Consumer willingness to pay for tree syrups derived from diversified forests

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Abstract

Despite the profound economic, ecological and cultural relevance of the maple syrup industry in the U.S., its ecological resilience is remarkably low. Reliance on a single species to maintain productivity inherently increases the industry's vulnerability to major disruptions. The focus of this study is to estimate consumer willingness to pay for syrup made from birch relative to maple and whether information on the benefits of diversified forests affects willingness to pay. We conducted a lab experiment in New Hampshire and Illinois. Those who received information on the benefits of forest diversification were willing to pay $0.90 more, relative to those who did not. On the other hand, respondents who received information on the type of tree syrup they tasted and on the benefits of forest diversification were willing to pay $1.10 more, relative to those who did not receive this information. Participants in New Hampshire had a WTP $1.43 higher for maple and 0.57 cents for birch, relative to those in Illinois. The effect of information treatments also differed across locations. The results indicate that consumer preferences might support the future diversification of maple forests, especially if labeling can successfully deliver the information on the ecological benefits of forest diversification.

1. Introduction

Diversification of socioecological systems enhances the sustainable provisioning of diverse ecosystem services and increases these systems' resilience to perturbations (Fitchner et al. 2020). Forests face a series of environmental challenges that are exacerbated by climate change such as droughts, heatwaves, and insect and disease outbreaks, especially in monocultures. Tree species' diversity increases the resilience of forests to such climate change effects. Maple forests in the US and Canada are examples of forest near-monocultures that can be diversified for increased climate resilience. Diversification can increase economic returns on average, minimize the fluctuations of economic returns, and decrease economic risk (Knobe et al., 2008; Macpherson et al., 2017; Ghorbani & Atallah, 2021). However, we know little about consumer demand for non-maple tree syrups and whether information on the environmental benefits of forest diversification matter for consumer willingness to pay for non-maple syrups. The broader literature on eco-labels suggests that consumers are willing to pay a premium for eco-friendly products (Sapci et al., 2015; Royne et al., 2011; Sorrqvist et al., 2013).

The overwhelming majority of tree syrup in the US and Canada is made from the sap of sugar maple (*Acer saccharum*) trees. The maple syrup industry is concentrated in the northeastern US and eastern Canada and expands throughout much of the Midwest. In the US, the economic contribution of maple syrup was valued at around $131 million in 2020 (USDA NASS 2021). Maple production is facing multiple challenges that are caused or exacerbated by climate change like changes in sap season timings, sap season length, invasive species, droughts, and heatwaves (Clasen et al., 2011; Matthews et al., 2017; Rapp and Crone; 2014; Snyder et al.; 2019). In Vermont, the leader in the US maple syrup industry, production decreased from 38 days to only 28 causing a production decline of about 21% (USDA NASS 2021).

There is a need to diversify maple forests to increase the resilience of syrup supply to climate shocks and to ensure the continued supply of all other forest ecosystem services provided by maple forests. In forestry like in agriculture, evidence shows that species diversity increases different measures of resilience (Clasen et al., 2011; Macpherson et al., 2017; Knoke et al., 2008). However, diversification involves high upfront financial and opportunity costs and might not necessarily attract a consumer price premium that is large enough to offset these costs to producers. One of the syrup tree species that can be used to increase the diversity of maple forests is birch. Birch trees can produce syrup using the same tapping equipment as maple, making it possibly feasible for syrup producers to diversify their maple stands without needing to invest in new machinery. However, birch syrup has lower sugar content, necessitating more sap to produce syrup relative to maple, making it pricier (Helfferich, 2004). More importantly, the market for birch syrup is limited and consumer demand for this product has not been studied. The focus of this study is to estimate consumer willingness to pay for syrup made from birch relative to maple and whether information on the benefits of diversified forests affects willingness to pay.

2. Data and methods

We used a Becker-DeGroot-Marschak (BDM) auction to elicit willingness to pay data for maple and birch syrups among on the campuses of the University of Illinois, Urbana-Champaign, IL, and the University of New Hampshire, Durham, NH. We selected these two locations to capture consumer preferences in areas that are closer (Durham, NH) and farther away (Urbana-Champaign, IL) from syrup tree forests. Any individual 18 and above was eligible to participate in this study. The total sample was 213, with 100 from NH and 113 from IL. An amount of $15 was given to each individual that they used to bid for 12.7 oz syrup bottles.

2.1 Experimental design

In our Becker-DeGroot-Marschak (BDM) auction, respondents were asked to bid between $0 and $15 and their bids were compared with a randomly generated price: a higher bid than the drawn price led them to buy the bottle by paying the drawn price. Individuals whose bid was less than or equal to the randomly drawn price kept their $15 (Becker et al., 1964; Ellison et al., 2016; Lusk et al., 2004). Before starting the experiment, the BDM mechanism was demonstrated using a chocolate bar auction to make participants familiar with the process.

This study involved two rounds of auctions. In the first round, respondents tasted the tree syrups, without being told from what tree species syrups were produced. In the second round, participants were randomly assigned to one of two information treatments. Half of the respondents received information on the type of tree syrup they tasted as well as the benefits of forest diversification (Full-information group). The second half was only provided information on the benefits of forest diversification (Partial-Information group). The information on forest diversification consisted of the following statement: "Alternative syrups, like syrup AAA, can support a more diverse syrup industry, as currently syrup 111 dominates production. Forests with multiple tree species are more resilient to climate change including droughts, heatwaves, and insect and disease outbreaks". The information was also given graphically using the illustration in Figure 1.

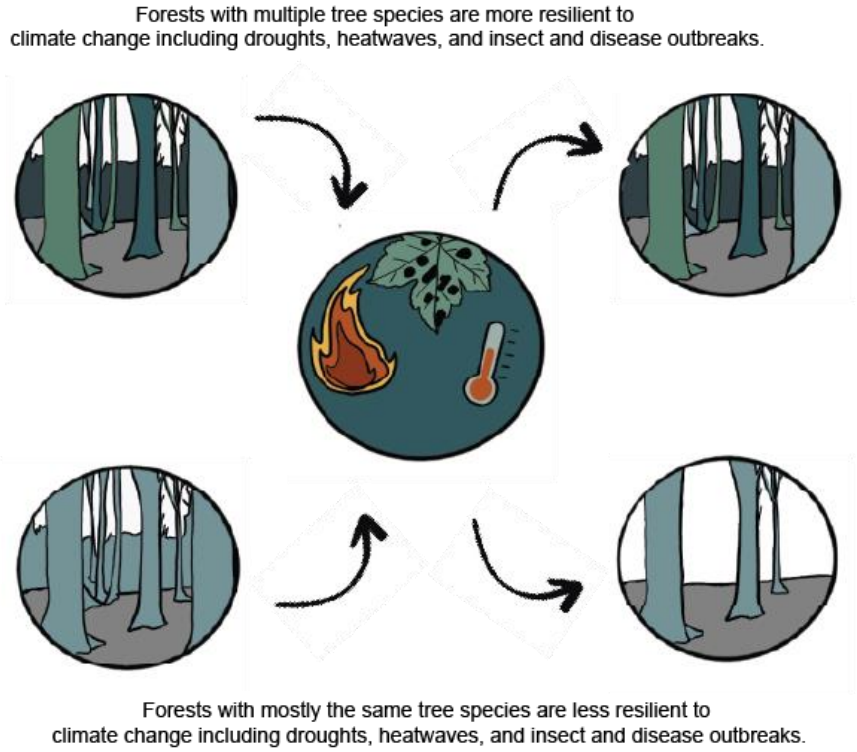

Figure 1. Information Treatment

2.2 Sample characteristics

This section lists the demographic profile of the participants. Table1 provides the name, definition, and proportion of basic demographic variables. Following a blind tasting, average, respondents rated birch syrup 3.46 out of 9 whereas the score was 7.21 for maple syrup. Most respondents agreed that purchasing novel tree syrups help farmers diversify their forests (average score of 1.84 where 1 means strongly agree). Most respondents (70%) have never worked on a farm.

Table 1: Characteristics of study participants and definition of variables (N = 213).

	Definition	Sample mean or proportion
Gender	Male	37%
	Female	63%
Age	18-24 year	64%
	18-25	20%
	25-34	5%
	35-44	5%
	45-54	4%
	65-74	1%
	>75	.47%
Location	New Hampshire	47%
	Illinois	53%
Annual Income	Less than $25,000	25%
	$25,000 to $49,999	16%
	$50,000 to $74,999	12%
	$75,000 to $99,999	12%
	$100,000 to $124,999	16%
	$125,000 to $149,999	5%
	$150,000 to $199,999	6%
	$200,000 or more	8%
Race	White	64%
	Non-White	36%
Education	Highschool	16%
	College	56%
	Undergrad	23%
	Grad	22%
Diversity	Purchasing alternative tree syrups helps farmers diversify their forests (1-5, Likert scale)	1.84
Farm	Worked on farm: Yes	21%
	No	79%
Taste (Maple)	Rate the syrup taste (1-9 [Most favorable], Likert scale)	7.21
Taste (Birch)	Rate the syrup taste (1-9[Most favorable], Likert scale)	3.46

The respondents' NEP index that ranges between 15 to 75. A higher value of this index indicates pro-ecological world view. The mean score for our respondents was 54.39, which indicates a moderately high pro-ecological worldview. Moreover, the scale reliability score was 0.755 (>0.7), which implies a reliable index (Grebitus et al., 2013) (Table 2).

Table 2:	NEP scale statements	Mean	SD
1	We are approaching the limit of the number of people the earth can support	3.91	1.06
2	Humans have the right to modify the natural environment to suit their needs	3.33	1.037
3	When humans interfere with nature it often produces disastrous consequences	3.91	0.72
4	Human ingenuity will ensure that we do NOT make the earth unlivable	3.09	1.021
5	Humans are severely abusing the environment	4.53	0.53
6	The earth has plenty of natural resources if we just learn how to develop them	2.92	1.30
7	Plants and animals have as much right as humans to exist	4.54	0.75
8	The balance of nature is strong enough to cope with the impacts of modern industrial nations	3.79	1.03
9	Despite our special abilities humans are still subject to the laws of nature	4.33	0.59
10	Humans will eventually learn enough about how nature works to be able to control it been greatly exaggerated	3.48	1.26
11	The earth is like a spaceship with very limited room and resources	3.68	0.94
12	The so-called eco-crisis facing humankind has been greatly exaggerated	4.27	0.76
13	Humans were meant to rule over the rest of nature with the impacts of modern industrial nations	1.82	1.06
14	The balance of nature is very delicate and easily upset	2.46	0.96
15	If things continue on their present course, we will soon experience a major ecological catastrophe	4.33	0.72
	NEP Index (Pro-ecological worldview)	54.39	

3. Results

Consumers had a higher WTP for maple relative to birch (Table 3). We found a regional difference in preferences for both tree species. Participants in New Hampshire had a WTP $1.43 higher for maple and 0.57 cents for birch, relative to those in Illinois. Those who received information on the

benefits of forest diversification (i.e., the partial information treatment) were willing to pay $0.90 more, relative to those who did not receive this information. On the other hand, respondents who received information on the type of tree syrup they tasted and on the benefits of forest diversification (i.e., the full information treatment) were willing to pay $1.10 more, relative to those who did not receive this information. The effect of both information treatments on the WTP for maple syrup was negative but the estimate is not statistically significant.

Having a farming experience increased the WTP for birch. As expected, higher taste scores increased the WTP for both tree syrups. Having a graduate degree and using tree syrups as substitute for sugars increased WTP for both tree syrups. Surprisingly, having greater pro-ecological views increased the WTP for maple only.

Table 3: Regression Analysis for Birch and Maple Syrups

Variables	Maple	Birch
Location (NH)	1.430***	0.567*
	(0.331)	(0.301)
Full-info treatment	-0.0458	1.095***
	(0.321)	(0.288)
Partial-info treatment	-0.464	0.930***
	(0.317)	(0.284)
Childhood Memories with Maple Syrup	0.327	0.0541
	(0.296)	(0.265)
Age (25-44)	-0.361	-0.505
	(0.540)	(0.483)
Age (44+)	0.856	-0.545
	(0.664)	(0.595)
Educ-grad	1.513**	1.032*
	(0.667)	(0.602)
Educ-undergrad	0.741	0.262
	(0.539)	(0.488)
Educ-college	0.635	0.168
	(0.394)	(0.357)
Farm	0.255	0.935***
	(0.358)	(0.327)
Gender (Male)	0.406	-0.202
	(0.293)	(0.265)

Race (White)	0.510	0.163
	(0.349)	(0.316)
Diversity	0.183	0.161
	(0.213)	(0.192)
Consumption (high)	0.0821	-0.0168
	(0.401)	(0.358)
Consumption (med)	0.185	0.248
	(0.361)	(0.323)
Income (high)	0.149	-0.322
	(0.325)	(0.291)
Income (med)	-0.215	0.0417
	(0.352)	(0.316)
Taste (maple)	0.766***	
	(0.0808)	
NEP	1.293***	0.362
	(0.392)	(0.347)
Taste (birch)		0.978***
		(0.0553)
Substitute for Sugar	1.433***	0.516*
	(0.306)	(0.278)
Constant	-7.099***	-2.583*
	(1.524)	(1.336)
Observations	420	418
R-squared	0.420	0.570

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

We generate a second set of results from models where we interact the location and information treatments to explore the impact of treatments across locations (Table 4). The interaction term for birch indicates a difference between the effect of full information treatment across locations and means that respondents in New Hampshire who were treated with both informational treatments had a WTP $1.11 greater than in Illinois. The WTP of respondents in Durham NH could be higher due to their greater proximity to forest resources, compared to respondents in Urbana-Champaign, IL The effect of the distance to resources on the WTP has been reported in the literature (Czajkowski et al., 2017). This difference is also positive ($0.30) for the partial information treatment, but the corresponding estimate is not statistically significant.

Table 4: Regression Analysis with interaction terms for Birch and Maple Syrups

Variables	Maple	Birch
Location (NH)	1.401***	0.218
	(0.421)	(0.379)
Full-info treatment	-0.269	0.564
	(0.444)	(0.399)
Partial-info treatment	-0.304	0.781**
	(0.438)	(0.391)
Childhood Memories with Maple Syrup	0.349	0.0762
	(0.297)	(0.265)
Age (25-44)	-0.401	-0.544
	(0.542)	(0.483)
Age (44+)	0.904	-0.497
	(0.666)	(0.595)
Educ-grad	1.526**	1.047*
	(0.668)	(0.601)
Educ-undergrad	0.740	0.263
	(0.540)	(0.487)
Educ-college	0.641	0.176
	(0.395)	(0.356)
Farm	0.256	0.935***
	(0.358)	(0.326)
Gender (Male)	0.411	-0.199
	(0.293)	(0.264)
Race (White)	0.504	0.155
	(0.349)	(0.315)
Diversity	0.207	0.184
	(0.215)	(0.193)
Consumption (high)	0.0948	-0.00598
	(0.401)	(0.357)
Consumption (med)	0.199	0.262
	(0.362)	(0.323)
Income (high)	0.126	-0.345
	(0.326)	(0.291)
Income (med)	-0.235	0.0220
	(0.353)	(0.315)
Taste (maple)	0.765***	
	(0.0809)	
NEP	1.286***	0.354
	(0.392)	(0.346)
Taste (birch)		0.979***
		(0.0552)
Substitute for Sugar	1.444***	0.523*
	(0.306)	(0.278)
Location x full information	0.470	1.108*

	(0.643)	(0.576)
Location x partial info	-0.336	0.310
	(0.635)	(0.567)
Constant	-7.118***	-2.448*
	(1.531)	(1.338)
Observations	420	418
R-squared	0.422	0.574

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4. Preliminary conclusions

These results support the existing literature on the existence of premiums for ecological products and the positive effect of environmental information on WTP. However, we find that the effect of information varies substantially across geographies. The results also indicate that consumer preferences might support the future diversification of maple forests, especially if labeling can successfully deliver the information on the ecological benefits of forest diversifications. Given the higher WTP for maple, the private sector might consider syrup blends that combine the taste benefits of maple syrup and the ecological benefits of birch in terms of diversifying maple forests and increasing their resilience to climate change. It remains to be seen if syrup producers are willing to diversify their maple forests to include other tree syrups such as birch.

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