Title: Is the public willing to pay to curb microplastic pollution?

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Summary: This study has examined the U.S. public's knowledge and concerns about microplastic pollution. The findings from this study indicate that while the public are not widely aware of microplastic pollution, they are willing to take action to mitigate risks related to such pollution once they have been informed.

Introduction

Microplastics are plastic particles less than 5mm in size in any one dimension (Arthur, Baker and Bamford, 2009), and can be found in most waterbodies. Microplastics bind with compounds containing toxins in the water, providing these toxins with a route into the human body (World Economic Forum, 2018). Many microplastic particles are around (or smaller than) the size of plankton, the primary source of food for many marine lifeforms. Therefore, toxins are accumulated through the marine life food pyramid and are eventually consumed by humans.

People eating seafood are ingesting up to 11,000 pieces of microplastic particles every year (World Economic Forum, 2018). Given such circumstances, will individuals be motivated to curb this potential threat? On a side note, it is important to identify which type of individuals have higher willingness to lessen microplastic pollution than others, from a policy perspective.

Analysis and Results

To ascertain consumer Willingness-To-Pay (WTP) to curb microplastic pollution, a survey[1] in which the sampled respondents were asked if they were willing to pay a certain amount of a new annual environmental tax for such a purpose was undertaken. Respondents were first asked their foreknowledge regarding microplastics. It was found that 60% of the respondents have not heard about microplastics at all, while 40% have. We gave the 60% respondents a general explanation of microplastics, while omitting specific mention of potential deleterious effects on individual health. 90% of the respondents

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[1] The survey sample was a targeted quota sample, with gender, age, region, ethnicity, education level, and income level accounted for and set to resemble the percentages found for the U.S. population in the last census. The survey was conducted from July 2020 to August 2020, with the sample size being 580. More details available upon request, from the authors.

think that microplastics will harm their health. It should be noted that regardless of whether the respondent has heard about microplastics or not, about 90% of the respondents in both heard and not heard groups think microplastics is harmful. The survey then exposed different respondents to 3 different types of information regarding pollution levels,[2] after which the respondents were asked a series of questions designed to elicit their WTP[3].

The other parts of the survey elicited 1) the attitudes/behaviors towards the environment; 2) WTP for items with other alternative ecolabels, such as organic; 3) the taxes that need to be levied on potentially harmful items, such as climate change inducing items; 4) the health consciousness of each individual; 5) how knowledgeable each respondent is about microplastics, especially about microplastic clothing fibers; and 6) their attitudes/behaviors towards plastics and microplastics.

Tables 1 and 2 below show various information elicited in the survey. Samples falling into each category for the categorical variables are reported in Table 1.

Table 1. Categorical Information, Percentages

Information Type	Subcategory	Percentage
Real Estate Ownership	Own	61%
	Not Own	39%
Ever Heard About Microplastics?	Yes	40%
	No	60%
Will Microplastics Cause Harm to You?	Yes	90%
	No	10%
Check for contaminants before seafood purchase?	I Do Not Buy or Eat Seafood	20%
	Yes	29%
	No	51%
Information Treatment:	Low Treatment: 225	32%
Number of microplastic particles	Middle Treatment:705	33%
encountered per day, from water usage alone	High Treatment: 3885	35%

Table 2 presents the mean and the median of continuous variables used in this analysis. WTP has a mean of 0.86, which means on average, the individuals sampled were willing to pay $0.86 annual tax to reduce microplastic pollution by 1%. However, the distribution of the WTP variable is skewed, with 24% of the respondents having 0 WTP and 5% of the respondents having an outlier value of 10. Therefore, the median WTP of $0.40 annual tax is a more accurate statistic for the WTP values.

Table 2. Continuous Variable Information

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[2] The information treatment given to respondents: The average U.S. resident encounters about 705 microplastic clothing fiber particles per day, from using water for everyday activities such as cooking and drinking. This figure is based on an increasing rate of pollution of 72,000,000 microplastic particles per day. The wording is the same in all three categories, with the underlined numbers changing, as listed in Table 1.

[3] The WTP was elicited using a hierarchical design. More details about the design available from the authors, upon request.

Information Type	Mean	50 Percentile
WTP	0.86	0.40
Number of Adults in the Household	2.17	2.00
Number of Kids in the Household	0.63	0.00
Hours/Week Spent on Volunteering for Environmental Protection	1.45	0.00
Q16Score	15.60	16.00
EnvstateScore	26.24	26.00
Clothplastic2Score	8.87	9.00
Health2Score	7.43	8.00
Dmlabpc1	0.00	-0.82
Dmlabpc2	0.00	-0.12
Dmtaxpc1	0.00	-0.72
Dmtaxpc2	0.00	-0.26

The Q16Score is the summation of responses to a set of questions about pollution control. The aggregate scores for respondents range from 4 to 20 with higher scores indicating a more pro-plastic-control attitude. EnvstateScore is generated like the Q16score, but focuses on attitudes about general environmental protection, ranging from 7 to 35. Clothplastic2Score is an index we create from questions about clothing choices or behaviors that may increase microplastic pollution. These questions measure awareness of microplastic pollution with higher scores indicating higher awareness. Health2Score was calculated in the same way using 4 questions about individual health consciousness and behaviors[4]. The last four variables are the first and second principal components which we use as indices of the willingness to pay for items with other alternative labels, such as Non-GMO and organic, and the taxes each respondent thinks need to be levied on potentially harmful items to the environment or individuals, such as climate change inducing items.[5]

The WTP variable had a significant number of individuals with zero marginal WTP, in which 140 out of 580 individuals had 0 WTP. To account for this high number of zero responses, a Tobit regression model was used to analyze the causal effect of the factors on WTP, with the lower bound set at 0. The model results are shown on Table 3 below.

We found that exposing respondents to differing information regarding the severity of the microplastic problem had a significant effect. Respondents being informed that the microplastic pollution levels were low and average expressed about 24.5 cents lower WTP than those in the high pollution information group. These results are reasonable because higher pollution will urge people to pay more to control it.

In terms of demographics, those who identified as Hispanic and Asian, those who chose 'other' as their marriage status, and those who resided in the South or Midwest regions at the time of the survey had higher WTP than those who did not fall into these categories. Due to the study being framed in a water pollution setting, it was expected that the Asian racial category will have higher WTP than other groups due to this group having the highest seafood consumption (Terry et al., 2018). The difference in WTPs between marriage status groups might be partially explained by the fact that those who lead alternative lifestyles tend to be politically liberal, who typically care more about environment protection than more

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[4] More details on the distribution of the response and about these indices are available from the authors, upon request.

[5] Principal components are perpendicular axes of the space spanned by the variables of interest, where the axes explain the variance of the variables of interest, in a decreasing order of magnitude. Principal components analysis is used to reduce the dimensionality of datasets, due to limited sample size and to avoid overloading the model. (James et. al., 2013)

conservative individuals, who are more likely to be in traditional marriages (Funk and Kennedy, 2020; Schnabel, 2018).

Table 3. Tobit Regression Results

Independent Variable	Average Partial Effect	Standard Error
Male	+0.0780	0.1103
Age	-0.0053	0.0036
Education	-0.0437	0.0291
Income	+0.0000	0.0000
Number of Adults in the Household	+0.0215	0.0530
Number of Kids in the Household	-0.0667	0.0612
Real Estate Ownership	-0.1538	0.1383
Full Time Student Status	-0.0430	0.2082
Have Heard About Microplastics	+0.0256	0.1154
Microplastics Will Cause Harm to Me	+0.0226	0.1829
Low Information Treatment	-0.2425*	0.1294
Middle Information Treatment	-0.2479*	0.1282
Q16Score	-0.0349**	0.0173
EnvstateScore	+0.0072	0.0106
Clothplastic2Score	+0.1057**	0.0439
Health2score	+0.1450***	0.0453
Hours/Week Spent on Volunteering for Environmental Protection	+0.0320**	0.0131
Dmlabpc1	+0.0644*	0.0345
Dmlabpc2	-0.0035	0.0858
Dmtaxpc1	+0.1066***	0.0357
Dmtaxpc2	+0.1150	0.0739
Every Other Race	-0.4825**	0.1940
Asian	-0.3799	0.2565
Black or African American	-0.4053**	0.1855
Non-Hispanic White	-0.4517**	0.1856
Not Married	-0.6730***	0.2216
Married	-0.5105**	0.2390
I Do Not Buy or Eat Seafood	-0.9543***	0.1109
I Check for Seafood Contaminants before Purchase	+0.2618**	0.1360
Northeast Region of the US	-0.3667**	0.1600
South Region of the US	-0.1574	0.1530
Western Region of the US	-0.3445**	0.1558
Constant	+1.4057	1.5826

Note: *=10%, **=5%, ***=1% statistical significance

For the seafood category, those who answered 'I do not buy or eat seafood' had on average 95 cents lower WTP than those who answered 'no' to whether or not they check seafood contaminants before purchase. Those who answered 'yes' had on average 26 cents (per 1% pollution reduction) more WTP

than those who answered 'no'. This follows an expected pattern, with those who are more sensitive about pollution in seafood showing the highest WTP.

It was also found that those who spend their time outside of work on environmental protection volunteer work, are more health conscious, or have less microplastic increasing clothing habits have higher WTP for microplastic reduction than those who do not. In addition, while both Dmlabpc1 and Dmtaxpc1 are statistically significant, the taxes principal component (PC) has twice the effects on WTP as the labels PC and is more significant. This is not surprising, since the study is about a new tax to decrease microplastic pollution[6].

Summary

The overall median WTP was $0.40 new annual household tax for a 1% reduction in pollution. Our results show that about 40% of the respondents were aware of microplastics at the time of this study, and that regardless of previous knowledge about microplastics, 90% believe they are harmful. The results also show that disseminating information showing severity of microplastic pollution can increase the individual WTP for microplastic reduction. This result calls for public education about microplastic pollution to bring this problem to people's attention and to increase the public's WTP to lessen microplastics in waterbodies. An individual's behavior related to environmental protection, individual's perceptions and behaviors regarding microplastics from clothing, their health consciousness, their attention to seafood contamination, and whether or not they had WTP for alternative labelled goods or taxes were also good indicators of higher WTP for microplastic pollution reduction.

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[6] Specific details and numbers available upon request, from the authors.