Journal of Environmental Management 197 (2017) 296–304

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Risk aversion and willingness to pay for water quality: The case of non-farm rural residents

Bruno Larue, PhD [a, *], Gale E. West, PhD [a], Alphonse Singbo, PhD [b], Lota Dabio Tamini, PhD [a]

[a] Center for Research on the Economics of the Environment, Agri-food, Transports and Energy (CREATE), University Laval, 2425 de l'Agriculture St., Québec, QC G1V0A6, Canada
[b] International Crops Research Institute for the Semi-Arid Tropics, Bamako, Mali

ARTICLE INFO

Article history:
Received 7 September 2016
Received in revised form
10 March 2017
Accepted 17 March 2017

JEL codes:
Q25
Q51
R11

Keywords:
Water quality
Willingness-to-pay
Risk aversion
Rural residents

ABSTRACT

Stated choice experiments are used to investigate the economic valuation of rural residents living in the province of Quebec for water quality improvements. In Quebec, rural residents played an important role in the setting of stricter environmental regulations. Unlike most stated choice experiments about the valuation of improvements in water quality, this study explicitly accounts for risk in the design and analysis of choice experiments. Risk in phosphorus and coliform reductions is introduced through a three-point uniform distribution in the choice sets. The results show greater support for constant absolute risk aversion preferences than for constant relative risk aversion. Rural residents value coliform and phosphorus reductions and the more educated ones are particularly willing to see the government tax farmers and taxpayers to secure such reductions. As the science improves and risk in water quality outcomes decrease and as the political weight of non-farm rural residents increase, it should be easier for governments to replace voluntary cost-share programs by polluter-payer programs.

1. Introduction

Agricultural activities have adverse environmental effects that can be mitigated by the adoption and implementation of Best Management Practices (BMPs henceforth). Intensive farming can trigger significant releases of pollutants into ditches, streams and groundwater that impact on water quality at the watershed level. Studies identified that excessive phosphorus loads is the major cause of blooms of blue-green algae in lakes and reservoirs (Lathrop et al., 1998).[1] Blue-green algae blooms are associated with episodes of toxicity, fish kills, anoxia, and generally noxious shoreline conditions resulting from wind-blown accumulations of algae during the summer and as a result, the public's perception of water quality in lakes is often associated with the frequency of alga blooms. The Chaudière region south of Quebec City is one where water quality is a major concern. Excess phosphorus in this region and in others has spurred opposition to large scale hog operations.

In Quebec, a province-wide moratorium on new hog facilities, including expansion projects, was put in place between 2002 and 2005. This policy did not reduce production in areas with excess phosphorus, but it gave time to the authorities to develop more coherent regulations and policies. For example, farmers must produce a phosphorus report[2] to participate in a revenue insurance program and to get a property tax credit. They are also required to have a sustainable fertilization plan prepared by an agronomist and public hearings must be held before new hog production projects

* Corresponding author.
E-mail addresses: bruno.larue@eac.ulaval.ca (B. Larue), gale.west@eac.ulaval.ca (G.E. West), alphonse.singbo@gmail.com (A. Singbo), Lota.tamini@eac.ulaval.ca (L.D. Tamini).

[1] Blue-green algae is a common name for cyanobacteria which relies on photosynthesis to grow and incidentally is not an algae. Blue-green algae is not always dangerous, but some may produce neurotoxins and hepatotoxins which attack the nervous system and the liver. Garnache et al. (2016) review the state of knowledge about phosphorus pollution and identify research gaps in various areas that need to be filled to design and implement better abatement strategies in the US.

[2] The report is an inventory of both produced and imported phosphorus loads and the capacity of soils to handle these loads in compliance with the maximum annual phosphorus deposits prescribed. More details are available at: http://www.mddelcc.gouv.qc.ca/milieu_agri/agricole/phosphore/bilan-en.htm.

http://dx.doi.org/10.1016/j.jenvman.2017.03.050
0301-4797/

can be implemented. The federal and provincial governments have also promoted the adoption of specific BMPs like crop rotations, surface runoff controls, reduced herbicide use, solid and liquid manure management with adoption rates ranging from 15% to 66% (Ghazalian et al., 2009). Government programs were underperforming in meeting sustainable development objectives and tensions between farmers and rural residents remained in spite of the additional regulations imposed on farmers (MDDEP, 2011a). A new approach was needed and in 2013, Quebec's provincial government introduced a new integrated water management program at the watershed level that provides funding to watershed organizations. The latter bring together representatives of regional county municipalities (RCM), municipalities, users, environmental groups and citizens. Watershed organizations are eligible to receive funding, up to $30,000 CAD/year, to tackle well-documented water quality problems. A farmer involved in a collective program can also receive cost-share funds covering 70% of eligible expenses or 90% of eligible expenses if a neighbor farmer whose land borders his, also applies for cost-share funds.[3] It is hoped that farmers and citizens working together will be able to develop more efficient interventions (MDDEP, 2011b). Taxpayers contributions toward BMP adoption is substantial and it is on this issue that this paper focuses by investigating the preferences of rural residents, excluding farmers, when it comes to trade-offs involving coliform and phosphorus reductions and added costs for taxpayers and farmers.[4]

Unlike previous stated choice experiments about water quality, this study explicitly accounts for risk in the design and analysis of choice experiments. As such, it is hypothesized that support for investments to improve water quality is conditioned by the expected improvement in water quality, but also by the distribution of possible improvements. More specifically, this study investigates the role of risk aversion[5] on willingness-to-pay estimates for water quality improvements. The expected utility (EU) theory has a long tradition in the analysis of decisions under risk. It revolves around the valuation and probability of different outcomes. One of the challenges in introducing risk aversion is to describe the outcomes and the probabilities in a succinct yet transparent manner (Palsson, 1996). This is accomplished by showing respondents 3-point discrete uniform distributions with different means and spreads about reductions in coliforms and phosphorus. Because the lower and upper bounds are equally distant from the means and each proposed reduction has the same probability, the mean reduction and the spread can be seen as attributes. Two utility functions incorporating risks are estimated. The first one posits that risk preferences display constant absolute risk aversion (CARA) while the second showcases constant relative risk aversion (CRRA). Different specifications are estimated with fixed and random parameters to assess the robustness of the results and to address observed and unobserved heterogeneities across respondents. One set of regressions allows unobserved heterogeneity in risk aversion while cost coefficients are fixed. A second set of regressions has fixed risk aversion coefficients, but allows for unobserved heterogeneity in costs.

To summarize, this article aims to analyze the preferences of non-farm rural residents, about water quality improvements and how the cost for such improvements should be divided between farmers and taxpayers. Risk in BMPs capacity to improve water quality as well as observed and unobserved heterogeneity in risk attitudes on the part of rural residents are taken into account. The research relies on stated-choice experiments involving 711 randomly-selected non-farm rural residents from the Chaudière region south of Quebec City.

The remainder of this paper is organized as follows. Section 2 reviews the literature on the adoption of BMPs and growing social and economic importance of rural residents. Section 3 presents the research methodology with subsections on expected utility theory, random utility models and the choice design behind the stated choice experiments. Section 4 presents the estimation results and the trade-offs between attributes like willingness to pay for expected coliform and phosphorus reductions and mean-standard deviations. Section 5 discusses the policy implications and limitations of our study.

2. The growing influence of rural residents and BMPs

The literature on BMP adoption focuses on farmers' characteristics and their farms (e.g., Baumgart-Getz et al., 2012). Tamini (2011) and Hadrich and Van Winkle (2013) find that extension services increase the probability of BMP adoption. Rahelizatovo and Gillespie (2004) and Hadrich and Van Winkle (2013) contend that problem awareness impacts on BMP adoption. Asci et al. (2015) argue that the incidence of BMPs on the mean and variance of profit and farmers' attitude toward risk condition adoption. Ghazalian et al. (2009) find that larger farms are more likely to adopt BMPs because they can more easily afford implementation costs[6] and are more often the object of criticism regarding the adverse effects of agricultural production. Reimer et al. (2012) did in-depth interviews with Indiana farmers and found that those who care about off-farm environmental benefits and feel responsible to others are most likely to adopt BMPs. Clearly, most farmers care about how they are perceived by non-farm rural residents.

The importance of rural residents as a proportion of the rural population is rising rapidly. In Quebec, the last census reveals that rural population increased from 1,420,330 in 2001 to 1,534,731 in 2011 with an annual average increase rate of 0.81% while the number of farms decreased from 32,139 to 29,437 over the same period (indicating an annual decrease rate of 0.92%).[7] A similar pattern applies for Canada as a whole. This trend has interesting political economy implications. Farmers must be increasingly sensitive to the preoccupations and expectations of rural residents. New institutions are being created to reflect the growing political power of rural residents. The aforementioned integrated water management approach that empowers rural residents in the decision-making process about environmental initiatives applied at the watershed level is clearly a step in this direction. Rural residents can directly benefit from BMP adoption by farmers[8] and that these benefits are valuable. For example, Luzar and Cossé (1998) find that having a private well tends to increase the willingness to pay for one's own and state-level water quality.

[3] For the details of the program, see http://www.gcaq.ca/client/uploads/179/68184964294112.pdf.

[4] Excess phosphorus is a global problem and increasing on-farm phosphorus efficiency is costly. Sharpley et al. (2015) discuss various policy options to internalize environmental costs in decisions made by farmers and consumers.

[5] Hirshleifer and Riley (1992, p.23) define a risk averse person as someone who "prefers a certainty consequence to any risky prospect whose mathematical expectation of consequences equals that certainty."

[6] Ghazalian et al. (2010) and Tamini et al. (2012) find that BMPs tend to slightly increase costs/decrease profit, but Valentin et al. (2004) find that the adoption of nutrient BMPs has a positive effect on net farm income. Hadrich and Van Winkle (2013) find that farms with low debt loads are more likely to adopt BMPs.

[7] For rural population statistics, see http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo62f-eng.htm and for the number of farms see http://www.omafra.gov.on.ca/english/stats/census/number.htm.

[8] Rural residents may also adopt BMPs for homeowners, a subject investigated by Brehm et al. (2013).