each mineral, we estimate interaction effects between respondents' characteristics and preferences for no new mine in columns 2, 4 and 6. Individual characteristics include standard socioeconomic variables such as income, sex, and holding a country home. Additionally, we control for the effect of experience with mining projects by interacting ASC with trust in mining industry, having been an employee for mining companies and developed social networks.

We find that for all the three minerals having a country home significantly increases opposition to new mining projects, while trusting in the mining industry decreases significantly contests for the production of resources. The interaction of *statu quo* option and others characteristics caused mixed results across minerals. For uranium and rare earth elements, respondents who have worked for a mining company have a low preference for protest against mining projects.

Table 2 – Results of Multinomial Logit

	Gold		Uranium		Rare earth elements	
	(1)	(2)	(3)	(4)	(5)	(6)
Underground mine	0.389***	0.391***	0.491***	0.502***	0.44***	0.453***
	(7.82)	(7.85)	(10.25)	(10.35)	(8.46)	(8.64)
Water monitoring Government	0.602***	0.603***	0.637***	0.648***	0.578***	0.583***
	(9.43)	(9.41)	(10.24)	(10.36)	(8.53)	(8.56)
Water monitoring Independent committee	0.677***	0.686***	0.639***	0.648***	0.628***	0.634***
	(10.78)	(10.88)	(10.34)	(10.44)	(9.40)	(9.45)
Information session with a mediator	0.0669	0.0639	0.159***	0.164***	0.114*	0.114*
	(1.17)	(1.11)	(2.89)	(2.96)	(1.88)	(1.87)
Co-construction with the community	0.209***	0.206***	0.191***	0.203***	0.262***	0.261***
	(3.16)	(3.10)	(3.00)	(3.15)	(3.77)	(3.74)
Public-private partnership	0.228***	0.236***	0.248***	0.248***	0.255***	0.255***
	(3.72)	(3.85)	(4.21)	(4.20)	(3.96)	(3.94)
Regional partnership	0.351***	0.354***	0.161***	0.164***	0.214***	0.221***
	(5.89)	(5.94)	(2.77)	(2.81)	(3.37)	(3.47)
500 new jobs	0.34***	0.348***	0.339***	0.334***	0.444***	0.448***
	(5.48)	(5.57)	(5.61)	(5.50)	(6.70)	(6.71)
800 new jobs	0.661***	0.669***	0.429***	0.436***	0.61***	0.619***
	(10.50)	(10.57)	(7.05)	(7.13)	(9.17)	(9.25)
Households tax reduction	0.0008***	0.0008***	0.0009***	0.00098***	0.0008***	0.00082***
	(5.77)	(5.80)	(6.75)	(6.78)	(5.43)	(5.30)
ASC	0.886***	1.313**	1.053***	1.407***	1.153***	1.458***
	(7.61)	(12.72)	(9.31)	(12.91)	(9.45)	(12.97)
ASC *X* Sex		0.0579		0.637***		-0.0253
		(0.61)		(7.12)		(-0.27)
ASC *X* Income		-0.000001		-0.000001		-0.000002**
		(-1.04)		(-0.96)		(-2.14)
ASC *X* Country home		0.423*		0.425*		0.826***
		(1.94)		(1.94)		(3.83)
ASC *X* Trust		-0.476***		-0.57***		-0.662***
		(-7.80)		(-10.25)		(-10.63)
ASC *X* Employee		-0.366		-0.798**		-1.244***
		(-1.19)		(-2.19)		(-3.88)
ASC *X* Network		-0.366***		-0.0663		0.0804
		(-2.81)		(-0.56)		(0.73)
ASC *X* M1M2		0.311**		0.0853		
		(2.35)		(0.70)		
ASC *X* M1M3		0.553***				-0.304**
		(4.31)				(-2.57)
ASC *X* M2M3				0.542***		0.634***
				(4.50)		(5.57)
Log-likelihood	-3000.2	-2923.71	-3297.32	-3169.68	-2838.06	-2729.78
Pseudo-R^2	0.007	0.007	0.005	0.005	0.004	0.004
AIC/n	0.67	0.67	0.73	0.73	0.69	0.69
Number of observations	9018	9018	9702	9702	8298	8298
Number of respondents	501	501	539	539	461	461

Note: * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. S.d. refers to standard deviations.

For gold experiment, respondents who know someone working in the mining sector prefer alternatives of mining projects instead of the *statu quo* option. Gender plays a role in the social preferences for the production of uranium and individuals with higher income reduces their protest against rare earth elements. On average, being experienced with the development of mineral resource projects reduces protests against the opening of new mines.

Until now, we do not compare the preference patterns across minerals and not distinguish perceptions over the three minerals. Hence, we test the interaction effects with the perception of homogeneous good between gold, uranium and rare earth elements. If the respondents consider homogeneous mining impacts between minerals, they will protest more against the opening of a new gold mine. For uranium experiment, respondents who confuse mining impacts between uranium and rare earth elements (*M2M3*) are against the production of uranium. Interestingly, respondents who consider similar impacts between gold and rare earth elements (*M1M3*) have low preference for protest while those who see close impacts between uranium and rare earth elements (*M2M3*) are more against uranium extraction. Put another way, this result suggests that uniformed citizens could judge similar characteristics across minerals explaining why they would choose for or against new mining projects. As uranium is perceived as a dangerous mineral due to its radioactivity, thinking of similar mining impacts between uranium and other minerals could lead respondents to protest more against any projects related to other minerals. On the contrary, respondents who refer to close mining impacts between gold and other minerals could have low preference for protest against other minerals.

For all the three resources, changes in the aesthetic view of landscape through underground mining are preferred to open-pit mining. Respondents prefer that environmental monitoring for water quality has been in charge of the government or an independent committee instead of mining companies only. Social preferences over the partnership of mining projects are different across minerals. Respondents are in favour of partnership between mining companies and regional partners for the opening of a gold mine while they prefer public-private partnership concerning the production of uranium and rare earth elements. Obviously, citizens attach importance to more job creation. About the compensation of payment vehicle, tax rebate has a little significant positive effect on the preference for the development of new mining projects.

Table 3 – Results of MNL model with interactions

	Gold		Uranium		Rare earth elements	
	(1)	(2)	(3)	(4)	(5)	(6)
ASC	0.993***	1.313**	1.133***	1.407***	1.202***	1.458***
	(4.67)	(12.72)	(6.06)	(12.91)	(5.83)	(12.97)
Mining	0.606	0.605***	0.528***	0.534***	0.436***	0.45***
	(6.57)	(6.55)	(6.60)	(6.6)	(4.93)	(5.06)
Government monitoring	0.506***	0.51***	0.602***	0.617***	0.5***	0.508***
	(4.33)	(4.36)	(5.80)	(5.91)	(4.35)	(4.40)
Commitee monitoring	0.727***	0.726***	0.621***	0.632***	0.768***	0.789***
	(6.30)	(6.28)	(6.01)	(6.07)	(6.74)	(6.90)
Information session	-0.0247	-0.0264	0.128	0.132	0.105	0.115
	(-0.24)	(-0.25)	(1.40)	(1.43)	(1.02)	(1.12)
Co-construction	0.149	0.15	0.234**	0.254**	0.381***	0.389***
	(1.23)	(1.23)	(2.19)	(2.36)	(3.24)	(3.29)
Public-private partners	0.17	0.17	0.329***	0.333***	0.237**	0.249**
	(1.51)	(1.50)	(3.34)	(3.35)	(2.16)	(2.25)
Regional partners	0.353***	0.35***	0.307***	0.314***	0.178*	0.183*
	(3.22)	(3.19)	(3.16)	(3.21)	(1.65)	(1.70)
500 jobs	0.22*	0.211*	0.331***	0.322***	0.415***	0.427***
	(1.91)	(1.84)	(3.30)	(3.19)	(3.67)	(3.77)
800 jobs	0.641***	0.637***	0.424***	0.433***	0.658***	0.681***
	(5.54)	(5.49)	(4.16)	(4.23)	(5.81)	(5.98)
Tax rebate	0.0007***	0.000804***	0.0005***	0.000537***	0.00095***	0.000968***
	(2.90)	(2.93)	(2.13)	(2.21)	(3.55)	(3.60)
ASC X Distance	-0.00212	-0.00257	-0.00179	-0.0009	-0.001	-0.0004
	(-0.61)	(-0.73)	(-0.55)	(-0.30)	(-0.30)	(-0.11)
Mining X Distance	-0.00427***	-0.004***	-0.0007	-0.0007	0.000157	0.0001
	(-2.84)	(-2.80)	(-0.57)	(-0.54)	(0.11)	(0.10)
Gov.monitoring X Distance	0.001	0.001	0.000752	0.0006	0.0016	0.00155
	(0.99)	(0.98)	(0.42)	(0.35)	(0.82)	(0.79)
Com. monitoring X Distance	-0.0009	-0.0008	0.00037	0.0002	-0.002	-0.0032*
	(-0.52)	(-0.46)	(0.21)	(0.17)	(-1.50)	(-1.65)
Information session X Distance	0.001	0.001	0.000692	0.0006	0.000141	0.000006
	(1.05)	(1.05)	(0.44)	(0.44)	(0.08)	(0.00)
Co-construction X Distance	0.00122	0.001	-0.0008	-0.001	-0.00244	-0.002
	(0.61)	(0.60)	(-0.49)	(-0.61)	(-1.22)	(-1.30)
Public-private partners X Distance	0.0009	0.00109	-0.00171	-0.00179	0.000407	0.00017
	(0.54)	(0.59)	(-1.02)	(-1.05)	(0.22)	(0.09)
Regional partners X Distance	-0.00006	0.00002	-0.0031*	-0.003*	0.000858	0.0008
	(-0.04)	(0.01)	(-1.88)	(-1.90)	(0.47)	(0.47)
500 jobs X Distance	0.002	0.002	0.0001	0.0002	0.000697	0.0005
	(1.25)	(1.38)	(0.09)	(0.15)	(0.37)	(0.28)
800 jobs X Distance	0.00036	0.0005	0.000114	0.00007	-0.001	-0.001
	(0.19)	(0.29)	(0.07)	(0.04)	(-0.54)	(-0.69)
Tax rebate X Distance	0.000001	0.000001	0.000009**	0.000009	-0.0000025	-0.000002
	(0.27)	(0.24)	(2.39)	(2.29)	(-0.55)	(-0.66)
ASC X Sex		0.0942		0.581***		-0.0566
		(1.00)		(6.58)		(-0.61)
ASC X Income		-0.000001		-0.0000009		-0.000002**
		(-0.79)		(-0.82)		(-2.23)
ASC X Country home		0.371*		0.455**		0.79***
		(1.72)		(2.08)		(3.68)
ASC X Trust		-0.514***		-0.595***		-0.696***
		(-8.51)		(-10.79)		(-11.45)
ASC X Employee		-0.235		-0.77**		-1.155***
		(-0.77)		(-2.12)		(-3.60)
ASC X Network		-0.393***		-0.101		0.106
		(-3.04)		(-0.86)		(0.97)
Log-likelihood	-2990.56	-2937.54	-3287.54	-3181.01	-2831.80	-2737.51
Number of observations	9018	9018	9702	9702	8298	8298

Table 3 presents results of MNL estimations similar to table 1 but including the interaction between distance and characteristics of the resource projects.

For gold experiment, distance has a significant negative effect on the type of mine. Thus, respondents far away the new gold mine would be paying less attention on the aesthetic consequences of mining on landscapes. Other characteristics of the mining project are not affected by the distance.

Tax rebate

Mixed Logit model

Table 4 – Results of mixed logit

	Gold		Uranium		Rare earth elements	
	Mean St. error	S.d. St. error	Mean St. error	S.d. St. error	Mean St. error	S.d. St. error
ASC	1.515*** (8.65)	– –	1.763*** (10.11)	– –	1.994*** (10.40)	– –
Underground mine	0.434*** (4.19)	1.607*** (13.37)	0.657*** (5.92)	1.855*** (14.05)	0.669*** (5.46)	1.858*** (12.43)
Water monitoring by government	0.867*** (7.60)	0.342*** (2.63)	1.040*** (8.71)	0.348*** (2.78)	0.744*** (6.02)	0.314*** (2.24)
Water monitoring by independent committee	1.037*** (8.98)	1.458*** (9.59)	0.994*** (8.38)	1.607*** (9.90)	1.067*** (7.83)	1.810*** (10.24)
Information session with a mediator	0.0896 (0.93)	-0.736*** (-5.00)	0.24*** (2.58)	-0.641*** (-4.88)	0.201* (1.81)	0.774*** (3.99)
Co-construction with the community	0.0847 (0.93)	0.849*** (4.91)	0.27** (2.55)	0.739*** (3.51)	0.436*** (3.56)	-1.047*** (-5.12)
Public-private partnership	0.472*** (4.60)	-0.527** (-2.55)	0.289*** (2.58)	1.18*** (7.26)	0.356*** (2.97)	1.134*** (5.79)
Regional partnership	0.52*** (4.85)	1.053*** (6.68)	0.186* (1.76))	-0.943*** (-6.08)	0.278** (2.43)	0.963*** (6.10)
500 new jobs	0.55*** (5.55)	-0.478** (-2.11)	0.47*** (4.77)	0.415 (0.99)	0.695*** (6.05)	0.862 (4.57)***
800 new jobs	0.912*** (7.31)	1.873*** (12.20)	0.506*** (4.23)	1.536*** (9.10)	0.86*** (6.24)	1.607*** (9.87)
Households tax reduction for the next ten years	0.00154*** (5.99)	– –	0.00189*** (7.29)	– –	0.00177*** (6.40)	– –
Log-likelihood	-2738.29		-2962.93		-2531.61	
Pseudo-R^2	0.084		0.098		0.104	
AIC/n	0.72		0.75		0.74	
Number of observations	9018		9702		8298	
Number of respondents	501		539		461	

Note: * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. S.d. refers to standard deviations.

In the mixed logit model, non-cost attributes are defined as random parameters while the payment vehicle and the alternative specific constant (ASC) are fixed parameters. Standard deviations represent unobserved heterogeneity in the preferences related to resource mining projects. Our result suggests strong heterogeneity across the preference patterns of minerals.

The standard deviations of random variables of random preference parameters are highly significant showing the importance of unobserved heterogeneity for these coefficients.

Table 5 – Results of Mixed Logit (distance effects)

	Gold		Uranium		Rare earth elements	
	Mean St. error	S.d. St. error	Mean St. error	S.d. St. error	Mean St. error	S.d. St. error
ASC	1.572***	–	1.669***	–	2.221***	–
	(5.03)	–	(6.15)	–	(7.01)	–
Underground mining	0.697***	1.607***	0.72***	1.737***	0.598***	1.867***
	(3.56)	(12.38)	(3.98)	(12.95)	(2.89)	(12.48)
Government monitoring	0.669***	1.233***	0.819***	1.337***	0.785***	1.67***
	(3.33)	(8.06)	(4.45)	(9.28)	(3.61)	(9.91)
Committee monitoring	0.996***	1.457***	0.843***	1.383***	1.431***	1.371***
	(4.68)	(7.14)	(4.65)	(6.76)	(7.05)	(10.24)
Information session	-0.0868	0.479**	0.207	-0.533***	0.176	-0.654***
	(-0.52)	(2.19)	(1.39)	(-2.90)	(0.94)	(-3.04)
Co-construction	0.177	0.679**	0.379**	0.247	0.633***	-1.103***
	(0.91)	(2.46)	(2.31)	(1.04)	(3.06)	(-6.52)
Public-private partners	0.358*	0.598***	0.385**	1.15***	0.46**	0.591***
	(1.85)	(3.55)	(2.12)	(6.71)	(2.42)	(2.98)
Regional partners	0.499***	1.051***	0.329**	-0.866***	0.205	0.925***
	(2.59)	(6.67)	(1.98)	(-5.96)	(1.04)	(5.58)
500 new jobs	0.466***	-0.207	0.478***	0.181	0.775***	0.366
	(2.64)	(-1.07)	(3.04)	(0.76)	(4.22)	(1.41)
800 new jobs	0.902***	-1.753***	0.307	1.643***	0.99***	1.744***
	(3.86)	(-9.34)	(1.59)	(9.29)	(4.35)	(10.65)
Rebate tax	0.001***	–	0.0009**	–	0.001***	–
	(3.45)	–	(2.50)	–	(4.01)	–
ASC *X* distance	-0.00225	–	0.00367	–	-0.00332	–
	(-0.43)	–	(0.73)	–	(-0.61)	–
Underground mining *X* distance	-0.0051	0.006**	0.000675	-0.00886***	0.00108	0.00375
	(-1.60)	(2.16)	(0.20)	(-2.60)	(0.30)	(1.44)
Gov. monitoring *X* distance	0.00409	-0.00573**	0.00466	0.00922***	0.00198	-0.00175
	(1.19)	(-2.15)	(1.39)	(2.93)	(0.54)	(-0.67)
Com. monitoring *X* distance	0.00169**	0.00859***	0.0035	0.0198***	-0.00985***	-0.0215
	(2.76)	(-2.15)	(1.03)	(4.85)	(-2.58)	(-5.49)
Information session *X* distance	0.0035	-0.005	0.00146	0.0071***	0.00141	-0.00876***
	(-1.24)	(2.19)	(0.53)	(2.84)	(0.44)	(-3.53)
Co-construction *X* distance	0.001	-0.00979***	-0.00178	-0.0167***	-0.004	-0.00298
	(0.42)	(-2.68)	(-0.57)	(-5.93)	(-1.20)	(-1.11)
Public-private partners *X* distance	0.001	0.00224	-0.002	0.00791**	0.0002	-0.015
	(0.40)	(0.74)	(-0.62)	(2.17)	(0.08)	(-5.79)
Regional partners *X* distance	-0.0007	0.0003	-0.0034	0.0126***	0.0002	-0.00239
	(-0.22)	(0.07)	(-1.11)	(4.40)	(0.07)	(-1.16)
500 jobs *X* distance	0.0007	0.00525*	0.00007	0.01***	-0.00139	-0.0106***
	(0.26)	(1.71)	(0.03)	(4.26)	(-0.42)	(-3.91)
800 jobs *X* distance	0.0007	0.0084	0.00743**	-0.00153	-0.003	0.0142***
	(0.20)	(1.63)	(2.10)	(-0.40)	(-0.86)	(5.32)
Rebate tax *X* distance	-0.000001	–	0.00002***	–	-0.0000007	–
	(-0.17)	–	(2.83)	–	(-0.09)	–
Log-likelihood	-2720.55		-2933.76		-2502.35	
Pseudo-R^2	0.45		0.41		0.51	
Number of observations	9018		9702		8298	

Note: * p ≤ 0.10 ; ** p ≤ 0.5 ; *** p ≤ 0.01. S.d. refers to standard deviations.

We explore the heterogeneity of preference patterns for multiple non-renewable resources by assessing a three-latent class specification for all the three minerals. We find that the optimal number of class latent is three by comparing …

Table – Latent class model

	Gold			Uranium			Rare earth elements		
	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
ASC	1.978***	3.498***	-2.167***	6.103***	-0.535**	2.350***	4.892**	2.571***	-1.243***
	(3.85)	(5.17)	(-4.66)	(7.42)	(-2.56)	(3.38)	(2.55)	(5.19)	(-4.13)
Underground mining	0.36	0.454	0.492****	0.896**	-0.141	2.321***	-1.005	1.311***	0.267***
	(1.52)	(1.50)	(3.74)	(2.17)	(-1.22)	(6.01)	(-1.05)	(4.76)	(3.20)
Government Monitoring	0.520***	2.355***	0.588***	1.342**	0.459***	1.710***	0.822	0.909***	0.611***
	(2.66)	(5.23)	(5.46)	(2.36)	(4.74)	(5.24)	(0.95)	(3.89)	(6.88)
Independant committee Monitoring	1.252***	1.118**	0.460***	1.358**	0.505***	1.587***	0.392	1.114***	0.588***
	(6.95)	(2.17)	(4.04)	(2.36)	(4.83)	(4.67)	(0.51)	(5.33)	(6.41)
Information Session	-0.15	0.139	0.146	1.061**	0.319***	-0.0686	-0.398	0.204	0.134*
	(-0.85)	(0.48)	(1.31)	(2.17)	(3.42)	(-0.40)	(-0.35)	(0.98)	(1.64)
Co-construction With the community	0.44**	0.0184	0.112	0.653	0.434***	-0.163	-0.153	0.301	0.306***
	(2.56)	(0.06)	(1.00)	(1.17)	(3.70)	(-0.70)	(-0.13)	(1.24)	(3.33)
Public-private Partnership	0.644***	0.0135	0.0723	0.503	0.152*	0.710***	0.668	0.619***	0.205**
	(3.84)	(0.04)	(0.62)	(1.12)	(1.70)	(3.56)	(0.74)	(3.27)	(2.38)
Regional Partnership	1.095***	-0.358	0.0245	0.496	0.133	0.518***	0.915	0.429**	0.179**
	(6.09)	(-1.10)	(0.17)	(1.07)	(1.57)	(2.64)	(1.13)	(2.26)	(2.15)
500 new jobs	0.765***	-0.412	0.243**	-0.64	0.447***	0.255	0.202	0.469**	0.467***
	(3.90)	(-1.29)	(2.38)	(-1.5)	(4.89)	0.255	(0.22)	(2.40)	(5.39)
800 new jobs	0.807***	0.15	0.809***	-0.911*	0.630***	0.519**	0.721	0.399**	0.780***
	(4.58)	(0.49)	(6.95)	(-2.00)	(6.56)	(2.48)	(0.78)	(1.99)	(8.58)
Tax rebate	0.002***	-0.0006	0.0002	0.0026**	0.001***	0.0009*	0.0016	0.0006	0.0009***
	(5.48)	(-0.74)	(0.67)	(2.32)	(5.43)	(1.91)	(0.89)	(1.47)	(4.50)
Avg class probability	0.342	0.167	0.49	0.169	0.52	0.311	0.146	0.272	0.582
Constant	-0.313	-1.069***	0	-0.594***	0.536**	0	-1.386***	-0.766***	0
	(-1.04)	(-5.15)		(-2.74)	(1.99)		(-8.42)	(-3.91)	
Log-likelihood		-2771.53			-3296.39			-2819.33	
Pseudo-R^2		0.145			0.184			0.167	
Number of observations		9288			9702			8298	
Number of respondents		510			507			461	

Note: * $p \leq 0.10$; ** $p \leq 0.5$; *** $p \leq 0.01$. S.d. refers to standard deviations.

Gold

For the experiment of a gold mine, respondents belonging to class 1 and class 2 have strong protests against the new mining project, while those who belonged to class 3 are in favour of new mining projects. Class 2 has only strong concerns for the environmental monitoring of water quality but does not consider other characteristics of mining projects. Class 1 prefers that the environmental monitoring would be led by an independent committee while class 2 and 3 prefer government's responsibility instead of independent committee's responsibility. Contrary to the indifference of class 1 and 2, class 3 largely prefers underground mining than open-pit mining. Class 3 is indifferent about the presentation of proponents although the class 1 is in favour of a co-construction between the mining proponent and the community. Again, class 1 prefers a partnership with regional partners than with the government. Both class 1 and class 3 attached importance to more job creation. Interestingly, class 1 is sensitive to tax rebate.

Uranium

Respondents in the class 1 have strong contests against the opening of a new uranium mine, while respondents in the class 3 have lower protests against the new mining project. Class 2 seems to be favorable of the new mine. Class 1 and class 3 prefer underground mining suggesting strong preferences for low changes in the landscape. Environmental monitoring for the water quality should be the responsibility of the government for the class 3 while being the responsibility of an independent committee for classes 1 and 2. Members in class 1 and class 2 have preferences for an information session and those in class 2 are more interested in the co-construction of the mining project with the community. Respondents in the class 1 are indifferent about the partnership structure. Additionally, they are indifferent about the job creation and are worried about the huge rise of labor force. Class 2 and class 3 want the government to monitor the water quality and they are also sensitive to the job creation. All the three classes would like a monetary compensation through tax rebate.

Rare earth elements

Overall, respondents in class 1 and 2 are opposed to the opening of a new REE mine, but conversely, respondents in class 3 are in favour of it. In the experiment of REE, classes 2 and 3 have high preferences for underground mining compared to open-pit mining. Respondents belonged to the class 1 are indifferent facing changes in the characteristics of the mining projects. Members in class 2 prefer a monitoring by an independent committee and those in class 3 prefer a monitoring by the government. Members in class 3 attach more importance for the presentation of the mining proponent and they prefer strongly a co-construction with the community than just information session. Class 2 and class 3 are in favour of a public-private partnership as well as job creation. Respondents in class 3 are interested in tax rebate following the opening of the new mine.

	Gold			Uranium			Rare earth elements		
	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3	Class 1	Class 2	Class 3
ASC	2.097***	3.369***	-2.131***	5.944***	-0.632***	2.717***	3.735***	-0.996***	2.761***
	(4.29)	(5.34)	(-4.67)	(8.10)	(-3.08)	(4.25)	(5.94)	(-3.26)	(5.23)
Underground mining	0.476**	0.382	0.439***	0.853**	-0.0958	2.428***	-0.082	0.03	1.851***
	(2.08)	(1.39)	(4.01)	(2.29)	(-0.97)	(7.49)	(-0.26)	(0.37)	(5.40)
Government Monitoring	0.63***	2.363***	0.546***	1.276**	0.441***	1.925***	0.229	0.532***	1.439***
	(2.85)	(5.35)	(5.02)	(2.45)	(4.81)	(6.14)	(0.57)	(5.28)	(5.45
Independant committee Monitoring	1.372***	1.094**	0.423***	1.34***	0.443***	1.86***	-0.0282	0.363***	1.84***
	(7.25)	(2.26)	(3.60)	(2.62)	(4.38)	(5.92)	(-0.07)	(3.10)	(6.36)
Information Session	-0.101	0.0468	0.127	0.92**	0.307***	-0.04	0.141	0.21**	0.08
	(-0.61)	(0.17)	(1.32)	(2.21)	(3.64)	(-0.23)	(0.40)	(2.08)	(0.43)
Co-construction With the community	0.448**	0.00686	0.132	0.653	0.387***	-0.02	-0.169	0.295***	0.527**
	(2.49)	(0.02)	(1.17)	(1.42)	(3.93)	(-0.10)	(-0.35)	(3.01)	(2.56)
Public-private Partnership	0.682***	-0.006	0.0718	0.533	0.15*	0.78***	0.19	0.118	1.012***
	(3.84)	(-0.02)	(0.70)	(1.28)	(1.75)	(3.80)	(0.45)	(1.18)	(4.59)
Regional Partnership	1.112***	-0.325	0.0457	0.593	0.123	0.593***	0.111	0.07	0.863***
	(5.98)	(-1.07)	(0.33)	(1.44)	(1.49)	(3.03)	(0.29)	(0.66)	(4.07)
500 new jobs	0.69***	-0.404	0.283***	-0.439	0.426***	0.279	0.519	0.487***	0.441**
	(3.78)	(-1.32)	(2.91)	(-1.12)	(4.82)	(1.45)	(1.30)	(4.77)	(2.16)
800 new jobs	0.703***	0.176	0.850***	-0.789**	0.622***	0.536***	0.733*	0.828***	0.373**
	(3.74)	(0.60)	(7.40)	(-2.00)	(6.90)	(2.61)	(1.94)	(8.30)	(2.03)
Tax rebate	0.002***	-0.0007	0.0003	0.002**	0.001***	0.001**	0.001*	0.001***	0.00009
	(4.69)	(-1.00)	(1.26)	(2.53)	(5.78)	(2.00)	(1.85)	(5.29)	(0.20)
Avg class probability	0.342	0.167	0.49	0.175	0.53	0.295	0.187	0.509	0.304
Knowledge	0.044	-1.272***	0	-1.014***	-0.266	0	-1.159***	-0.508	0
	(0.13)	(-3.93)		(-3.23)	(-0.98)		(-3.22)	(-1.50)	
Risks	-0.0174	-0.441***	0	-0.426***	0.107	0	-0.234*	0.329**	0
	(-0.14)	(-3.41)		(-3.34)	(0.96)		(-1.74)	(2.48)	
Trust	-0.569**	-0.538***	0	-0.388*	0.303*	0	-0.166	0.565***	0
	(-2.56)	(-2.35)		(-1.93)	(1.72)		-(-0.66)	(2.62)	
Constant	1.285**	2.440***	0	2.41***	-0.567	0	1.153 *	-2.145***	0
	(2.00)	(3.98)		(4.01)	(-0.97)		(1.89)	(-3.11)	
Log-likelihood		-2997.40			-3296.39			-2819.33	
Pseudo-R^2		0.152			0.195			0.179	
Number of observations		9288			9702			8298	
Number of respondents		510		1	507			461	

Note: * p ≤ 0.10 ; ** p ≤ 0.5 ; *** p ≤ 0.01. S.d. refers to standard deviations.

Table * - Latent class model (including knowledge, risks and trust)

6. CONCLUSIONS

Our paper has significant implications for new design policy. Mineral hetrogeneity ought to be taking into account as people over-estimate or under-estimate costs and benefits from mining projects. Hence, policy should be designed in a way that reflects the heterogeneous SA. Indeed, we highlight the importance of heterogeneous risks, which provides a partial explanation for the observed differences of perceptions between populations and regions. Innovation plays a key role in the perception of heterogeneous risks by the population. For now, the diversity of the mining context makes the understanding of SA more difficult. More research is needed to better understand the mechanism behind the perception of heterogeneous risks.

Acknowledgements:

The data collection for this research has received financial support from Fonds de recherche du Québec – Nature et technologies (FRQNT), Ministère de l'Énergie et des Ressources naturelles (MERN) and ArcelorMittal.

REFERENCES

Ali, S. H. (2014). Social and environmental impact of the rare earth industries. Resources, 3(1), 123-134.

Aragón, F. M., & Rud, J. P. (2013). Natural resources and local communities: evidence from a Peruvian gold mine. American Economic Journal: Economic Policy, 5(2), 1-25.

Aragon, F. M., & Rud, J. P. (2014). Polluting industries and agricultural productivity: Evidence from mining in Ghana.

Berman, N., Couttenier, M., Rohner, D., & Thoenig, M. (2017). This mine is mine! How minerals fuel conflicts in Africa. American Economic Review, 107(6), 1564-1610.

Boutilier, R. G., & Thomson, I. (2011). Modelling and measuring the social license to operate: fruits of a dialogue between theory and practice. Queensland, Australia: International Mine Management.

Bureau d'audience publique sur l'environnement (BAPE), 2015, Les enjeux de la filière uranifère au Québec. Enquête et audience publique, URL : http://www.bape.gouv.qc.ca/sections/mandats/uranium-enjeux/.

Bergeron, K., Jébrak, M., Yates, S., Séguin, C., Lehmann, V., Le Meur, P. Y., ... & Gendron, C. (2015). Mesurer l'acceptabilité sociale d'un projet minier: essai de modélisation du risque social en contexte québécois. [VertigO] La revue électronique en sciences de l'environnement, 15(3).

Brunnschweiler, C. N., & Bulte, E. H. (2008). Linking natural resources to slow growth and more conflict. SCIENCE-NEW YORK THEN WASHINGTON-, 320, 616.

Cebada, J. D. P. (2016). Mining corporations and air pollution science before the Age of Ecology. Ecological Economics, 123, 77-83.

Collier, P., & Hoeffler, A. (2009). Testing the neocon agenda: democracy in resource-rich societies. European Economic Review, 53(3), 293-308.

De Haas, R., & Poelhekke, S. (2016). Mining matters: Natural resource extraction and local business constraints.

Dell, M. (2010). The persistent effects of Peru's mining mita. Econometrica, 78(6), 1863-1903.

Devin-Wright, P. (2005). Beyond NIMBYism: towards an integrated framework for understanding public perceptions of wind energy. Wind energy, 8(2), 125-139.

Farrer, B., Holahan, R., & Shvetsova, O. (2017). Accounting for heterogeneous private risks in the provision of collective goods: Controversial compulsory contracting institutions in horizontal hydrofracturing. Journal of Economic Behavior & Organization, 133, 138-150.

Franks, D. M., Davis, R., Bebbington, A. J., Ali, S. H., Kemp, D., & Scurrah, M. (2014). Conflict translates environmental and social risk into business costs. Proceedings of the National Academy of Sciences, 111(21), 7576-7581.

Garrod, G. D., & Willis, K. G. (2000). Economic approaches to valuing the environmental costs and benefits of mineral and aggregate extraction. Minerals and Energy, 15(4), 12-20.

Gillespie, R., & Kragt, M. E. (2010). Valuing the non-market impacts of underground coal mining (No. 98239).

Van der Horst, D. (2007). NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy policy, 35(5), 2705-2714.

Ivanova, G., & Rolfe, J. (2011). Assessing development options in mining communities using stated preference techniques. Resources Policy, 36(3), 255-264.

Jones, C. R., & Eiser, J. R. (2010). Understanding 'local'opposition to wind development in the UK: How big is a backyard?. Energy Policy, 38(6), 3106-3117.

Kemp, D., Worden, S., & Owen, J. R. (2016). Differentiated social risk: Rebound dynamics and sustainability performance in mining. Resources Policy, 50, 19-26.

Mining Watch /Mine Alerte, 2014, Où s'arrête la limite des méga mines à ciel ouvert ? URL: http://www.miningwatch.ca/fr/news/o-s-arr-te-la-limite-des-m-ga-mines-ciel-ouvert

Muehlenbachs, L., Spiller, E., & Timmins, C. (2015). The housing market impacts of shale gas development. The American Economic Review, 105(12), 3633-3659.

Owen, J. R., & Kemp, D. (2013). Social licence and mining: A critical perspective. Resources policy, 38(1), 29-35.

Rolfe, J., & Windle, J. (2015). Testing attribute selection and variation in a choice experiment to assess the tradeoffs associated with increased mining development. Land Use Policy, 42, 673-682.

Ross, M. (2006). A closer look at oil, diamonds, and civil war. Annu. Rev. Polit. Sci., 9, 265-300.

Spyce, A., Weber, M., & Adamowicz, W. (2012). Cumulative effects planning: finding the balance using choice experiments. Ecology and Society, 17(1).

Windle, J., & Rolfe, J. (2014). Assessing the trade – offs of increased mining activity in the Surat Basin, Queensland: preferences of Brisbane residents using nonmarket valuation techniques. Australian Journal of Agricultural and Resource Economics, 58(1), 111-129.

Whittington, D., Adamowicz, W., & Lloyd-Smith, P. (2017). Asking Willingness-to-Accept Questions in Stated Preference Surveys: A Review and Research Agenda. Annual Review of Resource Economics, 9(1).

Dustbin

Kemp, Worden and Owen (2016) stress on unpredictable social impacts from mines while being anticipated as manageable at first.