Cross-national comparative study of demographic preferences for energy technologies: insights from online surveys in Brazil and the USA

Extended abstract

Description of the topic

Conducting comparative studies across countries using secondary data poses significant challenges. Data sources are often inconsistent, as different countries may collect information using varied methods, making direct comparisons difficult. Additionally, the quality of data may vary between countries due to disparities in resources, technology, or institutional capacity for data collection. Outdated or missing data is another common issue, especially in countries where data collection is infrequent or incomplete, such as low-income or conflict-affected regions. Methodological differences, such as variations in question wording, sampling techniques, or data collection methods, can also introduce inconsistencies. For example, while some countries may rely on face-to-face interviews, others might use online surveys, complicating the comparability of results.

The COVID-19 pandemic added another layer of difficulty to population data collection, causing delays in national censuses and forcing countries to shift to online surveys or phone interviews. This shift exacerbated challenges in reaching vulnerable or hard-to-reach populations, such as rural residents, informal settlements, or migrant communities, potentially leading to gaps in demographic data. Ensuring the safety of census workers also became a major concern, with field operations requiring strict health protocols, including the use of personal protective equipment (PPE), which increased logistical complexity and costs.

Furthermore, depending on the research topic, secondary data may not always provide sufficient answers to specific research questions, even in non-pandemic conditions. In such instances, alternative approaches, such as online population surveys tailored to the research objectives, are necessary to obtain accurate and representative data.

Theoretical focus

Population surveys are critical for gathering data on the characteristics, behaviors, and opinions of individuals. They play an essential role in fields such as public policy, business, health, and social science research. Governments use population surveys to track key demographic trends, including population growth, aging, migration patterns, and employment, which in turn inform decisions about resource allocation, social services, infrastructure planning, and legislation (Groves & Couper, 2012).

In demography, population surveys are vital tools for measuring processes such as fertility, mortality, and migration (Preston, Heuveline, & Guillot, 2001). Surveys also capture public attitudes on topics like government performance, elections, and policy proposals, providing data that helps governments respond to public needs and ensure accountability (Zukin et al., 2006). For researchers in fields like sociology, economics, and political science, surveys provide the empirical data that forms the foundation of their work, while in economics and demography, survey data are instrumental in refining theoretical models of human behavior (Bryman, 2015).

Data

This study uses data from two nationally representative online surveys conducted in Brazil and the USA (n=1,996 in Brazil; n=1,523 in the USA), stratified by age, gender, race, income, and education, with a 95% confidence interval for the sample. Data collection took place in February 2022. In Brazil, the survey was implemented through the Andia Integra platform by TESI Brasil, while in the USA, Qualtrics was used for distribution. These surveys were part of the larger "Convergence for Innovative Energy Solutions" project, funded by the National Science Foundation and coordinated by Michigan State University (MSU) in collaboration with the State University of Campinas (Unicamp), Brazil.

Research methods

This study employs a Discrete Choice Experiment (DCE) using Best-Worst Scaling to allow respondents to select among hypothetical energy technology attributes. DCE is a stated preference method, allowing researchers to statistically estimate how respondents value different aspects of preferences. Participants are presented with sets of hypothetical options, each defined by specific attributes (characteristics) at various levels. Respondents make choices based on trade-offs, seeking to maximize utility based on the attributes of each option.

Grounded in Lancaster's theory, which suggests that utility is derived from the attributes of goods, the DCE allows researchers to model the impact of these attributes on respondents' utility. The approach is rooted in random utility theory (Thurstone, 1927; McFadden, 1973).

Seven questions were used to assess respondents' preferences for a hypothetical energy technology to provide electricity to their households. **Each question presented a different set of four attributes**, and respondents were asked to select their MOST and LEAST preferred attributes. The **seven energy technology attributes** considered in the study were: Minimal Health Risk, Minimal Environmental Disruption, Minimal Residential Disturbances, No Displacement, Low Cost, High Reliability, and Community Empowerment.

An example of one of the seven questions presented to study participants:

Please consider the following four characteristics of an energy technology that will provide your household with electricity. Which is your MOST PREFERRED characteristic and which is your LEAST PREFERRED characteristic? [set order is randomized; item order within each block is randomized]

Most Preferred		Least Preferred
	Minimal Health Risk an energy technology that causes only minimal risk to human health	
	Minimal Environmental Disruption an energy technology that causes only minimal environmental disruption (e.g. deforestation, pollution, or species loss)	
	Minimal Residential Disturbances an energy technology that creates only minimal disturbances (e.g. noise nuisance, visual obstructions, or land removal) in residential neighborhoods and landscapes	
	No Displacement an energy technology that requires no displacement (or relocation) of households	

The choice experiment data was analyzed using a rank-ordered logit model with maximum likelihood estimation, enabling the extraction of the full preference ranking among the four options presented in each choice set (Louviere et al., 2015). This model has been applied to choice data since Beggs et al. (1981) and Chapman and Staelin (1982). The rank-ordered logit model operates as a sequential application of a standard multinomial logit (MNL) model, where the highest-ranked option is identified as the most preferred. The preference ranking between the remaining three alternatives is then assessed.

Using individual preference shares, we further examined the population's characteristics in relation to their energy technology preferences by applying fractional multinomial logit models (fmlogit). The covariates included in the models were:

- Gender (Male; Female),
- Age (≤34 years old; 35–64 years old; ≥65 years old),
- Income (divided into terciles for comparability across countries: in Brazil: ≤ R$ 3,300; R$ 3,301–R$ 11,000; ≥ R$ 11,001, and in the USA: ≤ $49,999; $50,000–$124,999; ≥ $125,000),
- Education (in Brazil: none or elementary school; high school; college, master's, or PhD, and in the USA: less than high school diploma; high school diploma or GED equivalent; associate's degree or bachelor's degree; master's, professional, or doctoral degree),
- Favorability towards hydropower (unfavorable; neither unfavorable nor favorable; favorable),
- Frequency of following environmental news (never or rarely; occasionally; frequently or very frequently),
- Agreement with the statement: "I enjoy following energy issues in the news" (disagree; neither disagree nor agree; agree).

All data processing and analysis were conducted using Stata 18 (StataCorp, 2023). The energy technology characteristics analyzed in the best-worst scaling were identical for both Brazil and the USA.

Findings

In Brazil, the most preferred energy technology characteristics, ranked from highest to lowest, were: 1) Low cost, 2) Minimal health risk, 3) Minimal environmental disruption, 4) High reliability, 5) Community empowerment, 6) No displacement, and 7) Minimal residential disturbances. In the USA, the rankings were: 1) Low cost, 2) High reliability, 3) Minimal health risk, 4) Minimal environmental disruption, 5) No displacement, 6) Minimal residential disturbances, and 7) Community empowerment.

Using fractional multinomial logit models to analyze who favored each of these energy technology characteristics, the results are presented in Table 1.

Table 1. Summary of population characteristics by preferences for hypothetical energy technologies

Energy technology characteristics	**Who cares in Brazil?**	**Who cares in the USA?**
Minimal Health Risk	Youngest, lowest income, higher education levels	Female, youngest, who follow news on environment
Minimal Environmental Disruption	Youngest, higher education levels	Female, youngest, higher education levels, who follow news on environment
Minimal Residential Disturbances	Male, lowest income, lowest education levels	Youngest, highest education, who follow news on environment
No Displacement	Middle-aged (35-64), unfavorable to hydropower	Youngest, who follow news on energy
Low Cost	Middle-aged (35-64), highest income	Older age groups, lowest income, lowest education, who does not follow news on environment, who does not follow news on energy
High Reliability	Favorable to hydropower	Male, oldest age group, higher income groups, highest education level
Community Empowerment	Lowest income, lowest education, who does not follow news on environment	Youngest, lowest income, highest education level, who follow news on environment

Our findings indicate that, in Brazil, individuals who are unfavorable toward hydropower prefer options with no displacement compared to other energy technology characteristics. This preference is understandable, as large hydropower projects in the country are known to cause significant population displacement, exemplified by the Jirau, Santo Antonio, and Belo Monte dams recently constructed in the Brazilian Amazon (Mayer et al., 2021; Johansen et al., 2024).

In the US, individuals with the lowest incomes prioritize low costs over other energy characteristics. The emphasis on low cost as the most preferred attribute of energy technology should be a focal point for stakeholders, as affordability appears to be crucial for encouraging the adoption of new, cleaner energy technologies that reduce CO2 emissions.

The findings of this study underscore the importance of population surveys in addressing pressing contemporary issues, such as energy transition. We demonstrated that best-worst scaling is a promising methodology for population studies, particularly in assessing public preferences. Other potential applications include understanding fertility preferences and family planning, prioritizing health and well-being, evaluating migration decision factors, exploring aging and retirement preferences, and assessing education and employment preferences.

Moreover, despite the challenges posed by COVID-19, online surveys can serve as an effective tool for gathering population data when face-to-face interviews are not feasible due to logistical, financial, or safety constraints. However, we note that not all segments of the population have equal access to technology and the internet, which complicates efforts to conduct specific population studies. This is particularly true when targeting older populations, low-income segments, and distinct groups, such as rural communities. Fortunately, our study successfully addressed these limitations by aiming for a representative sample of the national populations in both countries involved in the research.

Note for reviewers: Due to space constraints in this extended abstract, graphs and tables resulting from the statistical modeling will be presented to the conference audience upon acceptance of the manuscript.

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