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Are carbon pricing policies on a path to failure in resource-dependent economies? A willingness-to-pay case study of Canada

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ABSTRACT

There are limited studies on specific factors that affect willingness-to-pay (WTP) and public concerns on spending of pollution pricing in democratic economies that are carbon dependent. In light of the discourse on global pollution pricing, this study explores the complex influence of political-economic, attitudinal, and socio-demographic factors on carbon pricing, by estimating the WTP in a carbon resource-dependent economy such as Canada and the preferred revenue earmarking of Canadians. An online survey of 600 Canadian households was conducted using the random device engagement (RDE) approach. This study uses a contingent valuation method (CVM) and payment card (P.C.) to estimate the household WTP for carbon pricing on direct energy expenditure and an ordered logistic regression model for odds ratio estimates. The estimated annual WTP ranges between CAD$ 84 to CAD$ 230 in 2019 (CAD$ 1 = US$ 0.7538). This implies an acceptable increment of 1.5%–2.5% (CAD$ 157 to CAD$ 259) to the average yearly household energy expenditures. This study suggests that Canadians appear to be supportive of redistributing carbon price revenues and investing in clean energy technology. Canadian government needs to address public concerns surrounding political-economic factors, specifically the energy cost implication for vulnerable households in order to achieve emission reduction targets.

1. Introduction

There was a consensus at the end of the 2015 Paris Climate Conference among governments, academia, and civil society organizations for robust carbon pricing initiatives to help reduce emissions (Jacobs, 2016). Nearly half of the national plans on carbon emission reduction submitted at the Paris Conference consisted of carbon pricing strategies (World Bank, 2016). According to the World Bank (2021), there are currently 64 carbon pricing initiatives that have been implemented around the world that cover 11.65 gigatons (Gt) of carbon dioxide equivalent (CO_2e), corresponding to 21.5% of global greenhouse gas (GHG) emissions. However, the price levels of these initiatives remain well below that required to drive transformational change (New Climate Economy, 2019). With the current global average carbon pricing of less than US$ 3 per ton, achieving the goals of the Paris Climate Agreement will be unrealistic (International Monetary Fund, 2019; Gaspar and Parry, 2021; World Bank, 2019).

Canada is the 38th largest country in the world by population, 10th largest economy, and 7th largest emitter of GHG (Booth and Boudreault, 2016; Migiro, 2018). In 2015, Canada committed to reducing GHG emissions by 40–45% compared to 2005 levels by the year 2030 (Government of Canada, 2020; Vaillancourt et al., 2019). More recently, the Canadian government has committed to net-zero emissions by 2050 (Arnold and Olewiler, 2020). However, the recent *Brown to Green Report 2019* found that Canada's GHG emissions increased by 17% between 1990 and 2016 and the country would most likely miss its 2030 and 2050 emission reduction targets (Climate Transparency, 2019). The Canadian government figures show that GHG emissions only declined by about one million tons in CO_2e between 2005 and 2018, equivalent to a 1% reduction over 13 years (Environment and Climate Change Canada, 2019). Environment and Climate Change Canada (2018) argue that the carbon pricing would eliminate between 50 and 60 megatons (MT) of CO_2e annually, approximately 12% of all Canadian emissions, by 2022. However, the success or failure of carbon pricing may depend on public support of the policy to give pollution a price, in other words on carbon pricing.

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The current price on pollution is federally mandated until 2022 when it will reach CAD$ 50[1] per ton of CO_2e (almost US$ 40 in 2021) and there have been growing discussions for post-2022. The federal carbon pricing was launched by the current Liberal government's climate strategy in 2015 (Gabbatiss, 2019). Stokes et al. (2015) and the Angus Reid Institute (2018) found that 84% of all Canadians support the reduction of the country's GHG emissions under the Paris Climate Agreement and 56% support a national carbon pricing policy. However, according to Klein (2019), Canadians do not believe they have to be the major bearer of the financial burden. There have been attempts in the past to repeal the tax on pollution making carbon pricing a controversial and ballot topic in federal elections between Liberals and Conservatives in Canada (Loewen and Bernstein, 2019).

This contribution aims to fill the gaps in understanding the dynamics of carbon pricing in Canada concerning public support, earmarking, and willingness-to-pay (WTP). Jenkins (2014) argues that citizens tend to favor measures other than carbon pricing such as subsidies to adopt cleaner technologies to induce GHG emissions reductions. Earmarking of revenues based on public opinion is relevant for the success or failure of carbon pricing in Canada (Kotchen et al., 2017; Rotaris and Danielis, 2019). Kallbekken and Aasen (2010) found that citizens of natural resource-rich countries in the global north, e.g. Norway, want to have an opinion on the earmarking of carbon pricing revenues. Several studies on the WTP a price on pollution (Akter and Bennet, 2011; Duan et al., 2014; Gupta et al., 2014; Kotchen et al. 2013, 2017; Rotaris and Danielis, 2019) have focused on socio-demographic factors and environmental awareness. These studies found that certain parameters such as gender, education, political affiliation, income, and environmental awareness significantly affect the WTP. However, there is limited scientific evidence on whether the Canadian carbon prices reflects its citizens WTP and its effect on household energy expenses. Thus, the influence of socio-demographic, attitudinal, or political-economic factors on the WTP and the public opinion on the distribution of public revenues from the carbon tax have been neglected. Furthermore, it is important to validate whether the additional energy costs, due to carbon pricing, matches the WTP of Canadians. This has resulted in the following research questions:

1. What is the level of support for carbon pricing in Canada and how does household WTP for energy expenditure match their carbon pricing?
2. How would Canadians choose to earmark public revenues from carbon pricing - redistribution programs versus investment spending?
3. Does public understanding and perception of carbon pricing affect the Canadian political economy?

This research follows methods that are similar to other WTP studies (Akter and Bennett, 2011; Carattini et al., 2017, 2018; Carattini et al., 2018a,b; Jenkins, 2019; Kallbekken and Aasen, 2010; Kotchen et al. 2013, 2017; Rotaris and Danielis, 2019; Sælen and Kallbekken, 2011). An online survey consisting of six hundred respondents was conducted in March 2020. A contingent valuation method (CVM) - Payment Card (P.C.) approach and ordered logistic regression models (ordered logit) was used to investigate Canadian WTP.

2. Literature review

There is still some degree of public opposition to carbon pricing in global north, especially among carbon dependent countries. Reasons are distrust of political spending of public revenues from carbon pricing, equity and fairness, disruption to traditional practices, and the financial burden to enterprises and households (Hsu et al., 2008; Rosenbloom et al., 2020). Some of this opposition by the public may also be based on tax concerns, which according to Winter et al. (2021) disproportionately affect vulnerable and poor households. This is supported by the political economy theory (Hammar et al., 2004; Hsu, 2011; Carattini et al., 2018a,b), namely that political parties and voters in resource dependent countries oppose high carbon pricing measures. Opposition to carbon pricing in North America specifically focuses on gasoline taxes (Hsu et al., 2008). This is understandable considering the heavy reliance on automobile transport; however, it is important to look at the whole spectrum of household energy consumption and expenditure. This is because carbon pricing will also affect other aspects of household energy expenditures, as the compositions of the basket of goods changes so does the budget frame. For instance, Carattini et al. (2017) highlighted distributional and competitiveness concerns as well as ineffectiveness of energy taxes as reasons for public opposing by the Swiss public. However, providing comprehensive information on how such taxes work and are earmarked in the public budget can improve the acceptance of carbon pricing.

Another important aspect of carbon pricing largely under researched in Canada is the estimated cost to households of such taxes not matched by household WTP. According to Winter et al. (2021: p.2), the "politicized nature of carbon pricing discussions in Canada" is resulting in unrealistic and false costs estimates to households. For instance, there where cases in Canada were political parties estimated a price on pollution of CAD$ 1200 for a family; which is high and far from what the average household may be willing and able to afford (Winter et al., 2021). Canada is planning a carbon pricing floor model across its provinces of CAD$ 170 (US$ 128) per ton of CO_2e by 2030 (Gaspar and Parry, 2021). Therefore, it is paramount to investigate the effect of political affiliations, attitudinal beliefs and WTP of the average Canadian household for carbon pricing. Such a study should provide a true and realistic estimate of the Canadian household WTP as well as other concerns that can influence acceptance or opposition to carbon pricing. This study aims to bridge these research gaps.

3. Material & methods

3.1. Data

An online survey was conducted in March 2020 through Pollfish, a market research outlet, based on random sampling technique, namely random device engagement (RDE). Six hundred respondents completed the survey online with all of them answering all questions of the questionnaire. While Arrow et al. (1993) argued that CVM questionnaires should be conducted based on a face-to-face interview, more recently several studies have reverted to an online survey (see Duan et al., 2014; Rotaris and Danielis, 2019) as it allows access to respondents from a wide geographic area. Furthermore, online surveys provide flexibility to respondents who often ignore face-to-face or phone interviews (Duffy et al., 2005).

The survey focused on attitudinal beliefs about climate change in general, carbon price awareness WTP as well as political and economic considerations. With regards to the WTP for pollution, carbon prices were presented as an increment in the respondent's energy bill in absolute Canadian dollar amounts as well as a percentage, i.e., as a fixed percentage increase in the energy bill. The survey consisted of three sections: (1) Demographics, (2) Attitudes towards climate policies and political affiliation, and (3). Contingent valuation and payment card (P.C.) questions to derive a price on pollution estimations (see Appendix A for the survey). An example of a P.C. question in absolute dollar term is as follows:

If a price on pollution (through coal, oil, and natural gas consumption) it to help meet Canada's commitment to the Paris Climate Accord, were to cost you more each year in higher energy bills, would you continue to support or oppose it? If yes, which amount would you be

[1] In the survey year 2019, the average exchange rate of one Canadian dollar to the US dollar was 0.7538. US dollar figures are rounded to avoid decimals.

willing to pay?

Bid	Definitely Support It	Definitely Oppose It
CAD$ 100 more per *year*		
CAD$ 200 more per *year*		
CAD$ 400 more per *year*		
CAD$ 600 more per *year*		
CAD$ 800 more per *year*		

A limitation of the P.C. approach is the dependence on the bids offered to the respondents. The range (from CAD$ 100 to CAD$ 800) chosen for the P.C. in this research was based on a study by Tombe (2016), who estimated average energy prices for Canadian households at CAD$ 600. This range also considers the average cost for direct energy prices to households, i.e., increased gas, heating, and electricity prices due to the price on pollution of CAD$ 40 per ton of CO_2e at the time of the survey (see Winter 2017). The lower bid range is based on nationwide polls of WTP for price on pollution in 2019 (Grenier, 2019). Thus, the respondents were asked to choose the highest amount(s) they were (un)willing to pay. This study also used the Canadian government census statistics to validate the results of our sample. Additionally, data from other reputable international organizations such as the Organization for Economic Cooperation and Development (OECD) were also used for validation. There were no significant differences between the survey sample and averages in Canadian census data.

Table 1 depicts descriptive statistics from the online survey. The median age of respondents from the online survey is comparable to the Canadian average of 41 years. Women are slightly overrepresented with 59% compared to the Canadian average of 50.4% (Statistics Canada, 2020a; Country Meters, 2020). The urban population sample (Census Metropolitan Area [CMA]) is similar to the Canadian average of 81% (Plecher, 2020). The share of respondents with a bachelor degree (48%) was higher than the national average (31%) (Statistics Canada, 2020b). However, Canada has the highest proportion of college and university graduates in the OECD due to its large college sector (OECD, 2020). The medium household income of CAD$ 48,076 from our survey is below the median Canadian household income of CAD$ 61,400 (Statistics Canada, 2020b). This is likely due to the relatively large share (45%) of single and divorced individuals in the sample. Furthermore, there was a large percentage of retirees, students, and unemployed respondents. The average household size of two persons is comparable with the Canadian average at 2.47 (Statistics Canada, 2017a). The majority of the respondents (73%) identified themselves as white; similar to the Canadian census that shows 73% of Canadians are of European ancestry (Statistics Canada, 2019b). The sample's representation of political affiliations is close to the federal election result of 2019. Exactly 25% of the respondents in the sample identify themselves most with the political agenda of the Conservative Party. This by 9 percentage points higher than the result of the last federal election. Greens were slightly overrepresented with 9% of the respondents when they only had about 6.5%, and the Bloc Quebecois is under-represented. The Independent affiliation is overrepresented at 4% compared to less than 1% in the last election. Furthermore, we asked respondents diverse questions on their awareness of anthropogenic climate change and carbon pricing (i.e., pollution price awareness), beliefs on equitable and fair pricing on pollution (i.e., climate policy belief and equity) and transparent communication by government of current and future pollution policies (i.e., government transparency). Finally, respondents were asked whether the price on pollution had affected Canada's competitiveness in the world market (i.e., global competitiveness). These questions were based on a discrete choice, i.e. yes (= 1) or no (= 0) answer. For more information, please see the Supplementary Materials.

Table 1
Descriptive statistics from the online survey.

Characteristics	Sample Breakdown
Age Range	18-24: 13%, 25–34: 20%, 35–44: 19%, 45–54: 16%, >54:32%
Education Level	High-School: 27%, Technical College: 13%, Bachelor's: 48%, Post-Graduate: 12%
Marital Status	Married: 39%, Common Law: 13%, Single: 35%, Divorced or Separated: 10%, Widowed: 3%,
Household Size	1: 41%, 2: 37%, 3: 9%, 4: 9%, 5+: 5%
Number of Children	0: 68%, 1: 14%, 2: 12%, 3: 5%, >4: 2%
Gender	Male:41%, Female: 59%
Yearly Household Income	≤ CAD$ 30,000: 22%, CAD$ 30,001–60,000: 35%, CAD $ 60,001–90,000: 20%, CAD$ 90,001–120,000: 12%, CAD$ 120,001–200,000: 9%, > CAD$ 200,001: 2%
Political Affiliations	Bloq Quebecois: <1%, Conservative: 25%, Green: 9%, Liberal: 32%, New Democratic Party: 17%, Independent: 4%, None: 12%
Census Metropolitan Area (CMA)	CMA: 76%, Non-CMA:34%
Employment Status	Employed for Wages: 48%, Self-Employed: 10%, Student: 8%, Retired: 18%, Unemployed: 6%, Cannot Work: 5%, Other: 6%
Race	White: 73%, Asian: 14%, Black: 3%, Hispanic: 2%, Arab: 1%, Other: 7%

Source: Author

3.2. Methodology

A number of studies (e.g., Mankiw, 2009; Nordhaus, 2007; Gaspar and Parry, 2021) agree that carbon prices are the most cost-effective way to reduce GHG emissions. The CVM is a common and widely adopted valuation method for different environmental policies (OECD, 2018; Snowball, 2008). CVM generally uses public surveys to investigate the WTP to protect an environmental good by constructing a hypothetical market or referendum (FAO, 2000). There are different question options when using CVM, namely open-ended, dichotomous choice (D. C.), payment card (P.C.), and iterative bidding (I.B.) (Boyle et al., 1996). This study chose to use the P.C. option (see Akter and Bennett, 2011; Duan et al., 2014; Kotchen et al., 2013; Rotaris and Danielis, 2019), where each respondent is presented with a range of bid payments and asked to choose an amount, he/she would be (un)willing to pay. Furthermore, the P.C. method is a rather simple calculation and every respondent's WTP is assumed to be located above the bid value chosen and below the next higher one (Hu, 2006; OECD, 2018).

The ordered logit method has been utilized in other CVM and P.C. studies related to WTP for environmental goods (Hackl and Pruckner, 1999: Xu et al., 2011). This research identified several factors that affect the WTP and thus should be considered in a WTP survey (Akter and Bennett, 2011; Blaine et al., 2005; Duan et al., 2014; Gupta, 2016; Hsu et al., 2008; Kotchen et al., 2013; Kotchen et al., 2017; Rotaris and Danielis, 2019).

These include the place of residence, i.e., the census metropolitan area (CMA), gender, age, household size, number of children, employment status, business ownership, education level, household size, yearly per capita income, political affiliation. Other political-economic factors (see also section 3.1) included binary regressors regarding pollution price awareness, climate policy belief and equity, government transparency, and pollution pricing communication. The perception of the effect of carbon pricing on global competitiveness was also investigated. In the regression equation, the latent variable, is continuous (see Williams, 2015; Trang et al., 2019) and denoted as:

$$Y_i^* = \sum_{j=1}^{J} \beta_j X_{ji} + \varepsilon_i = Z_i + \varepsilon_i$$

Y_i^* represents a single measure of a respondent's WTP on direct energy costs. β_j represents parameter coefficients that influence the dependent variable. X_{ji} is a vector of factors that affect household WTP. According to the proportional odds approach, the variable Y_i^* has various threshold points and a six-point scale (see P.C. question in Section 3.1). A zero represents the answer 'No bid'. Along the five categories of the surveyed WTP (CAD$ 100 increment in energy bill or 1% increase in the energy bill; CAD$ 200 or 2%; CAD$ 400 or 3%; CAD$ 600 or 4%; and CAD$ 800 or 5%), a threshold is determined based on the categories in equation (2). Implying a respondent's choice to accept one threshold can be measured if it passes a defined threshold, Y_i. Thus, Y_i^* can be understood as an infinite set of values that are separated into observable Y_i values. Using the estimated value of Z_i and the assumed logistic distribution of the disturbance term, the ordered logit model can be used to estimate the probability that the unobserved variable Y_i^* falls within the various threshold limits. β_j represents parameter coefficients that influence the dependent variable. X_{ji} is a vector of factors that affect household' WTP. Z_i stands for the ordered logit model estimates. Using the estimated value of Z_i and the assumed logistic distribution of the disturbance term, ε_i , assumed to be normally distributed, the probability that the unobserved variable Y_i^* falls within the various threshold limits is calculated (Williams, 2015). The probability calculations used for this research can be seen in Appendix B.

$$Y_i = \begin{cases} 0 = if\ Y_i^* < j1(CAD\$\,100\,or < 1\%) \\ 1 = if\ Y_i^* < j = 1(CAD\$\,100\,or < 1\%) \le Y_i^* < j = 2(CAD\$\,200\,or < 2\%) \\ 2 = if\ Y_i^* < j = 2(CAD\$\,200\,or < 2\%) \le Y_i^* < j = 3(CAD\$\,400\,or < 3\%) \\ 3 = if\ Y_i^* < j = 3(CAD\$\,400\,or < 3\%) \le Y_i^* < j = 4(CAD\$\,600\,or < 4\%) \\ 4 = if\ Y_i^* < j = 4(CAD\$\,600\,or < 4\%) \le Y_i^* < j = 5(CAD\$\,800\,or < 5\%) \\ 5 = if\ Y_i^* < j = 5(CAD\$\,800\,or < 5\%) \ge Y_i^* \end{cases} \tag{2}$$

The ordered logit equation for the two WTP models within this research is shown in equation (3):

$$\begin{aligned} WTP_j = {} & \alpha\ + \beta_1 CMA + \beta_2\ Age + \beta_3 Gender + \beta_4 Number\ of\ Children + \\ & \beta_5 Household\ Size + \beta_6 Education + \beta_7 Employment\ Status + \beta_8 Race + \\ & \beta_9\ Organization\ Role + B_{10} Log\ Household\ Income + \\ & \beta_{11} Political\ Affiliation + \beta_{12} Pollution\ Price\ Awareness + \\ & \beta_{13} Climate\ Policy\ Belief + \beta_{14} Equitable\ \&\ Fair + \beta_{15} Transparency + \\ & \beta_{16} Competitivenss \end{aligned} \tag{3}$$

Where WTP_j is the ordinal dependent variable, α is the constant j is the number of categories minus 1. β_1, β_2,… β_n are estimated parameter coefficients.

This research estimates the mean WTP based on the lower bound approach in line with methods from other studies (Turnbull, 1976; Cameron & Huppert, 1989; Hackly & Pruckner, 1999; Blaine et al., 2005; Xu et al., 2011). The equation for Lower Bound Mean WTP is given as:

$$Lower\ Bound\ Mean\ WTP\ (LBM - WTP) = \sum_{i=1}^{n} F_0(A_0) + F_i(\mathrm{A_i} - \mathrm{A_{i-1}}) \tag{4}$$

The non-parametric estimate follows the Turnbull (1976) method, which utilizes a measure that provides a lower-bound mean estimate of WTP. F_0 represents the initial bid and n is the number of bids within the CVM question. This estimate follows the true "lower bound" bid as there are no attempts to extrapolate higher bids into the estimated WTP. F_i represents the frequencies (in percentage terms) of supported bids from the survey, which is represented as $\mathrm{A_i}$ (for the frequencies and bid levels supported see Fig. 1 and Fig. 2). The equation for Interval Midpoint (IM) of the mean WTP is given as:

$$Interval\ Midpoint\ WTP\ (IM - WTP) = \sum_{i=0}^{H-1} \frac{A_i + A_{i+1}}{2} {}^* F_i + \frac{A_H + A_T}{2} {}^* F_H \tag{5}$$

The IM-WTP (non-parametric) method assumes that the individual

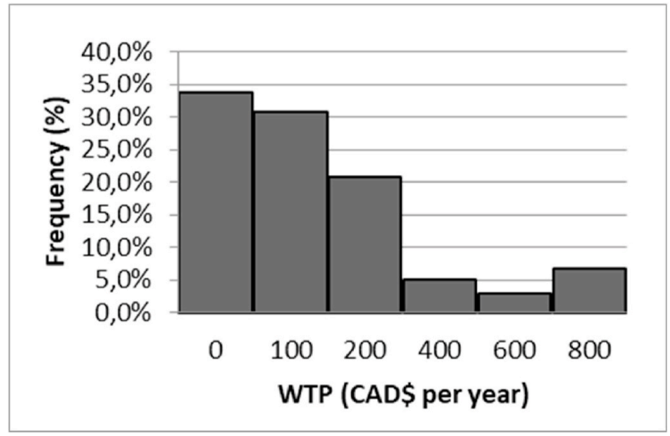

Fig. 1. Respondents frequency distribution for WTP for fixed increase in energy bills in CAD$.

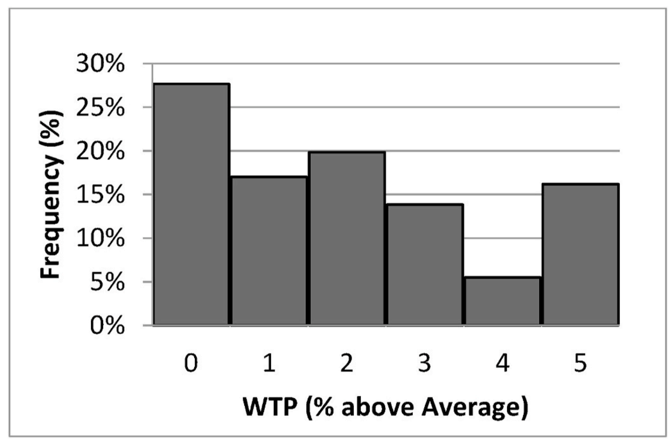

Fig. 2. Respondents frequency distribution for WTP for fixed increase in energy bills in %.

WTP is distributed within a given interval. In other words, the respondent's true WTP lies somewhere between the chosen value and the next higher one (Cameron and Huppert 1989). Where A_H represents the highest value (e.g., CAD$ 800 or 5% increment in energy bill) from the payment cards and A_T represents the truncated value (upper limit value). A_i and F_i are similar to the notations in equation (4). Equation (5) provides the mean value of the IM-WTP, while the respondent's median WTP can also be estimated. The equation for ordered logistic regression of the mean WTP is given as:

$$Ordered\ Logistic\ Regression\ WTP\ (OL - WTP) = \frac{\sum_{k=0}^{n}(A_k {}^* P_k)}{\left(\sum_{k=0}^{n} P_k\right)} \tag{6}$$

The estimation of the OL-WTP is similar to that of the IM-WTP (but parametric in nature). A_k represents the chosen bid from the P.C. of the k^{th} respondent and P_k stands for the estimated probabilities from the ordered logit model.

This research used a predict function in the statistics software R to obtain estimated probabilities of each category when all predictors are evaluated at their mean. In doing this, R created a predicted probability based on the econometrics results associated each respondent's accepted bid value and stored them in variable P_k.

4. Results and discussion

4.1. Explorative analysis of descriptive results

The attitudes of the Canadian respondents towards different options to earmark carbon price revenues by the government are presented in Table 2. The choice of earmarking of carbon price revenues was based on six different options including an option to suggest a seventh option when they chose "Other". Respondents were allowed to give multiple answers if they supported more than one option of earmarking public revenues from carbon pricing. Interestingly, there was broad support for several of the public expenditure options. For instance, plus/minus a quarter of the respondents supported the development of clean energy in Canada and returning money in equal amounts to all Canadian households. Furthermore, around 17% of the respondents chose to earmark revenues to fund programs helping communities to prepare for climate change adaptation. Thus, 71% of all answers supported some form of investment in people, infrastructure, or adaptation measures. Approximately half of the Canadians in our sample would opt for a combination of investing revenues and redistributing part of them back to the public.

The results of the aforementioned P.C. for the absolute Canadian dollar amount and the fixed percentage increase in energy bill are presented in Figs. 1 and 2. Around 34% of the respondents were not willing to accept the lowest absolute dollar bid offered ($\geq$ CAD$ 1), while only 28% of the respondents did not accept the lowest percentage bid-offer (1%).

An estimated 79% of respondents felt that there were policies (see Supplementary Materials), that Canada could use other than carbon pricing to lower GHG emissions. Lastly, 65% of the respondents said they would not vote for any political party that proposed a price on pollution of CAD$ 100 per ton of GHG emission starting in 2025. This finding suggests a strong opposition to short-term carbon pricing increase irrespective of political affiliation. However, it is important to mention that in the 2021 federal election campaign all of the four major political parties (Liberals, Conservatives, NDP, Greens) proposed particular ranges of carbon prices. Starting with CAD$40 per ton, the federal carbon tax for consumers would rise to CAD$50 per ton in 2022 under the Liberal minority government, thereafter it would increase annually by CAD$15 per ton until it reaches CAD$170 per ton in 2030. To offset costs to most households, they are given a fixed rebate by the government even though the amount in question varies between provinces. Under the Conservative plan, the consumer carbon price would have been set initially at CAD$20 per ton and would have topped out at CAD$50 per ton (Economist Intelligence, 2021). While this points to a possible future political limitation of increasing the price on pollution, exogenous shocks (e.g., heatwave, drought, and flooding) may change the minds of the Canadians.

Table 2
Canadians pollution price revenue earmarking.

Categories	Percentage of respondents	Percentage of answers
Return money to all Canadian households in equal amounts (i.e., Carbon Dividend).	47.67%	24.66%
Assist workers in industries that may lose their jobs because of the price on pollution.	23.67%	12.24%
Support development of clean energy in Canada (e.g., solar, wind, geothermal, hydro, etc.).	53.83%	27.84%
Fund improvements to Canada's infrastructure (e.g., public transport, bridges, etc.).	27.00%	13.97%
Fund programs to help communities prepare for and adapt to climate change.	32.50%	16.81%
Keep the current plan your province is already using.	6.00%	3.10%
Other	2.67%	1.38%

Source: Author

4.2. Econometric analysis and mean WTP

The ordered logistic econometric analysis of the survey responses was conducted to assess whether and how the sociodemographic, political affiliations, and environmental beliefs affected the respondent's WTP (see Supplementary Materials). The ordered logit results for the households' mean WTP for pollution priced in both CAD dollars and percentage bids in relation to their energy expenditures are presented in Table 3. The pseudo R-square of Model 1 (0.1191) shows a better fit compared to that of Model 2 (0.0951). In Model 1, parameters such as age, number of children, household size, education, employment status, position in organization, political affiliation, climate policy belief, and equity are all significant at the 5% level. The explanation of the significant parameters are as follows.

4.2.1. Model 1

In Table 3, we present the *Beta* coefficient (β) and odds ratio, which give the direction as well as magnitude of the independent variable, respectively. However, only a number of significant parameters are highlighted. Odds ratios must be interpreted such that the other variables are held constant in the model. Assume k is the level of the response variable. The interpretation would be that for a one unit change in the predictor variable, the odds for cases in a group that is greater than k versus less than or equal to k are the proportional odds. For instance, if the *age* of the respondent increases by one year, the odds of being in a higher CAD dollar WTP category are 0.98 times lower, *ceteris paribus*. This implies that older respondents were more likely to choose lower CAD dollar WTP categories. This might reflect discounting of costs over time related to the relative position in the finite lifetime. If the *number of children* in the family increases by one, the odds of being in a higher CAD dollar WTP category are 1.55 times greater. This result could reflect considerations beyond the own lifetime. With increasing *household size*, the odds of being in a higher dollar WTP category decreases by 0.6 times. If the respondent were to have one additional year of *education*, the odds of being in a higher dollar WTP category increases by 1.18 times. The *employment status* influenced the WTP too. The odds of a self-employed respondents being in a higher dollar WTP category is 0.49 times lower than non-self-employed respondents. The odds of a *business owner* being in a higher dollar WTP category is 2.12 times greater than that of a nonbusiness owner. *Political Affiliation:* The odds of a conservative respondents being in a higher dollar WTP category is 0.5 times lower as compared to a non-conservative respondent. *Climate Policy Belief:* The odds of respondents that agree with the current climate policies being in a higher dollar WTP category is 1.58 times more than respondents who disagree. The odds of respondents that believe pollution pricing is *equitable* being in a higher dollar WTP category is 4.25 times more than those respondents who do not find it equitable.

4.2.2. Model 2

The results of model 2 show that parameters such as age, number of children, household size, log household income, climate policy belief, equitability and transparency are all significant at the 5% level. Political affiliation was excluded, as it was significant at the 10% level. As in model 1, if the *age* of the respondent increases by one year, the odds of being in a higher dollar WTP category would decrease, but more pronounced, namely by 0.99 times, *ceteris paribus* (holds for all others). The direction of the response variables *number of children*, *household size*, *education*, *climate policy belief*, *equity* are in line with model 1 too. The regressor log *household income:* was not significant in model 1 but 2. If the log household income of the respondent were to increase by one-unit, the odds of being in a higher dollar WTP category increases by 1.22 times. The odds of respondents agreeing that pollution pricing is *transparent* (not significant in model 1) being in a higher dollar WTP category is 1.42 times higher than of those who do not find it equitable.

Table 3
Ordered logit regression results and WTP.

	Model 1 (CAD$ WTP)			Model 2 (% WTP)		
	Odds Ratio	*β (Beta)*	StandardErr.	Odds Ratio	*β (Beta)*	Standard Err.
Census Metropolitan Area	1.33	0.28	0.26	1.03	0.02	0.19
Gender	1.26	0.23	0.21	0.94	−0.05	0.15
Age	0.98***	−0.01***	0.004	0.99***	−0.01***	0.004
Number of Children	1.55***	0.43***	0.22	1.47***	0.39***	0.20
Household Size	0.60***	−0.51***	0.07	0.60***	−0.51***	0.07
Education	1.18**	0.16**	0.09	1.17**	0.15**	0.09
Employment Status	0.49**	−0.69**	0.16	0.63	−0.44	0.20
Race	1.05	0.05	0.19	0.82	−0.19	0.14
Business Owner	2.12**	0.75**	0.65	1.54	0.43	0.47
Log Household Income	1.10	0.10	0.11	1.22**	0.20**	0.12
Political Affiliation	0.56***	−0.56***	0.11	0.73*	−0.31*	0.13
Pollution Price Awareness	1.28	0.25	0.22	1.16	0.15	0.20
Climate Policy Belief	1.58**	0.45**	0.31	1.48**	0.39**	0.27
Equity	4.25***	1.44***	0.86	3.61***	1.28***	0.69
Transparent	1.13	0.12	0.21	1.42**	0.35**	0.25
Competitiveness	0.99	−0.00	0.15	1.08	0.07	0.16
Observations (n)	600	600	600	600	600	600
Log-Likelihood	−755.63	−755.63	−755.63	−859.29	−859.29	−859.29
LR Chi2 (16)	204.3	204.3	204.3	180.54	180.54	180.54
Pseudo R2	0.1191	0.1191	0.1191	0.0951	0.0951	0.0951

Note: *** denote statistically significant at the 1% level, ** at the 5% level, and * at the 10% level.
Source: Author

4.2.3. Willingness-to-pay (WTP)

The results of the WTP estimations are presented in Table 4. In Model 1, depending on the parametric or non-parametric estimates, the WTP of respondents ranges from about CAD$ 84 to CAD$ 230 per year (about US$ 63 to US$ 174). This is equivalent to between 7 and 20 Canadian dollars per month. In Model 2, the estimated WTP range is between 1.5% and 2.5% increase in annual energy expenditure costs. The yearly household expenditures of Canada was CAD$ 86,070 (US$ 64,880) in 2019 (Statistics Canada, 2020). Given that 12% of the expenditures of a Canadian household is spent on energy (Canada Energy Regulator, 2019), this is equivalent to CAD$ 10,328 (US$ 7786). Assuming an annual inflation rate of 2%, which is the approximate inflation range in household expenditures between 2013 and 2017, the maximum increase in energy expenditure acceptable to Canadian household in 2019 would be approximately CAD$ 10,794 (US$ 8137) (Statistics Canada, 2020). From the Model 2 estimation of a WTP ranging between 1.52% and 2.51%, the increase in energy expenditures of Canadian households, due to carbon pricing, would be between CAD$ 157 (US$ 118) and CAD$ 259 (US$ 195) per year. While this is somewhat similar to the absolute amount of Canadian dollars, politically it could seem misleading to submit carbon price costs to Canadian households as a percentage of their yearly energy expenditures (i.e., it could be perceived as hiding the true cost and thus as deliberate ambiguous). The differences in model 1 and model 2 may be due to the real, i.e. absolute dollar amount versus the hypothetical, i.e. percentage amounts, which according to Schmidt and Bijmolt (2020) may result in overestimations.

5. Conclusion and policy implications

This study revealed that public support for carbon pricing depends on how the cost is presented to the public by the government. Previous studies (e.g., Hsu et al., 2008) found that in certain Canadian provinces such as British Columbia there is some opposition to implementing a pollution tax because the population resents government misspending or perceives increased economic hardships upon specific individuals, groups, or industries. The results of this study seem to suggest, however, that Canadians remain uncertain of the economic and political issues surrounding carbon pricing. For instance, when asked if they are willing to pay one to two percent more per year in household energy costs, which can seem like a comparatively small amount, the responses were rather favorite among households with higher incomes. This result is in line with Kotchen et al. (2013) who pointed out that higher household income increases the WTP of U.S households for carbon pricing instruments.

Clearly the framing of the question has an impact on the expressed WTP. Using the absolute Canadian dollar amount is more straightforward and can be used for a simple cost/benefit calculation. Politically, it may be misleading to present carbon price costs to Canadian households as a percentage of their yearly energy expenditures as this may be perceived as ambiguous. In order to increase the transparency and reduce the uncertainty associated with the pollution tax, the province of Ontario in 2019 enacted the Federal Carbon Tax Transparency Act, a directive that mandates gas stations to show how the provincial government constitutes the federal carbon tax. This was done by affixing a sticker with a federal carbon tax of 4.4 cents per liter in 2019 and increment to 11 cents a liter by 2022 on pumps. From an political

Table 4
The estimated mean and median willingness to pay (WTP).

	Model 1 (CAD$ Bids)			Model 2 (% Bids)		
CVM	LBM-WTP	IM-WTP	OL-WTP	LBM-WTP	IM-WTP	OL-WTP
	Conservative Estimate	*Upper Bound Estimate*	*Lower Bound Estimate*	*Conservative Estimate*	*Upper Bound Estimate*	*Lower Bound Estimate*
Mean WTP	$162.90	$230.40	$84.32	2.01% ($1836)	2.51% ($2298)	1.52% ($1388)
95% CI	[145.80–180.2]	[211.9–249.3]	[72.50–89.26]	[1.87–2.15]	[2.37–2.66]	[1.31–1.62]

Notes: CI = confidence interval; IM interval midpoint; = LBM = lower bound measure; OL = ordered logistic; WTP = willingness to pay.
Source: Authors

economic point of view unfortunate, the Canadian judicial system struck down the Federal Carbon Tax Transparency Act in 2020 as it was declared unconstitutional.

Some reports (see Gaspar and Parry, 2021) applaud the planned carbon pricing floor model across Canadian provinces as a suitable prototype for an international price level given the minimum carbon price of CAD$ 170 (US$ 128) per ton of CO_2e emission by 2030 via the Greenhouse Gas Pollution Pricing Act (GHGPPA) mandates. This carbon price is expected to increase to CAD$ 50 (US$ 38) per ton of CO_2e by 2022, reaching CAD$ 170 (US$ 128) per ton of CO_2e emitted by 2030. However, this study estimated the mean WTP of Canadians at CAD$ 162 (US$ 122) per year or CAD$ 7 (US$ 5) to CAD$ 20 (US$ 15) per month. Our results are in line with Grenier (2019), who found that only one in four Canadians were willing to spend more than CAD$ 9 (US$ 7) per month in taxes to tackle climate change. Thus, a carbon price of CAD$ 170 (US$ 128) per ton of CO_2e emitted by 2030 may present a challenge for the Canadian government. To take along the Canadian population, the government would have to improve the transparency regarding policy formulation and eventually increase the WTP of Canadians. More than half (55%) of the respondents in our study believe that the carbon price was equitable and fair to the Canadian public while transparency of carbon pricing programs were disapproved by 62% of Canadians. Ragan et al. (2019) found that only 35% of the Canadians would support a political party proposing a carbon price of CAD$ 100 (US$ 75) per ton of CO_2e starting in 2025, which is less than half the CAD$ 210 (US$ 158) per ton of CO_2e suggested by Canada's Eco-Fiscal Commission. However, there is a positive effect of household income and education on respondents expressing a higher WTP, which aligns with studies of Kotchen et al. (2013) and Kotchen et al. (2017). In the current carbon pricing policy of the federal government, carbon tax revenues are used to support households through the Climate Action Incentive payments, which may increase household income (Environment and Climate Change Canada, 2021). Furthermore, households in rural areas or outside the CMA are eligible to a 10% subsidy under the Federal Climate Action Incentive and 1% of the carbon tax revenues is returned to the indigenous communities (Environment and Climate Change Canada, 2021). However, Winter et al. (2021) argue that lump-sum rebates, similar to the federal Climate Action Incentive, can only provide small gains in consumable income to the majority of the poor and vulnerable Canadian households while benefitting the middle income and upper-class households. This study found that respondents with children are more likely to have a higher WTP. The reason for the number of children being significant and increasing the willingness to pay could be that respondents consider preferences beyond own lifetime, which includes a better future for the children (Larson and Bromley, 1990).

This study provides evidence that household income and education, to a large extent, do matter in terms of WTP in Canada. Therefore, the federal Canadian government should consider this in the redistribution or investment discourse. It should also focus on building a more detailed, constitutional, public engagement strategy, an easily communicable concept for carbon pricing revenue earmarking, and public feedback strategy on revenue earmarking such as investment in clean energy and climate change adaptation strategies, e.g. (agro)forestry (Benjamin and Blum, 2015; Benjamin et al. 2016, 2018).

There are some limitations with this study. First, this study uses a relatively small sample size (600 respondents) as a representative sample of Canada. Furthermore, the survey was only conducted in English and for a bilingual (French and English) country like Canada, this may create a bias towards the English-speaking part of the population. According to Statistics Canada (2017b), approximately 20% of the Canadian population are native French speakers. As such, one should approach the results with some caution. However, this research is a starting point for future comprehensive research in Canada, as there has been little to no scientific studies on the behavioral understanding of pollution pricing regarding the Canadian public attitudes.

This study set out to investigate whether the Canadian population supports or opposes the price on pollution to reduce the emission of GHG in order to mitigate climate change using the WTP for carbon pricing as proxy. Furthermore, the attitude of Canadians towards the earmarking of carbon pricing revenues, i.e. redistribution programs versus investment, was analyzed. Finally, we explore the influence of political-economic factors on Canadian WTP. The study refrains from using carbon pricing in $/t because households may not know exactly how much they emit in CO_2e and such question will not be easily understood by respondents. Thus, asking a question in terms of $/household expenditure makes it easier for them to understand and answer. The estimated annual WTP ranges between about CAD$ 84 (US$ 63) to CAD$ 230 (US$ 174) in 2019. This implies an acceptable annual increment of 1.52%–2.51% (or CAD$ 157 ≅ US$ 118 to CAD$ 259 ≅ US$ 195) to the annual average household energy cost. While it is argued that Canadians are still undecided on carbon pricing (Grenier, 2019), two-thirds of the respondents in this study agreed to pollution pricing above CAD$ 1 (US$ 0.75) per ton of CO_2e emitted. However, only 35% declared that they would support a political party proposing a carbon price of CAD$ 100 (US$75) per ton of CO_2e starting in 2025. Interestingly, this amount is very close to the carbon price plan set out by the Liberal minority government during the 2021 election campaign, yet they won. Still, it is less than half the CAD$ 210 (US$ 158) per ton of CO_2e suggested by Canada's Eco-Fiscal Commission (Ragan et al., 2019).

Certain attitudinal, political-economic, and demographic characteristics such as age, number of children, household size, education, climate policy beliefs influence the acceptability of pollution pricing among Canadians. For instance, age appears to influence the WTP negatively and the number of children positively. The result for age may reflect a higher preference for consuming income now, which is related to the relative position in the finite lifetime. With regard to having children, parents may consider preferences beyond their own lifetime, which includes a better future for the children.

Furthermore, we found that carbon pricing models that are perceived as equitable and transparent positively influence the WTP of Canadians. This study also explored Canadian's choice of earmarking public revenues from carbon pricing based on six different options. Returning money in equal amounts to all households and supporting the development of clean energy in Canada were the two preferred options. An estimated, 54% of the respondents chose earmarking revenues towards renewable energy sources, while 48% chose returning money in equal amounts to all Canadian households. Thus, most Canadians would likely support some hybrid (investment and redistribution) model of earmarking carbon pricing revenues. Political and economic factors should be considered in future research on carbon pricing and WTP in resource dependent countries.

Credit author statement

Daniel Hall.: Conceptualization, Methodology, Software, Validation, Writing – original draft. Emmanuel O. Benjamin.: Conceptualization, Methodology, Software, Validation, Writing- Reviewing and Editing preparation. Gertrud Buchenrieder.: Visualization, Investigation, Validation, Methodology, Writing- Reviewing and Editing. Johannes Sauer.: Validation and Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2022.112805.

References

Akter, S., Bennett, J., 2011. Household perceptions of climate change and preferences for mitigation action: the case of the Carbon Pollution Reduction Scheme in Australia. Clim. Change 109 (3–4), 417–436. https://doi.org/10.1007/s10584-011-0034-8.

Angus Reid Institute, 2018, November. Carbon Pricing: rebate announcement tips opinion in favour of federal plan, slim majority now support it. http://angusreid.org/carbon-pricing-rebate/.

Arnold, J., Olewiler, N., 2020, January 21. *Getting to zero: Canada plans to hit net-zero emiss*ions by 2050. What's next?. Canadian Institute for Climate Choices. https://climatechoices.ca/getting-to-zero-canada-plans-to-hit-net-zero-emissions-by-2050-whats-next/.

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H., 1993. Report of the NOAA panel on contingent valuation. Fed. Regist. 58 (10), 4601–4614.

Benjamin, E.O., Blum, M., 2015. Participation of smallholders in agroforestry agri-environmental scheme: a lesson from the rural mount Kenyan region. J. Develop. Area. 49 (4), 127–143. https://doi.org/10.1353/jda.2015.0125.

Benjamin, E.O., Blum, M., Punt, M., 2016. The impact of extension and ecosystem services on smallholder's credit constraint. J. Develop. Area. 50 (1), 333–350. https://doi.org/10.1353/jda.2016.0020.

Benjamin, E.O., Ola, O., Buchenrieder, G., 2018. Does an agroforestry scheme with payment for ecosystem services (PES) economically empower women in sub-Saharan Africa? Ecosystem Services 31, 1–11. https://doi.org/10.1016/j.ecoser.2018.03.004.

Blaine, T.W., Lichtkoppler, F.R., Jones, K.R., Zondag, R.H., 2005. An assessment of household willingness to pay for curbside recycling: a comparison of payment card and referendum approaches. J. Environ. Manag. 76 (1), 15–22. https://doi.org/10.1016/j.jenvman.2005.01.004.

Booth, P., Boudreault, F.A., 2016. By the numbers: Canada GHG emissions. Lawrence National Centre for Policy and Management. https://www.ivey.uwo.ca/cmsmedia/2112500/4462-ghg-emissions-report-v03f.pdf.

Canada Energy Regulator, 2019, August 21. NEB -Market snapshot: household expenditures on energy are highest in Atlantic Canada. https://www.cer-rec.gc.ca/nrg/ntgrtd/mrkt/snpsht/2019/08-03hshldxpndtrs-eng.html.

Carattini, S., Baranzini, A., Thalmann, P., Varone, F., Vöhringer, F., 2017. Green taxes in a post-Paris world: are millions of nays inevitable? Environ. Resour. Econ. 68 (1), 97–128. https://doi.org/10.1007/s10640-017-0133-8.

Carattini, S., Carvalho, M., Fankhauser, S., 2018a. Overcoming public resistance to carbon taxes. Wiley Interdisciplinary Reviews: Clim. Change 9 (5), e531.

Carattini, S., Carvalho, M., Fankhauser, S., 2018b. Overcoming public resistance to carbon taxes. Wiley Interdisciplinary Reviews: Clim. Change 9 (5). https://doi.org/10.1002/wcc.531.

Duan, H.-X., Yan-Li, L., Yan, L., 2014. Chinese public's willingness to pay for CO2 emissions reductions: a case study from four provinces/cities. Adv. Clim. Change Res. 5 (2), 100–110. https://doi.org/10.3724/SP.J.1248.2014.100.

Duffy, B., Smith, K., Terhanian, G., Bremer, J., 2005. Comparing data from online and face-to-face surveys. Int. J. Mark. Res. 47 (6), 615–639. https://doi.org/10.1177/147078530504700602.

Economist Intelligence, 2021. Canada's Conservative Party unveils alternative carbon pricing plan. Available at: https://www.eiu.com/n/canadas-conservative-party-unveils-alternative-carbon-pricing-plan/ (last visited: 23.12.2021).

Environment and Climate Change Canada, 2018. Estimated Impacts of the Federal Carbon Pollution Pricing System. Government of Canada. https://www.canada.ca/en/services/environment/weather/climatechange/climate-action/pricing-carbon-pollution/estimated-impacts-federal-system.html.

Environment and Climate Change Canada, 2019. Canadian Environmental Sustainability Indicators: Progress towards Canada's Greenhouse Gas Emissions Reduction Target. Government of Canada. https://www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/progress-towards-canada-greenhouse-gas-reduction-target/2019/progress-towards-ghg-emissions-target-en.pdf.

Environment and Climate Change Canada, 2021. Guidance for Using Carbon Pollution Pricing Proceeds. Government of Canada. In: https://www.canada.ca/en/environment-climate-change/services/climate-change/pricing-pollution-how-it-will-work/putting-price-on-carbon-pollution/guidance-using-carbon-pollution-pricing-proceeds.html.

Food and Agriculture Organization, 2000. Applications of the contingent valuation method in developing countries: a Survey. Food and Agricultural Organization of the United Nations. http://www.fao.org/3/X8955E/x8955e03.htm#P0_0.

Gabbatiss, J., 2019. The carbon brief: Canada. Carbon brief. https://www.carbonbrief.org/the-carbon-brief-profile-canada.

Gaspar, V., Parry, I., 2021. A proposal to scale up global carbon pricing. IMF blog. https://blogs.imf.org/2021/06/18/a-proposal-to-scale-up-global-carbon-pricing/.

Government of Canada, 2020, January 9. Progress towards Canada's greenhouse gas emissions reduction target. https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/progress-towards-canada-greenhouse-gas-emissions-reduction-target.html.

Grenier, E., 2019, June. Canadians are worried about climate change, but many don't want to pay taxes to fight it: Poll. Canadian Broadcasting Corporation. https://www.cbc.ca/news/politics/election-poll-climate-change-1.5178514.

Gupta, M., 2016. Willingness to pay for a carbon tax: a study of Indian road passenger transport. Transport Pol. 45, 46–54. https://doi.org/10.1016/j.tranpol.2015.09.001.

Hackl, F., Pruckner, G.J., 1999. On the Gap between payment card and close-ended CVM-answers. Appl. Econ. 31 (6), 733–742. https://doi.org/10.1080/000368499323940.

Hammar, H., Lofgren, A., Sterner, T., 2004. Political economy obstacles to fuel taxation. Energy J. 25, 1–17.

Hsu, S.L., 2011. The Case for a Carbon Tax: Getting Past Our Hang-Ups to Effective Climate Policy. Island Press, Washington, DC.

Hsu, S.-L., Walters, J., Purgas, A., 2008. Pollution tax heuristics: an empirical study of willingness to pay higher gasoline taxes. Energy Pol. 36 (9), 3612–3619. https://doi.org/10.1016/j.enpol.2008.06.010.

International Monetary Fund, 2019, December. The economics of climate. https://www.imf.org/external/pubs/ft/fandd/2019/12/pdf/fd1219.pdf.

Jacobs, M., 2016. High pressure for low emissions: how civil society created the Paris climate agreement. Juncture 22 (4), 314–323. https://doi.org/10.1111/j.2050-5876.2016.00881.x.

Jenkins, J.D., 2014. Political economy constraints on carbon pricing policies: what are the implications for economic efficiency, environment efficacy, and climate policy design? Energy Pol. 69, 467–477. https://doi.org/10.1016/j.enpol.2014.02.003.

Jenkins, J.D., 2019. Why carbon pricing falls short: and what to do about it. Kleinman Center for Energy Policy. https://kleinmanenergy.upenn.edu/sites/default/files/policydigest/KCEP-Why-Carbon-Pricing-Falls-Short-Digest-singles.pdf.

Kallbekken, S., Aasen, M., 2010. The demand for earmarking: results from a focus group study. Ecol. Econ. 69 (11), 2183–2190. https://doi.org/10.1016/j.ecolecon.2010.06.003.

Klein, S., 2019, August 12. When it comes to climate action, the public is ahead of our politics: analysis of national climate poll. Policy Note. https://www.policynote.ca/climate-poll-2019/.

Kotchen, M.J., Boyle, K.J., Leiserowitz, A.A., 2013. Willingness-to-pay and policy-instrument choice for climate-change policy in the United States. Energy Pol. 55, 617–625. https://doi.org/10.1016/j.enpol.2012.12.058.

Kotchen, M.J., Turk, Z.M., Leiserowitz, A.A., 2017. Public willingness to pay for a US carbon tax and preferences for spending the revenue. Environ. Res. Lett. 12 (9) https://doi.org/10.1088/1748-9326/aa822a.

Larson, B.A., Bromley, D.W., 1990. Property rights, externalities, and resource degradation: locating the tragedy. J. Dev. Econ. 33 (2), 235–262.

Loewen, P., Bernstein, M., 2019, October 29. Poll shows climate change sunk Scheer - and could cost Ford. Tor. Star. https://www.thestar.com/opinion/contributors/2019/10/29/poll-shows-climate-change-sunk-scheer-and-could-cost-ford.html.

Mankiw, N.G., 2009. Smart taxes: an open invitation to join the Pigou club. E. Econ. J. 35 (1), 14–23. https://doi.org/10.1057/eej.2008.43.

Migiro, Geoffrey, 2018. Countries with the most natural resources. World atlas. https://www.worldatlas.com/articles/countries-with-the-most-natural-resources.html.

New Climate Economy, 2019. Unlocking the inclusive growth story of the 21st century: accelerating climate action in urgent times. Global Commission on the Economy and Climate. https://newclimateeconomy.report/2018/wp-content/uploads/sites/6/2019/04/NCE_2018Report_Full_FINAL.pdf.

Nordhaus, W.D., 2007. To tax or not to tax: alternative approaches to slowing global warming. Rev. Environ. Econ. Pol. 1 (1), 26–44. https://doi.org/10.1093/reep/rem008.

Organisation for Economic Co-operation and Development (Oecd), 2018. Cost-benefit Analysis and the Environment: Further Developments and Policy Use. OECD Publishing. https://doi.org/10.1787/9789264085169-en.

Ragan, C., Beale, E., Boothe, P., Cappe, M., Dahlby, B., Drummond, D., Elgie, S., Hodgson, G., Leroux, J., Lipsey, R., Olewiler, N., St-Hilaire, F., Tedds, L., 2019, November. Bridging the gap: real options for meeting Canada's 2030 GHG Target. Canada's Ecofiscal Commission. https://ecofiscal.ca/wp-content/uploads/2019/11/Ecofiscal-Commission-Bridging-the-Gap-November-27-2019-FINAL.pdf.

Rosenbloom, D., Markard, J., Geels, F.W., Fuenfschilling, L., 2020. Opinion: why carbon pricing is not sufficient to mitigate climate change—and how "sustainability transition policy" can help. Proceedings of the National Academy of Sciences, vol. 117, pp. 8664–8668, 16.

Rotaris, L., Danielis, R., 2019. The willingness to pay for a carbon tax in Italy. Transport. Res. Transport Environ. 67, 659–673. https://doi.org/10.1016/j.trd.2019.01.001.

Schmidt, J., Bijmolt, T.H., 2020. Accurately measuring willingness to pay for consumer goods: a meta-analysis of the hypothetical bias. J. Acad. Market. Sci. 48 (3), 499–518.

Snowball, J.D., 2008. Measuring the Value of Culture. Springer. https://doi.org/10.1007/978-3-540-74360-6.

Stokes, B., Wike, R., Carle, J., 2015. Global concern about climate change, broad support for limiting emissions. Pew research. http://www.pewresearch.org/wp-content/uploads/sites/2/2015/11/PewResearch-Center-Climate-Change-Report-FINAL-November-5-2015.pdf.

Trang, T.T.T., Rañola, R.F.J., Nguyen, V.S., 2019. Factors affecting the households willingness-to-pay for wastewater treatment in agro-food processing craft villages, nhue-day river basin, vietnam. J. Environ. Protect. 10 (9), 1119–1130. https://doi.org/10.4236/jep.2019.109066.

Transparency, Climate, 2019. Brown to green: the G20 transition towards a net-zero emissions economy. https://www.climate-transparency.org/wp-content/uploads/2019/11/Brown-to-Green-Report-2019.pdf.

Turnbull, B.W., 1976. The empirical distribution function with arbitrarily grouped, censored, and truncated data. J. Roy. Stat. Soc. B 38 (3), 290–295. https://doi.org/10.1111/j.2517-6161.1976.tb01597.x.

Vaillancourt, K., Bahn, O., Levasseur, A., 2019. The role of bioenergy in low-carbon energy transition scenarios: a case study for Quebec (Canada). Renew. Sustain. Energy Rev. 102, 24–34.

Williams, R., 2015. Ordered Logit Models—Overview. University of Notre Dame. https://www3.nd.edu/~rwilliam/stats3/Ologit01.pdf.

Winter, J., Dolter, B., Feollows, G.K., 2021. Carbon pricing costs for households and the progressivity of revenue recycling options in Canada. WP 21–06. The Clean Economy Working Paper Series. https://institute.smartprosperity.ca/sites/default/files/Winter_Dolter_Fellows_working_version_June2021.pdf.

World Bank, 2016, April 15. Carbon Pricing: Building on the Momentum of the Paris Agreement. World Bank. https://www.worldbank.org/en/news/feature/2016/04/15/carbon-pricing-building-on-the-momentum-of-the-paris-agreement.
World Bank, 2019. State and Trends of Carbon Pricing 2019. World Bank. http://documents.worldbank.org/curated/en/191801559846379845/pdf/State-and-Trends-of-Carbon-Pricing-2019.pdf.
World Bank, 2021. Carbon Pricing Dashboard. World Bank. https://carbonpricingdashboard.worldbank.org/.
Xu, T., Xiaohua, Y., Holst, R., 2011, June 23–24. Applying the payment card approach to estimate the WTP for green food in China. Insititute of agricultural development in transition economies (IAMO) forum 2011: will the "BRICs decade" continue?, halle (saale). https://doi.org/10.22004/ag.econ.115533.

Further reading

Brant, R., 1990. Assessing proportionality in the proportional odds model for ordinal logistic regression. Biometrics 46 (4), 1171–1178. https://doi.org/10.2307/2532457.
Canada, Statistics, 2020. Table 11-10-0222-01 Household Spending, Canada, Regions and Provinces. Government of Canada. https://doi.org/10.25318/1110022201-eng.
Long, J.S., 1997. Regression Models for Categorical and Limited Dependent Variables. Advanced Quantitative Techniques in the Social Sciences Number 7. Sage Publications.
Nielson, J.S., 2011. Use of the Internet for willingness to pay surveys: a comparison of face-to-face and web-based interviews. Resour. Energy Econ. 33 (1), 119–219. https://doi.org/10.1016/j.reseneeco.2010.01.006.
Williams, R., 2018, April 17. Brant test: insignificant 'all' but several variables significant? [Online forum comment] Statalist: The Stata Forum. https://www.statalist.org/forums/forum/general-stata-discussion/general/1439769-brant-test-insignificant-all-but-several-variables-significant.