Consumer Response to Food Fraud

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Abstract

This study uses a laboratory experiment to examine whether food fraud occurring in one country affects the valuation of products from that and other countries. We invited regular consumers of olive oil to participate in a valuation experiment. The experiment was designed to compare consumers' valuation of extra virgin olive oil (EVOO) from different countries before and after receiving information about mislabeling, or food fraud, in one of the countries. Results show that information about food fraud in one country negatively affects the valuation of EVOO not only from that country, but also from other countries, indicating that consumers' response to fraudulent behavior in one country can spill over to other countries. Additionally, this study finds that consumers with prior knowledge of food fraud incidents decrease their valuation less when they receive information about olive oil fraud.

Keywords: Willingness to pay, spillover effect, olive oil fraud, fraud perception

1. Introduction

Over the last decade, food fraud scandals, such as the adulteration of Chinese milk with melamine, the discovery of horsemeat in many European meat products, and the mislabeling of Italian olive oils, have increased the attention of the media, consumers, and governments about the vulnerability of the food system to intentional adulteration or misrepresentation of product ingredients or products themselves based on economic motives (Lotta and Bogue 2015; Elliot 2014; Premanandh 2013). The economic costs of a food fraud scandal can range from lost sales and bankruptcies to adverse health consequences. For example, the total cost of the Chinese melamine milk scandal 2008 was estimated to be 10 billion dollars, which includes the costs associated with product recalls and withdrawals, incident investigation, lost sales, decreases in shareholder value, and adverse health consequences (Grocery Manufacturers Association 2010). According to the United States Pharmacopeial Convention (USP), which monitors food fraud, 60 percent as many incidents of food adulteration were confirmed in the two years from 2011 to 2012 as had been identified in the three decades between 1980 and 2010, while media coverage

of incidents increased by nearly 80 percent (Moore et al. 2012; Johnson 2014). In the United Kingdom (UK), the National Audit Office revealed that confirmed food fraud incidents in the UK were 67 percent higher in 2012 compared to 2009 (Avery 2014). In 2016, Operation Opson V, the largest food fraud investigation launched by Interpol and Europol to date, which operated in 57 countries, seized 1.44 million liters and 5.5 million units of mislabeled and adulterated beverages and food products, respectively (Europol 2016).

According to Johnson (2014), olive oil is one of the food categories most vulnerable to food fraud. Most olive oil fraud cases involve the substitution or adulteration of extra virgin olive oil (EVOO) with less expensive or lower quality alternatives. Olive oil is a product differentiated by geographical region, olive type, and chemical and sensory characteristics; therefore, it is not a commodity with one world reference price. Olive oil is an experience good and some economically important attributes are credence goods (Darby and Karni 1973). The wide range of prices at which olive oil is sold, and difficulty in verifying the veracity of label claims, provides an incentive to mislabel or adulterate EVOO with lower quality olive oils or cheap seed oils (Cercaci et al. 2003).

In fact, a number of recent investigations have identified food fraud in widely sold EVOOs. Conducting one of the largest olive oil fraud investigations on 186 samples of EVOO sold in California, scientists from the University of California, Davis Olive Center found that 73 percent of the samples across the top five imported extra-virgin olive oil brands in the United States were either mislabeled or adulterated. Moreover, about 11 percent of top-selling Italian EVOO brands failed to meet the criteria that define EVOO (Frankel et al. 2011). The frequency of olive oil fraud has been on the rise (Foglia 2016). For example, there have been allegations in Italy that rules and regulations regarding olive oil standards are frequently ignored. In 2012,

Italian law enforcement authorities found that the largest Italian olive oil producer had mislabeled less expensive imported olive oil as domestic high-quality extra virgin olive oil. Some producers have been found to use chemicals to cover up sensory defects in lower quality olive oils (Kirchgaessner 2015). In 2015, Italian anti-fraud authorities again investigated top Italian olive oil companies for mislabeling, finding that nine out of twelve top-selling brands mislabeled low-quality olive oil as EVOO (Squires 2015). During Operation Opson V, which lasted from November 2015 to February 2016, cooking oil, and EVOO in particular, was one of the largest categories of products seized. During this period, the National Forestry Police of Italy seized seven thousand tons of olive oil fraudulently labeled as extra-virgin (Europol 2016).

A spate of food fraud incidents over the last decade raises important questions about the impact of food fraud incidents on consumers' wellbeing and behavior. A recent study by a Dutch consumers' association, Consumententbond (2016), examined consumer attitudes toward food fraud in response to increasing concerns about food authenticity and safety. Survey results reveal that perceptions about the frequency of food fraud in different food categories do not correspond to findings from tests of product mislabeling. For example, they find that consumers are suspicious about meat. However, fraudulent behavior is more common among milk products, dried herbs, and honey in the Netherlands. A second study examined German consumers' attitudes towards food fraud after a well-documented food fraud event (Reiger et al. 2016). While the authors find heterogeneity in consumers' perceptions of the event, they do not delve into the underpinnings of this heterogeneity, such as differences in awareness of the event, knowledge of food fraud, or risk preferences. There are, in addition, studies that focus on consumers' valuation of food safety attributes and local food in the presence of food fraud. Studies by Ortega et al. (2011) and Sckokai et al. (2014) find that consumers are willing to pay a

premium for food safety attributes. Agnoli et al. (2016) shows that, in the presence of food fraud, consumers strongly prefer local food.

While the abovementioned studies focus on consumers' preferences for food safety attributes and local food, there is a lack of information about how consumers update their valuation of products after learning about food fraud. The main goal of this study is to examine how information about food fraud occurring in one country affects willingness to pay (WTP) for products from that and other countries. Specifically, we 1) evaluate changes in consumers' WTP for EVOO after they receive information about food fraud, 2) examine how information about food fraud attributable to one country affects WTP for products from other countries, and 3) evaluate how information about food fraud affects the valuation of olive oils in different price segments.

Despite the growing awareness of the need to understand and combat food fraud (PwC Network, 2015), little has been done to understand the economics of food fraud. In particular, there are significant gaps in the empirical evidence needed to understand the effects of food fraud. This study will provide insights into how consumers respond to information about food fraud incidents in the Italian olive oil industry, and how that information influences consumers' valuation of olive oils from countries not implicated in these incidents. Information about how consumers form their perception of food fraud can help supply chain managers and policymakers understand and develop appropriate strategic responses to food fraud. Moreover, in addition to identifying and measuring the externality of consumers' fraud perception, the results of this study will provide evidence about whether spillovers mean that governments need to collaborate to effectively combat fraud in the agri-food marketing system.

The rest of the paper is organized as follows. The next section describes the experimental design used to collect data, followed by a summary of data in section three. Section four focuses on the estimation strategy. Empirical results are discussed in section five. Section six summarizes and concludes this paper.

2. Experimental design and procedure

To examine the effect of food fraud on consumer valuation, we developed a laboratory experiment based on the demand-revealing Becker-DeGroot-Marschak mechanism (BDM) (Becker et al., 1964). The experimental design permits an examination of changes in consumer WTP upon receiving information about olive oil fraud. Specifically, the experiment was structured to examine consumers' perceptions of EVOO produced in three different countries when consumers with different levels of demographic characteristics, consumption experiences, and knowledge are informed about the occurrence of olive oil fraud in one country.

In the BDM mechanism, research participants are presented with a good and asked to submit a bid for it. Then, an "experiment" price is randomly drawn from a distribution of prices. If the bid is higher than the randomly drawn—and therefore exogenous—"experiment" price, the subject purchases the good, paying the experiment price. Since the amount the subject pays does not depend on their bid, it is in the subject's interest to value the object truthfully: bidding truthfully is a weakly dominant strategy (Becker et al., 1964). One of the strengths of the BDM is that the individuals' bids are free from bid affiliation, a phenomenon in which others' bids influence the participant's bid (Corrigan and Rousu, 2006). Since the main objective of this study is to evaluate changes in consumers' WTP before and after receiving information about olive oil

fraud, we use the BDM to avoid bid affiliation, which would have confounded estimates of consumer response to information.

We recruited 107 olive oil consumers (who use olive oil regularly but do not earn their livelihood in olive oil, and have not been formally trained in evaluating olive oil) and conducted the study at the University of Nebraska-Lincoln between September and November 2017. The experimental design consisted of two stages: a no-information stage, and an information stage. For this study, we used two types of EVOO, i.e., high-priced and low-priced EVOO (see Table 1). Moreover, these EVOO bottles were produced by the following three countries: Greece, Italy, and the United States. Since the frequency of olive oil scandals in Italy, as noted earlier, have been on the rise, we provided information about food fraud in the Italian olive oil industry to participants to examine how information about food fraud affects their valuation for Italian EVOO, for EVOO from Greece, and for EVOO from the US.[1]

Table 1: Descriptive information of olive oil used in the experiment

Olive Oil	**Country of Origin**	**Bottle Size**	**Shelf Price Range**
High-priced EVOO	Greece, Italy, and the United States	500 ml	$24-29
Low-priced EVOO	Greece, Italy, and the United States	500 ml	$5-10

Source: Laboratory experiment

Upon arrival, a researcher explained the experimental procedure to the participants. After an opportunity to participate in a practice round to familiarize participants with the valuation mechanism and the computer interface, the researcher started the experiment. In the first round, participants were asked to submit their maximum willingness to pay for six different bottles of olive oil produced by Greece, Italy, and the United States. Each country had both a bottle of EVOO from the low-end of the price distribution ($5-$10 per 500 ml bottle) at which EVOO is sold, as well as a bottle from a higher price range ($24-$29 per 500 ml bottle). Before and during

[1] Since olive oil scandals related to Greek and Californian brands have not occurred, we selected EVOO bottles produced by Greece and California (United States) along with Italy to capture the spillover effects of Italian olive oil scandal.

the first round, participants did not receive any information about food fraud in the olive oil industry. This was followed by a short survey on demographic variables and one question about whether participants were aware of the occurrence of fraud in the US food industry.

In the second round, participants were asked to read an article about the Italian olive oil industry and mislabeling scandals. After providing information about food fraud in the Italian olive oil industry, participants were again asked to submit bids for the same set of EVOO bottles. This was followed by surveys regarding olive oil knowledge and olive oil market experience (such as number of EVOO bottles purchased per month, the bottle size, average price spent per bottle and types of olive oil purchased). After the completion of the surveys, participants took a short quiz on the article they read in the second round, which was included to capture how much detail of the article participants remembered.

3. Descriptive statistics

Table 2 summarizes data on participants' WTP for EVOO, demographic characteristics, prior knowledge of food fraud, quiz score, frequency and price range of olive oils consumed, and knowledge about olive oil. In this study, we want to examine how regular consumers of olive oil respond to information about olive oil fraud. It is important to note that regular olive oil consumers are not necessarily going to reflect the mean demographic characteristics of Lincoln, NE. Moreover, we want participants who make food purchasing decisions for their households, which tends to skew female (GFK MRI Survey of the American Consumer, 2011).

Women comprise 60 percent of the sample, which is 10 percent higher than the percentage of females in Lincoln, NE.[2] The mean age of the participants is 25.5 years old, which

[2] According to the 2010 US Census, the female population comprises 49.98 percent of the total population of Lincoln, NE.

is lower than the mean age of Lincoln, NE.[3] About 50 percent of participants have a bachelor's degree or higher, compared to the 36.7 percent of the population living in Lincoln, NE that has a bachelor's degree or higher (American Community Survey, 2015). Moreover, participants, on average, believe that about 54 percent and 48 percent of domestically produced (*perusfda*) and imported food products (*perimfda*), respectively, are tested by the US Food and Drug Administration (FDA). It should be noted that the variables *perusfda* and *perimfda* are categorical, which we convert to a numerical value using the midpoint of each category. Only 36 percent of participants report having prior knowledge of food fraud.

Table 2: Descriptive statistics (n=107)

Variable	Definition	Mean	SD	Min	Max
wtp	WTP for EVOO (overall)	10.93	7.74	0	35
highpriced_evoo	1 if high-priced EVOO; 0 otherwise	0.5	0.5		
inf_fraud	1 if information about Italian olive fraud available; 0 otherwise	0.5	0.5		
gender	1 if female; 0 otherwise	0.60	0.40		
age	Age of the participants	25.5	7.73	19	55
educ	Years of education	15	2.39	10	18
perusfda	Participants' perception (in percentage)	54.11	27.57	10	90
perimfda	Participants' perception (in percentage)	48.32	28.03	10	90
prior_know_ff	1 if prior knowledge about food fraud; otherwise 0	0.36	0.48		
type_oliveoil	1 if participant consumes EVOO; 0 otherwise	0.67	0.47		
quantity	Quantity per month (in ml)	766.5	523.0	25	4000
know_oliveoil	Index of olive oil knowledge	0.43	0.15	0	0.80
quiz	Quiz regarding the article on Italian olive oil fraud	6.15	1.34	2	8

Source: Experiment

[3] The mean age of population living in Lincoln, NE is 35.5 years (American Community Survey, 2015).

Regarding olive oil use, participants consume an average of 0.77 liters per month. In addition, when asked about the type of olive oil they consume, table 2 shows that 67 percent of participants purchase EVOO and rest of the participants purchase low-quality olive oil, such as pure and virgin olive oils. To assess consumer knowledge, we asked respondents 10 questions regarding olive oil quality, types, and production process, and construct an index that incorporates all responses. Moreover, after the completion of the laboratory experiment, participants were asked to take a short quiz, which consists of eight questions on the article they read in the experiment. The variable *quiz* presents the average score of the quiz. On average, participants answered six questions correctly.

4. Estimation strategy

We use data from a laboratory experiment that provided participants with information about Italian olive oil fraud to 1) study how information about fraud affects consumers' willingness to pay for Italian EVOO, 2) evaluate whether information on Italian olive oil fraud spills over onto valuation of EVOO produced by Greece and the United States, and 3) examine the role of product price range in consumers' response to food fraud information. In addition to estimating externalities arising from fraudulent behavior in one country on valuation of other countries' products, this study analyzes the effects of other factors, such as demographic features, olive oil knowledge, olive oil market experience, price range, and knowledge about food fraud on valuation.

To estimate the effects of food fraud on consumers' valuation of EVOO, this study uses regression techniques that make use of the panel structure of this dataset. We regress consumers' WTP for EVOO on the dummy variable which captures differences in information while taking into account the following control variables: demographic variables (i.e., age, gender, education,

and income), olive oil knowledge, olive oil market experience (i.e., quantity consumed per month and types of olive oil purchased), price differences, and knowledge about food fraud:

$$(1) \quad WTP_{it} = \beta_0 + \beta_1 Inffraud_{it} + \beta_2 \boldsymbol{X_{it}} + \varepsilon_{it}$$

where WTP_{it} denotes the WTP of participant i observed at time t; while $Inffraud_{it}$ is a dummy variable taking a value of one for WTP data generated in the second round of valuation after participant i received information about Italian olive oil fraud; $\boldsymbol{X_{it}}$ is a vector of control variables, and ε_{it} is an i.i.d. standard normal error term.

The panel regression model in equation (1) can be estimated either with fixed effects (FE) or random effects (RE) panel estimators. However, since the laboratory experiment is designed in such a way that all participants have the same information in both rounds of the experiment, and the values of the variables related to consumers' characteristics do not change across time (i.e., time-invariant values), we anticipate that the RE specification is appropriate. We run the Hausman test for all panel regression models, which confirms that the RE specification is preferred (Hausman, 1978). We use standard errors which are cluster-corrected at the individual level.

5. Results and discussion

5.1 Effects of information about Italian olive oil fraud on consumers' WTP for EVOO

Table 3 shows the results of the panel regression models analyzing the effect of information about Italian olive oil fraud on consumers' valuation for EVOO from Greece, Italy, and the United States. We use panel regression models with the RE specification. As mentioned earlier, we use consumers' WTP for EVOO from all the countries as the dependent variable. Column 1, our most parsimonious specification, shows consumers' response to Italian olive oil

fraud information while controlling for differences in the price range of the olive oils. A notable result is the negative and statistically significant coefficient of the *inf_fraud* variable. After receiving information about Italian olive oil scandal, participants, on average, decrease their WTP for EVOO (pooled across countries) by $2.75, which is statistically significant at the 1% level.

Column 2 presents a specification in which, in addition to the variables in column 1, we include consumers' perception about FDA testing of food products, knowledge about olive oil and food fraud, country-of-origin, and nine interaction terms between *highpriced_evoo, inf_fraud, know_oliveoil, prior_know_ff, perusfda,* and *perimfda*. It should be noted that adding variables related to consumers' perceptions of FDA oversight, knowledge about olive oil and food fraud, and interaction terms results in a larger negative effect of food fraud on consumers' WTP, which is statistically significant at the 1% level. Now, on average, consumers' WTP for EVOO decreases by $4.53 when they receive information about Italian olive oil fraud. We also find that participants prefer Italian EVOO to Greek and Californian EVOO before receiving any information about Italian olive oil. Specifically, on average, consumers are willing to pay $1.13 and $2.05 less for Greek and Californian EVOO than for Italian EVOO. However, when consumers receive information about Italian olive oil fraud, they prefer Greek and Californian EVOO to Italian EVOO, and are willing to pay approximately $3 more for Greek and Californian EVOO than Italian EVOO.

A few variables related to consumer knowledge are also important in explaining bidding behavior. Upon receiving information about Italian olive oil scandals, the WTP of consumers who reported prior knowledge of food fraud decreased $0.88 less than the WTP of consumers who had no prior knowledge of food fraud, which indicates that they may have already partially

accounted for the possibility of food fraud in their initial bids. Consumers who score better on questions concerning olive oil knowledge are willing to pay less for EVOO, which is statistically significant at the 5% level. Another notable result is that, after receiving information about Italian olive oil fraud, consumers' WTP for high-priced EVOO decreases by $4.41 more than low-priced EVOO, which is statistically significant at the 1% level.

In Column 3 of table 2, we include demographic characteristics, quiz score, and market experience along with all variables of column 2. The regression results in column 3 are very similar to those in column 2. In other words, column 3 of table 2 documents the robustness of our column 2 specification.

5.2 Effects of Italian olive oil fraud on consumers' WTP for Italian EVOO

In this section, we focus on consumers' valuation of Italian EVOO when they receive information about Italian olive oil fraud. Column 1 in Table 4 shows the panel regression with WTP for Italian EVOO as the dependent variable. In this context, the vector of control variables includes demographic characteristics, consumers' perceptions about the frequency of FDA testing, knowledge about food fraud and olive oil, market experience, and quiz score.

The regression results find that, on average, the estimated mean WTP for Italian EVOO decreases by $6.70 after receiving information about Italian olive oil fraud, which represents a 51 percent decrease in WTP.[4] Consumers with no prior knowledge of food fraud react more when they receive information about fraud. Compared to consumers with prior food fraud knowledge, those who have no prior knowledge about food fraud decrease their WTP by $2.27 more for Italian EVOO, which is significant at the 1% level. Other results in Table 4 show that

[4] The mean WTP for Italian EVOO before receiving information about Italian olive oil fraud is $13.03.

consumers' WTP for high-priced Italian EVOO is $8.73 higher than that for low-priced Italian EVOO, which is not surprising.

Table 3: Effects of Italian olive oil fraud on consumers' WTP

Independent variables	(1)	(2)	(3)
inf_fraud (1,0)	-2.75*** (0.25)	-4.53*** (0.69)	-4.53***(0.69)
highpriced_evoo (1,0)	9.70*** (0.51)	10.86***(0.56)	10.86*** (0.56)
highpriced_evoo inf_fraud*		-4.41*** (0.53)	-4.41*** (0.53)
*highpriced_evo * inf_fraud* gr_evoo*		3.03*** (0.50)	3.03*** (0.50)
*highpriced_evo * inf_fraud* ca_evoo*		3.29*** (0.59)	3.29*** (0.59)
gr_evoo (1,0)		-1.13*** (0.52)	-1.13*** (0.52)
ca_evoo (1,0)		-2.05*** (0.61)	-2.05*** (0.61)
*gr_evoo * inf_fraud*		3.11*** (0.39)	3.11*** (0.39)
*ca_evoo * inf_fraud*		3.19*** (0.46)	3.19*** (0.46)
prior_know_ff		-0.05 (0.97)	-0.31 (1.02)
prior_know_ff inf_fraud*		0.88** (0.45)	0.88** (0.45)
know_oliveoil		-5.10** (2.49)	-4.97** (2.60)
*know_oliveoil*inf_fraud*		1.21 (1.36)	1.21 (1.36)
perusfda		-0.01 (0.02)	-0.01 (0.02)
*perusfda * ca_evoo*		0.01 (0.01)	0.01 (0.01)
perimfda		0.03 (0.02)	0.03 (0.02)
*perimfda * gr_evoo*		0.01 (0.01)	0.01 (0.01)
quiz			-0.29 (0.30)
gender (1,0)			-0.82 (0.84)
age			0.04 (0.09)
educ			-0.08 (0.25)
type_oliveoil			0.35 (0.83)
quantity			0.0 (0.00)
Constant	7.45*** (0.43)	8.78*** (1.41)	10.86*** (3.59)
R^2	0.42	0.48	0.48
Wald χ^2	438.37***	583.72***	641.16***
Number of observations	107	107	107

Source: Experiment
Notes: Reported values are the estimated coefficient and, in parentheses, cluster robust standard errors.
*** significant at 1%, ** significant at 5%, * significant at 10%

5.3 Spillover effects of Italian olive oil fraud

One of the main objectives of this study is to evaluate how information about food fraud attributable to one country affects the valuation of products from other countries. Columns 5 and 6 in table 4 present spillover effects of Italian olive oil fraud on consumers' valuation for Greek and Californian EVOO, respectively.

Table 4: Effects of Italian olive oil fraud on consumers' WTP for Italian, Greek, and Californian EVOO

Independent variables	Italy (1)	Greece (2)	United States (3)
inf_fraud (1,0)	-6.70*** (0.59)	-1.60*** (0.47)	-1.04** (0.50)
highpriced_evoo (1,0)	8.73*** (0.52)	10.00*** (0.55)	10.43*** (0.59)
gender (1,0)	-0.36 (0.86)	-0.46 (1.01)	-1.58* (0.90)
age	0.05 (0.10)	0.02 (0.10)	0.05 (0.09)
educ	-0.05 (0.25)	0.02 (0.27)	-0.20 (0.26)
perusfda	-0.01 (0.02)	-0.003 (0.02)	0.01(0.02)
perimfda	0.03 (0.02)	0.04** (0.02)	0.03 (0.02)
prior_know_ff	-1.65 (1.10)	-0.66 (1.06)	0.12 (1.05)
prior_know_ff inf_fraud*	2.27*** (0.89)	0.85 (0.56)	-0.06 (0.65)
type_oliveoil	0.24 (0.84)	1.12 (0.97)	-0.30 (0.95)
quantity	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
know_oliveoil	-3.02 (2.71)	-4.22 (2.83)	-4.42* (2.69)
quiz	-0.04 (0.32)	-0.08 (0.33)	-0.24 (0.28)
Constant	9.75*** (3.60)	6.55 (4.28)	10.99*** (3.78)
R^2	0.48	0.47	0.49
Wald χ^2	484.07***	393.47***	366.18***
Number of observations	107	107	107

Source: Experiment
Notes: Reported values are the estimated coefficient and, in parentheses, cluster robust standard errors.
*** significant at 1%, ** significant at 5%, * significant at 10%

Column 2 in table 4 presents random effects regression results with WTP for Greek EVOO as the dependent variable. The results show that there is a negative spillover effect of Italian olive oil fraud on Greek EVOO. After receiving information about Italian olive oil fraud,

consumers' WTP for Greek EVOO decreases by $1.60, which constitutes a 13-percent decline in WTP for Greek EVOO.[5] This result is statistically significant at the 1% level. Intriguingly, while the prior knowledge of food fraud affects the valuation of Italian EVOO after receiving information about Italian olive oil fraud, it does not affect the valuation of Greek EVOO. Moreover, none of the key demographic characteristics (i.e., age, gender, and education) is statistically significant.

Column 3 of table 4 presents the effects of Italian olive oil fraud on consumers' valuation of Californian EVOO. We estimate panel regression using RE estimators with WTP for Californian EVOO as the dependent variable. A notable result is that, like Greek EVOO, the valuation of Californian EVOO is also negatively affected by the information about Italian olive oil fraud. Participants' WTP for California EVOO decreases by $1.04, or about 9 percent, after reading an article on Italian olive oil fraud. This WTP decrease is significant at the 5% level.[6]

The other regression results in column 3 of table 4 show that female consumers, on average, are willing to pay $1.86 less for Californian EVOO than male consumers, which is statistically significant at 10% level. No other demographic variables are statistically significant.

6. Conclusions

The incidence of food fraud in the agri-food marketing system is not a new phenomenon. In fact, some of the earliest reported food fraud incidents trace back thousands of years (Johnson, 2014). However, in recent years, the intensity and frequency of food fraud have been on the rise since both the modernization of food processing and the globalization of food supply chains create an

[5] Consumers' valuation of Greek EVOO before receiving information about Italian olive oil fraud was, on average, $12.23.
[6] Consumers WTP for Californian EVOO before receiving information is, on average, $11.65.

opportunity to commit fraud on an international scale (Lotta and Bogue, 2015). In the presence of food fraud, consumers suffer welfare losses, which may include damages to their health in the event that foods have been adulterated with harmful substances. Consequently, the incidence of food fraud reduces consumers' trust in labeling policy, which, in turn, creates financial and reputational damages to firms and the food industry as a whole (Giannakas 2002; UK National Food Crime Unit 2016). In fact, the financial loss to the agri-food industry due to food fraud has adverse effects at every stage of the supply chain, from farmers to retailers (UK National Food Crime Unit 2016). As mentioned previously, several studies find that the reputational damage to a company brand resulting from food fraud has spillover effects across competing brands. While these prior studies focus on the spillover effects of negative brand information across competing brands, it is unknown whether food fraud identified with one country affects the valuation of food products from other countries. To fill this knowledge gap, this study examines how information about food fraud in a country affects the valuation of products from other countries.

We designed a laboratory experiment to understand how consumers respond to Italian olive oil fraud. We recruited 107 olive oil consumers and asked them to place bids on six olive oil bottles produced by three different countries (i.e., Italy, Greece, and the United States) in two different scenarios. Data generated in the laboratory experiment allow us to (i) measure consumers' valuation of Italian EVOO in the presence of Italian olive oil fraud, (ii) examine whether consumers' perception of Italian olive oil fraud affects the valuation of Greek and Californian EVOO, and (iii) to determine the importance of price range in consumers' response to information about Italian olive oil fraud.

The analyses of the laboratory experiment data show consumers change their preference for EVOO when they receive information about olive oil fraud. For instance, while initially

consumers prefer Italian EVOO to Greek and Californian EVOO, their preferences change after receiving information about Italian olive oil scandals. This result suggests that Italian olive oil fraud damages consumer trust in Italian EVOO.

Moreover, the analysis shows that in the presence of olive oil fraud, consumers, on average, reduce their valuation of EVOO, irrespective of country of origin. The econometric results show that after receiving information about olive oil fraud in Italy consumers decrease their valuation of Greek and Californian EVOO, in addition to Italian EVOO. This key result of this study highlights the importance of collaboration among different governments and NGOs to effectively combat fraud in the agri-food marketing system. Moreover, this empirical result demonstrates the importance of accounting for externality costs while calculating the cost of food fraud.

The empirical results also show that consumers decrease their valuation for high-priced EVOO more than that for low-priced EVOO after receiving information about food fraud. This result suggests that consumers' trust in high-priced product is damaged more in the presence of food fraud.

These results suggest that in the presence of food fraud consumers reduce their valuation of food products linked to the fraud incident, and consumers' perception of fraud negatively spills over across countries. Moreover, the role of price range is important in determining consumers' response to food fraud. Consumers with prior knowledge about food fraud are less reactive to information about food fraud. It should be noted that our results should be interpreted with caution given the limited consumer pool used in this study and its regional focus. Another caveat of this study is that the design of the experiment captures only within-subject analysis. It would be interesting to examine consumers' response to food fraud using a between-subject

experimental design. Future research could explore why knowledge about olive oil affects consumers' valuation negatively. Are there any ways that specific countries or brands can counteract general negative information? Are there intra-country spillover effects across different product categories? These are some important questions that await investigation.

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