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International honey laundering and consumer willingness to pay a premium for local honey: an experimental study

Chian Jones Ritten, Linda Thunström, Mariah Ehmke, Jenny Beiermann and Donald McLeod†

Fraudulent activities in the international honey market affect 10% of food, and cost the global food market $50 billion per annum. Although many developed countries have created regulations to combat food fraud, illegally imported honey, especially originating from China, still enters through transshipments and relabelling to mask its true origin. This honey laundering poses a health risk to consumers, as Chinese honey potentially contains illegal and unsafe antibiotics and high levels of herbicides and pesticides. We analyse whether information about the negative health impacts of laundered honey increases the proportion of consumers willing to pay a premium for local fraud-free honey. Using a laboratory experiment, we find when consumers are given honey laundering information, their willingness to pay a premium for local fraud-free honey increases by as much as 27 percentage points. Our findings suggest that by conveying honey laundering information and guaranteeing their honey is fraud-free, producers can potentially increase revenues and reduce the prevalence of food fraud. Our results further show that consumers' preference for various honey characteristics and age also influence the probability of paying a premium for local honey.

Key words: food fraud, honey laundering, international honey markets, trade diversion.

1. Introduction

In 2002, Australian investigators intercepted a large shipment of honey labelled as originating in Singapore, although Singapore did not produce honey at that time. Tracing the shipment back to China, investigators first discovered the use of fraudulent activities to illegally divert Chinese honey into countries with bans or tariffs directed towards Chinese honey imports (Leeder 2011). The illegal importation of honey from China over the last 15 years has had far-reaching global consequences. In 2011, a multinational investigation on honey market fraud led to one of the biggest food fraud

Secondary authorship is shared between Linda Thunström and Mariah Ehmke.

†Chian Jones Ritten (email: chian.jonesritten@uwyo.edu) is an Assistant Professor in the Department of Agricultural and Applied Economics, University of Wyoming, Laramie, Wyoming, USA. Linda Thunström is an Assistant Professor in the Department of Economics, University of Wyoming, Laramie, Wyoming, USA. Mariah Ehmke is an Associate Professor, Jenny Beiermann is a Research Assistant and Donald McLeod a Professor are in the Department of Agricultural and Applied Economics, University of Wyoming, Laramie, Wyoming, USA. Jenny Beiermann is currently the Agriculture & Business Management Specialist in Colorado State University.

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busts in history. Fifteen people across multiple countries were indicted for illegally diverting more than $80 million worth of honey from China to the United States (Leeder 2011). Despite the enormity of such crimes, it is unclear whether consumers experience indignation to a degree that diminishes the probability they purchase honey from unknown sources.

Food fraud is not confined to the honey market. It is estimated that global trade in fraudulent food may be worth as much as $50 billion per year and affects nearly 10% of all commercially sold food products (Johnson 2014; Ferrari 2016). Food fraud is a collective term referring to the intentional substitution, addition, tampering or misrepresentation of food, food ingredients, or food packaging (Spink and Moyer 2011, p. 1; Spink and Moyer 2011). Types of food fraud include adulteration (intentional substitution or addition of a inferior substance), tampering (product and packaging are used in a fraudulent way), theft (product is stolen and passed off as legitimately procured), over-run (produced in excess of production agreements), counterfeit (infringement of intellectual property rights), simulation (illegitimate product is designed to look like a legitimate product), and diversion (product is sold or distributed outside of its original market; Spink and Moyer 2011). We are most concerned with this last type, diversion.

As a result of increased prevalence of diversion and other forms of food fraud, the EU and other developed nations have adopted national policies to halt food fraud. At the same time, non-governmental organisations (e.g. SSAFE and US Pharmacoupia) have developed networks and databases to counteract fraudsters (e.g. Nestle 2016; Spink *et al*. 2015).

Even with multiple actions intended to decrease the prevalence of food fraud, it is still prolific. In the United States, for example, no single federal or state agency is legally required to address food fraud (Spink *et al*. 2016). Cases are rarely prosecuted due to the substantial coordination and resource requirements to do so (Johnson 2014, p. 26). Adding to these challenges, many food fraud regulation and policy gaps exist (Spink *et al*. 2016).

Although the fight against food fraud is aided with companies and countries reporting and communicating instances of fraud (Spink *et al*. 2017), tracking food fraud risks is challenging at best for industry and non-governmental groups. The complex nature of the global food supply chain makes tools ineffective for many food producers. There is no comprehensive surveillance system to detect food fraud, making it impossible to know whether current databases capture the universe of food fraud incidents (Johnson 2014).

The lack of enforceability of regulations and the limitations of non-governmental databases and tools has led to an increase in the number of cases of food fraud. Particularly, instances of food fraud originating in China are prevalent. The recent transformation of China's food industry with massive food processing has partially caused over 1,500 media reports of food scandals from 2004 to 2014 (Zhang and Xue 2016). Many of these cases involved the use of forbidden additives, foreign substances, counterfeit foods,

recycled or disregarded foods, expired or perished foods, chemical substitutes, microorganisms, or pesticides (Zhang and Xue 2016).

One of the foods illegally diverted from China into unsuspecting markets is honey (Strayer *et al.* 2014; Zhang and Xue 2016; Johnson 2014). Honey is the third most common ingredient affected by fraudulent activities (Moore *et al.* 2012). The EU and Canada banned Chinese honey imports from 2002 to 2004 due to a lack of origin labelling and risk of lead contamination (Dong and Jensen 2004; Laucius 2004). The ban in the EU was lifted due to increases in demand, and Chinese honey imports are now regulated by the Honey Directive (Directive 2014). Yet, the EU's requirements for declaring the origin of imported honey mixed with EU honey are low, creating an avenue for undetected fraudulent honey to enter into the EU honey market. As a result, consumers are not provided with information on the source of the honey (Tamma 2017). In 2001, the United States placed tariffs and anti-dumping regulations on Chinese honey. Even with these efforts, illegally imported Chinese honey still infiltrates these markets.

To halt the prevalence of fraudulent activates, focus should shift away from mitigation with current laws to prevention (Spink *et al.* 2017). In this paper, we examine whether providing consumers with information about the negative health implication of food fraud will increase their willingness to pay a premium for fraud-free local food and therefore may substitute away from fraudulent products. If consumers purchase fraud-free products, this may provide incentives for producers to ensure (and communicate to consumers) their products are free from fraudulent activities and may prevent some consumers from purchasing potentially fraudulent products.

To meet our objective, we develop an economic experiment that entails locally produced honey, for which we vary information on fraudulent activities in the international honey market that may affect the substitute (non-local) honey. There are two reasons we chose locally produced honey in our experiment. First, as mentioned above, honey is a common ingredient in food fraud incidents. Second, the local characteristic is important, since locally produced honey ensures there is no mix of foreign honey that may include fraudulent honey. Increasing consumer knowledge of honey laundering may therefore particularly affect locally produced honey. Obtaining consumer value to avoid possible food fraud risk may then be used to construct more comprehensive estimates of food fraud costs to society.

1.1. Fraudulent activities in the international honey market

The growing complexity of the food supply chain, which often includes mixing of ingredients, may foster an environment conducive to fraudulent activities that are difficult to detect (Charlebois *et al.* 2016; Manning, 2016). Most cases of food fraud are in the fish and seafood, honey, dairy products, fruit juices, oils and fats, and grain products markets (see Everstine *et al.,* 2013; Moore *et al.,* 2012).

Because of strong economic incentives, higher value foods are common targets of food fraud, especially honey. The international price of honey has increased drastically, reaching a historic high in 2014 (Phipps, 2017). Many methods of food fraud have been detected in the honey industry, including the use of adulterating additives (e.g. not reporting the inclusion of sugar syrup, corn syrup, fructose, glucose, high-fructose corn syrup, or beet sugar) designed to extend or dilute honey, supplemental feeding of honey bees to increase honey production, use of chemicals and pesticides on honey bee colonies that are found in trace amounts in honey and the masking of the country of origin to avoid tariffs and bans (Strayer *et al.,* 2014).

Countries such as the United States, Japan and throughout the EU are large importers of honey, potentially increasing the risk of food fraud beyond federal jurisdictions (UN, 2018). Even with U.S. tariffs placed on Chinese honey and anti-dumping regulations, together with heavy regulation of Chinese honey imports in the EU, the largest source of honey imports is China (Workman, 2018). Aside from cheap Chinese honey hurting domestic honey producers, Chinese honey has the potential to contain illegal and unsafe antibiotics (specifically, Chloramphenicol, enrofloxacin, and ciprofloxacin) and high levels of herbicides and pesticides (Bottemiller, 2013; FDA, 2016). The presence of unapproved chemicals in honey has been documented with reports showing certain unapproved antibiotics and other agricultural chemicals in Chinese honey (see Johnson, 2014). In addition, Chinese honey has the risk of being traced with potentially harmful heavy metal (e.g. Ru *et al.,* 2013).

Even with bans, tariffs and anti-dumping regulations, illegally imported Chinese honey has the potential to make it into the domestic honey supply due to fraudulent activities in the international sweetener market (Gua-xue *et al.,* 2012). Although imports of Chinese honey have drastically decreased in countries such as the United States, substantial increases in exports from countries that historically have not exported honey have concurrently arisen (Wei *et al.,* 2004). Evidence suggests that Chinese honey is being transshipped and relabelled to mask the true origin of the honey to avoid large tariffs and potential bans, also known as honey laundering (Gua-xue *et al.,* 2012; Strayer *et al.*, 2014). In some trade diversion instances, honey is filtered to remove pollen in order to make the determination of the geographic origin and the traceability and identity of the actual source of the honey difficult (Johnson, 2014). The practice of honey laundering is so prolific that an estimated one-third of honey available for sale in the United States is illegally imported from China and may contain illegal antibiotics and heavy metals (Schneider, 2011).

Educating consumers about these risks associated with imported honey may help in efforts to support demand for domestic honey. Knowledge about the fraudulent activities that lead to unsafe Chinese honey flooding honey markets may cause consumers to choose honey that is guaranteed to be produced locally, even when it comes at a premium.

1.2. Review of honey demand

Relatively few studies have assessed consumer demand for honey. Ghorbani and Khajehroshanaee (2009) found that packaging, colour, and scent affect consumer demand for honey in Iran. Honey consumption in Romania was established to be motivated by medical benefits, preservation, taste, and the ethical character of honey (Arvanitoyannis and Krystallis, 2006). The thickness, colour, size of the producer, price, and container influence Irish honey consumers (Murphy *et al.,* 2000). Consumers in the United States are found to pay premiums for honey based on containers, brands, and floral source (Unnevehr and Gouzou, 1998). Wu *et al.* (2015) find that consumer demand in the United States for honey increases for locally produced honey when consumers are given information about the negative aspects of internationally produced honey. Demand for honey was also found to vary significantly on the location of honey production (Wu *et al.,* 2015).

Using an economic experiment, we estimate consumers' willingness to select local honey at a premium when provided with information on the negative health implications of honey laundering[1]. Further, we estimate the impact of other consumer characteristics on honey selection decisions.

2. Material and methods

Primary data were collected using a controlled economic laboratory experiment. Laboratory experiments allow researchers to control for essential marketplace elements to test economic theory and predict consumer demand choices (Davis and Holt, 1993; Hagel and Roth, 1995). Experiment participants optimise their behaviour according to their inherent preference structure. Subjects were recruited through a variety of methods, including emails, Facebook posts, and word of mouth. All participants were 18 years of age or older. In total, 148 participants participated in the research. These voluntary participants selected an experimental session in which they participated. In each session, the treatment was randomly chosen[2].

In the experiment, participants were presented with two eight-ounce jars of honey labelled Honey A and Honey B. Since consumers have been found to vary preferences for honey based on the container and colour (Unnevehr and

[1] The information regarding honey laundering in the current study was similar to that provided by Wu *et al.* (2015) on the negative aspects of internationally produced honey. Information about the direct link to personal health of honey laundering was highlighted in the present study since health has been shown to be an important determinant of food choice (see Espinoza-Ortega *et al.,* 2016; Glanz *et al.,* 1998; Hebden *et al.,* 2015; Prescott *et al.,* 2002; Wardle *et al.* 2004). Specifically, honey laundering information provided in the present study included information on the use of EPA-approved chemicals in domestic honey production that are not expected to harm human health, and stated that laundered honey may include additives that are detrimental to human health.

[2] Based on results found by Wu *et al.* (2015), we projected a 20% increase in the probability of paying a premium for local honey when providing honey laundering information. A power analysis implies this sample size generates a power level of 0.8.

Gouzou, 1998; Ghorbani and Khajehroshanaee, 2009; Wu *et al.,* 2015), the jars labelled Honey A and Honey B were identical and the honeys were of very similar colour. Honey A was honey from an unknown origin, and Honey B was honey produced locally. The previous research by Wu *et al.* (2015) estimated that consumers are willing to pay a premium of $4.96 for a 16-ounce jar of locally produced honey when given information about potential negative impacts of consuming international honey. Based on this result, this study used the premium of $2.48 for an 8-ounce jar of local honey.

The economic experiment began with a study monitor welcoming participants and reading a general study overview. Once participants provided written consent to participate in the experiment, the study monitor then read specific instructions and a paper copy was given to subjects as well. Participants were instructed not to communicate with other participants and not to open the honey jar containers. The study monitor also encouraged and answered questions. Participants were told they would be paid $35, from which they would make a purchasing decision between the two jars of honey.

2.1. Treatments and hypotheses

As stated above, the main objective of this study is to examine whether consumers value local fraud-free honey. Therefore, we test the hypothesis that when given information about honey laundering, the proportion of consumers willing to pay a premium for local honey will increase. The secondary objective is to determine consumer demographic and honey preferences that influence willingness to support locally produced, and hence fraud-free honey. As a result, the second hypothesis tested whether other covariate factors influence consumers' willingness to pay a premium for local honey (see Appendix 1 for full instructions).

To test the specified hypotheses, two treatments were utilised. Specifically, our experiment entailed the following steps and treatment groups:

Step 1. The experiment director informed participants they were participating in an experiment on how consumers use information to make decisions. The participants' role in the study was to make a honey purchase decision. Participants were informed that they would be asked to choose between two honey jars, labelled Honey A and Honey B. One jar of each honey was placed in front of each subject.

Step 2. Participants received information specific to their treatment group:

2.1.1. Control

Participants were informed that Honey B was honey produced locally and does not contain any foreign honey, while Honey A may contain an unknown amount of foreign honey. In addition, participants were also given the price of each jar of honey. They were informed that Honey A was $0 and Honey B was $2.48.

2.1.2. Treatment

Participants were given the same information as those in the control group but were also given information regarding honey laundering in international honey markets, specifically from Chinese honey[3].

Step 3. Participants were asked to indicate their preferred honey choice on a piece of paper. To ensure individual decisions were not observed by other participants or the experiment director, participants were seated at a table with partitions. The experiment director then collected that piece of paper.

Step 4. Subjects completed a survey with preference questions and demographics.

3. Theory

We use an attribute-based, random utility model to analyse the data (see McFadden, 1973). Each individual, i, has j response choices around the opportunity to purchase local honey. When consumers choose to abstain from paying the premium for local honey, they accepted their endowed, free honey, which is of unknown origin. We assume that participants 'buy' local honey when the utility associated with doing so exceeds the utility of 'abstain'. For the *ith* consumer, choice j is based on the equation:

$$\text{response}_i = H_j(A; Z_i; \gamma) \tag{1}$$

where j is equal to 0 for 'abstain' and 1 for 'buy', A is the premium for domestic honey in the experiment, Z_i represents a vector of attributes describing the product or individual, and γ is a vector of parameters (to be estimated from the data; see Hanemann and Kanninen 2001). Equation (1) is constrained to values between 0 and 1. Thus, with our two possible outcomes, (1) reduces to:

$$\begin{aligned} &\Pr\{\text{response}_i \text{ is}'\text{buy}'\} = H_j(A_i; Z_i; \gamma) \equiv H(A) \\ &\Pr\{\text{response}_i \text{ is}'\text{abstain}'\} = 1 - H_j(A_i; Z_i; \gamma) \equiv 1 - H(A) \end{aligned} \tag{2}$$

[3] More precisely, subjects received the following information, both verbally (from the monitor) and in writing: 'Honey may be produced from domestic or foreign beehives. In the United States, beekeepers do add some pesticides and antibiotics to their hives to support bee health. The chemicals are added using chemical strips that receive approval from the United States Environmental Protection Agency or EPA. Given the EPA approval, these chemical additives are not expected to harm human consumption and health. Honey imported from other countries may be produced under similar regulations or come from countries with looser or no regulations on hive chemical inputs. Approximately one-third of the honey found on the international market comes from China. The United States has banned importations of Chinese honey due to concerns about illegal antibiotics and heavy metals found in Chinese honey. Some of these additives may be detrimental to human consumption and health. Still, Chinese honey has the potential to make it into the American honey supply due to fraudulent activities in the international sweetener market. It is not clear that imported honey available for sale in the United States did not originate in China'.

A logit model is used to estimate the probabilities associated with Equation (2).

4. Results

Of the 148 participants, 60 participants were in the control group and not given honey laundering information. The other 88 participants were in the treatment group and given information regarding honey laundering. The average age of the study participants was 30.7 years. Women were also slightly oversampled in the study, with 63.7% women. Nearly 20% of the sample had not completed high school or only earned a high school diploma (or GED). Over 44% had some college, while 20% had a college degree. Less than 14% of the sample had earned a graduate degree (Table 1).

Of all participants, 2.01% stated the nectar source of their honey is important, 6.71% indicated that health of their honey was important, 2.01% stated that honey being organic was important, 3.66% stated that their honey being ethically produced was important, 8.91% stated that honey being locally produced was important, and 5.35% stated that none of these characteristics were important. *Nectar Important*, *Health of Honey Important*, *Organic Honey Important*, *Ethical Production of Honey Important*, and *Local Honey Important* are dummy variables indicating if a participant stated he or she would be most willing to pay for that honey characteristic and ranked the characteristic as one of the most important[4]. *No Honey Characteristic Important* is a dummy variable indicating if a participant stated that he or she was not willing to pay for any of the above honey characteristics. *Price Rank* is the relative rank given by a participant of the importance of the price of honey compared with other characteristics when generally purchasing honey (1 - 6; where 1 is lowest rank and 6 is highest rank). Approximately a quarter of the sample ranked the general price as the least important honey characteristic, while the same proportion rated it as the most important. Lastly, nearly 35% of participants use honey for medicinal purposes (Table 1).

In total, 53.38% of participants across the treatments chose local honey at a $2.48 premium over honey of unknown origin. This finding is consistent with other studies (Wu *et al.,* 2015), suggesting that consumers may be willing to pay this premium for local honey.

To determine the impact of honey laundering information on the probability that participants are willing to pay the $2.48 premium for local honey together with preferences for honey characteristics and demographics, multiple logit regressions were completed. Arvanitoyannis and Krystallis (2006) find that consumers consume honey due to health and medicinal

[4] The characteristic most willing to pay for was based on a list of honey characteristics (health, organic, locally produced, ethical, nectar source, and none) that the participants stated he or she would be most willing to pay for. The rank of the characteristic was based on a list of honey characteristics (health, organic, locally produced, ethical, nectar source, and price) that the participant ranked from lowest to highest importance when generally purchasing honey.

Table 1 Description and summary statistics of participants

Variable	Category	Category %	Mean	Min	Max
Honey laundering information	1 = Yes	59.46		0	1
	0 = No	40.54			
Age	Under 25 years	57.72	30.7	18	78
	25–45 years	23.49			
	45–60 years	6.04			
	60 years or over	12.75			
Gender	1 = Female	63.70		0	1
	0 = Male	36.3			
Education	Less than high school	3.40			
	High school degree (or equivalent)	17.01			
	Vocational	1.36			
	Some college	44.22			
	College degree	20.41			
	Graduate degree	13.61			
Nectar important	1 = Yes	2.01		0	1
	0 = No	97.99			
Health of honey important	1 = Yes	6.71		0	1
	0 = No	93.29			
Organic honey important	1 = Yes	2.01		0	1
	0 = No	97.99			
Ethical production of honey important	1 = Yes	3.36		0	1
	0 = No	96.64			
Local honey important	1 = Yes	8.91		0	1
	0 = No	91.09			
No honey characteristic important	1 = Yes	5.35		0	1
	0 = No	94.65			
Price rank	1 (Least important)	24.82	3.6	1	6
	2	11.68			
	3	15.33			
	4	10.22			
	5	13.87			
	6 (Most important)	24.09			
Medicinal purposes	1 = Yes	34.23		0	1
	0 = No	65.77			

factors. Unnevehr and Gouzou (1998) show that consumers value the floral or nectar source of honey. Wu *et al.* (2015) find that consumers have a higher willingness to pay for local honey compared with either U.S. or international honey. Further, previous research shows ethical practices of production including fair trade (e.g. see De Pelsmacker *et al.,* 2005) affect consumers' preferences for local food. Adams and Salois (2010) find that demand for local foods may be tied to consumers linking local to organic. In addition, demographic variables have been found to affect preferences for local food (e.g. Garcia *et al.,* 2012). To understand the influence of these factors on consumers' willingness to pay a premium for local honey, a logistic regression model was performed, from which marginal effects were generated based on the following:

$$U_{i,j} = V_{i,j} + \varepsilon_{i,j} \tag{3}$$

where $U_{i,j}$ is individual i's utility, and j is equal to 0 for honey of unknown origin and 1 for local honey. $V_{i,j}$ is the portion of $U_{i,j}$ that is observable and $\varepsilon_{i,j}$ is an error term. The probability that individual i pays the premium for local honey is:

$$\Pr(local) = \Pr(V_{i,j=1} + \varepsilon_{i,j=1} > V_{i,j=0} + \varepsilon_{i,j=0}) \tag{4}$$

where $\Pr\{local\}$ is participant i's probability of being willing to pay the \$2.48 premium for local honey and:

$$V_{i,j} = \alpha_j + \beta_j Laundering_i + \gamma_j Characteristics_i + \varphi_j Medicinal_i + \omega_j Demographic_i \tag{5}$$

Laundering is a dummy variable indicating if the participant received the honey laundering information (*Laundering* = 1 if given the information, *Laundering* = 0 if not given); *Characteristics* is a vector that includes the characteristics of honey participants deem important including the nectar source (*Nectar Important*), health (*Health of Honey Important*), organic (*Organic Honey Important*), ethical production (*Ethical Production of Honey Important*), locally produced (*Local Honey Important*), no characteristic (*No Honey Characteristic Important*) and the general price of honey (*Price Rank*); *Medicinal* is a dummy variable representing if a participant uses honey for medicinal purposes (1 = yes, 0 = no); *Demographic* is a vector of demographic variables including gender (0 = male, 1 = female), age, and the dummy variable *College* (*College* = 1 if the participant has attended at least some college, *College* = 0 if otherwise). The model is estimated when honey laundering information is the only independent variable included (Model 1), when covariates found in previous studies to influence honey and local food decision are added (Model 2) and when demographic variables are also included (Model 3). Results of the three models are presented in Table 2[5].

Results in Table 2[6] show when accounting for only the effect of honey laundering information, this information seems to have no effect on the probability of choosing to pay the premium for local honey (Table 2, Model 1). However, we find that prognostic variables are unbalanced between the control and treatment groups. Although the estimator used in Model 1 is

[5] Analyses were conducted on the entire sample and a subset of the sample that included participants who indicated purchasing honey at least once a year. Results are consistent across these two sets. For brevity, only results for the entire sample are reported.

[6] We have identified Model 3 as the best specification based on the log-likelihood value. The robustness of the results for our primary variable of interest has been explored over various model specifications. We find that the results of Model 3 are robust over model specifications that generate similar log-likelihood value.

Table 2 Logit results and marginal effects for factors influencing willingness to pay a $2.48 premium for an eight-ounce jar of local honey

Variable	Model 1	Model 2	Model 3	Marginal effects (Model 3)
Honey laundering information (Control group = 0, Treatment group = 1)	0.116 (0.336)	0.736* (0.408)	1.097** (0.457)	0.267**
Nectar important (Yes = 1, No = 0)		−1.371 (1.392)	−1.32 (1.723)	−0.294
Health of honey important (Yes = 1, No = 0)		−3.581*** (1.167)	−3.504*** (1.190)	−0.533***
Organic honey important (Yes = 1, No = 0)		0.912 (1.301)	1.179 (1.271)	0.265
Ethical production of honey Important (Yes = 1, No = 0)		−0.913 (0.988)	−0.751 (1.065)	−0.181
Local honey important (Yes = 1, No = 0)		−0.370 (0.782)	−0.106 (0.796)	−0.026
No honey characteristic important (Yes = 1, No = 0)		−1.360 (0.872)	−1.351 (0.883)	−0.303*
Medicinal purposes (Yes = 1, No = 0)		0.871** (0.420)	1.061** (0.458)	0.257**
Price rank (1 Lowest rank–6 Highest rank)		−0.219** (0.107)	−0.267** (0.1115)	−0.067**
Age			0.041*** (0.016)	0.010***
Gender (Male = 0, Female = 1)			0.350 (0.428)	0.087
College (Yes = 1, No = 0)			0.715 (0.499)	0.175
Constant	0.0667 (0.258)	0.452 (0.469)	−1.683** (0.833)	
Log-likelihood	−102.188	−82.955	−76.527	
LR χ^2	0.12	22.51	34.03	
χ^2 *P*-value	0.7304	0.0074	0.0007	
N	148	136	135	

Standard error in parentheses.
***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.

unbiased (Imbens and Rubin, 2015), the point estimate generated in Model 1 likely includes both the treatment effect and the differences in these variables (Mutz *et al.,* 2017). For instance, the variable *Price Rank* is unbalanced between the control and treatment groups, where those in the treatment group are over four times more likely to care about the price of the honey they purchase than those in the control group (8.99% and 1.67%, respectively). Since previous literature suggests this variable influences honey choices, adjusting for this variable is appropriate (Athey and Imbens, 2017).

Further, Mutz *et al*. (2017) show that all prognostic variables should be included to generate more precise estimates. Following Athey and Imbens (2017) and Mutz *et al*. (2017), we correct for these differences by adjusting for these variables and others known to affect the dependent variable. We note that Freeman (2008) argues including covariates may create biased regression estimates in randomised experiments. Lin (2013) shows this concern is, however, overly cautious and likely does not apply in most cases. Therefore, Models 2 and 3 adjust for several characteristics known to influence honey and local food decisions (e.g. see Adams and Salois, 2010; Arvanitoyannis and Krystallis, 2006; De Pelsmacker *et al.,* 2005; Unnevehr and Gouzou, 1998). Once we control for only honey preferences and use, access to honey laundering information significantly increases the probability ($P < 0.10$) of participants being willing to pay a $2.48 premium for an 8-ounce jar of local honey (Table 2, Model 2). When also including the influence of demographic variables on the probability of paying the premium, honey laundering information still significantly increases the probability ($P < 0.05$) of participants choosing local honey (Table 2, Model 3). Jointly, the results in Table 2 imply that information on honey laundering may increase the probability of consumers choosing to pay a premium for local honey that is guaranteed to be fraudulent free.

The results suggest that providing honey laundering information increases the probability of participants being willing to pay the premium by as much as 27 percentage points[7]. Consistent with Arvanitoyannis and Krystallis (2006), we find using honey for medicinal purposes and a high importance of the health of honey (i.e. *Health of Honey Important*) significantly affects consumers' willingness to pay the premium for local honey. Participants who indicated they use honey for medicinal purposes have an increased probability of paying the premium for local honey compared with those that do not use honey for this purpose by 25 percentage points. Yet, somewhat surprising, those participants indicating that the health of their honey is important were 53 percentage points less likely to pay the premium for local honey. One possible explanation is that participants believe no correlation between the origin and health of honey exists (i.e. healthy honey can originate from any location). Similar to Feldmann and Hamm (2015), those stating a high importance over the general price of the honey they consume are seven percentage points less likely to pay the premium. In addition, for each year increase in age, the probability of participants being willing to pay the premium increases by one percentage point, similar to findings of Garcia *et al*. (2012).

Gender and education were not found to influence participants' willingness to pay $2.48 for local honey, which is consistent with studies that do not find

[7] This estimate may be an upper bound, since Model 1 and Model 2 suggest a lower marginal effect of honey laundering information on the probability of participants paying the premium for local honey.

demographics are related to purchasing local foods (e.g. Zepeda and Li, 2015). Contrary to previous findings, the importance of the nectar source, organic, ethical production, and local characteristics was not found to have a significant influence on honey choice (De Pelsmacker *et al.,* 2005; Adams and Salois, 2010; Wu *et al.,* 2015). Similarly, placing no value on these characteristics was not found to influence honey choice (Table 2).

5. Conclusion

Results from this study indicate that giving consumers information about honey laundering may increase the percentage of consumers that are willing to pay a premium for locally produced honey. This result may imply that producers will see increased revenues for their products through either increased sales or a higher end price, when communicating their honey as fraud-free. If consumers are made aware of the fraudulent activities, they may switch from honey at risk of fraud to honey that entails no such risk, such as locally produced honey. By providing consumers with a guarantee that their honey is locally produced, and communicate the potential health risks of honey of unknown origin, honey producers may see an increase in consumers willing to pay a premium for their honey. Together with existing policies and programs, making food fraud information salient to consumers may help meet goals of reducing fraudulent activities. Providing this information may be costly to implement, yet it may generate an increase in consumers who are willing to pay a substantial premium by as much as 27 percentage points.

In addition, other factors including age, the importance of the general price of honey, the overall importance of the health of honey, and using honey for medicinal purposes were all found to affect consumers' willingness to pay a premium for local honey. Therefore, there is evidence to support the secondary hypothesis of this research and provide additional marketing opportunities to local honey producers. Targeting certain groups may be most effective at increasing those willing to pay a premium for local honey. Targeting older consumers will most likely be successful at garnering more local consumers that are willing to pay for local honey than targeting younger consumers. Additionally, the seemingly most successful marketing campaign will target those consumers who use honey for medicinal purposes.

Information about the negative health impacts of honey laundering may impact some consumers more than others. Due to sample limitations, this study did not address consumer heterogeneity. Thus, future research can be designed to determine whether certain subgroups of the population are more likely to change their purchasing behaviour based on information about honey laundering specifically, and food fraud more generally. This additional information may be important in creating market-based approaches to curbing food fraud.

The findings of the study are sensitive to the context of honey laundering and may not be broadly applied to other commodities or types of fraud.

Fraudulent activities are widespread in food markets, and further research should measure whether consumer information can affect local food choices elsewhere. Within the honey market, there are also many different end uses for honey. For example, New Zealand Manuka honey has medicinal properties, boosting the value of medical-grade Manuka above that of standard food-grade honey. While the Manuka market has suffered greatly from fraud (see Leake, 2013), it is unclear whether the results of consumer decisions over food-grade honey will transfer to the medical Manuka market. Thus, additional research is needed to create more reliable estimates of societal loss and costs of food fraud and food-related products globally.

Additionally, the findings of this study are especially reliant on the type and amount of information relayed to consumers. In the study, we did not indicate the specific origin of the unknown honey. Rather, participants were unaware if the honey was domestically produced or imported. Further, participants were unaware if the honey of unknown origin contained laundered honey. Further research can aim to measure the influence of varying these factors on the demand for local honey.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix 1. Treatment 1 instructions.