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Consumer Willingness to Pay for Organic and Animal Welfare Product Attributes: Do Experimental Results Align with Market Data?

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This study estimates distributions of consumer willingness to pay (WTP) for organic and animal welfare product attributes using the store scanner data and compares the results to existing experiment-based findings. We find that the WTP premium estimated for organic eggs is consistent with experimental results, while estimated WTP premiums for animal welfare attributes are significantly lower than experimental findings. The results suggest the importance of considering biases when estimating the price premium for animal welfare attributes in experiments. In addition, consumers are not always willing to pay premiums for organic products. Our results also show that WTP premiums are heterogeneous across store brands.

Key words: demand estimation, differential products, price premium, willingness to pay

Introduction

Willingness to pay (WTP) for product attributes provides valuable information on consumer behavior for marketing research. Studies have used WTP for various purposes, such as documenting changes in consumer preferences (Adams and Salois, 2010), measuring the effect of additional product information (McFadden and Huffman, 2017), and predicting market performance for products that are not yet available (Brooks and Lusk, 2010). By far, the majority of the studies of WTP have used contingent valuation, choice-based conjoint analysis, and auction methods. Among 116 studies of consumer WTP for organic foods reviewed by Hemmerling, Hamm, and Spiller (2015), 50 studies (43.1%) used contingent valuation and 44 (37.9%) used a choice-based conjoint analysis or an auction. Among 54 selected articles in a meta-analysis of animal welfare WTP by Clark et al. (2017), 50 (92.6%) used contingent valuation, choice-based conjoint analysis, or an auction. Most studies of WTP have used surveys and experiments to collect data since market data often are not readily available.

To minimize potential bias in these experiments and surveys, researchers have adopted several bias-correction techniques such as cheap talk (Cummings and Taylor, 1999) and a randomly drawn binding scenario (Lusk and Schroeder, 2004). These methods have significantly improved the accuracy of surveys and experiments, but concerns remain. There seems, for example, to be no consensus regarding how well cheap talk works in reducing hypothetical bias (Loomis, 2014), and biases arising from nonmonetary factors such as social desirability (Lusk and Norwood, 2009b,a;

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Norwood and Lusk, 2011), attribute nonattendance (Scarpa et al., 2009), and participation bias (Slonim et al., 2013) in surveys and experiments generally have not been addressed.

Few consumer WTP studies have been based on market data because such data can be difficult to obtain, but market-data studies are as important as studies based on surveys and experiments when examining consumer WTP premiums. Market data convey consumers' revealed preferences free from potential bias associated with experiments and thus serve as an important reference for evaluating the external validity of experimental results. When the results of experiments and analyses of market data do not align, it is difficult to determine which factor(s) led to the potential bias, but comparing the results provides implications for further research. Consider, for example, a case in which results from experiments and market data align in terms of WTP for product quality attributes (e.g., color, flavor) but do not align in terms of WTP for animal welfare attributes. In that case, social desirability bias should be considered. In addition, because of recruiting methods and sample size limitations, participants in experiments are not always representative of the population of interest.

In this study, we estimate consumer WTP using Nielsen Retail Scanner Data (NRSD) for three products—eggs, milk, and potatoes—and compare our estimates of WTP based on market data to estimates generated by experiments. These products were selected primarily because there are experiment-based studies available for comparison and the market data of these three products are measured in consistent quantity units. Other fresh foods (e.g., tomatoes), are measured in various ways in the NRSD; 39.7% of the data measure tomatoes as counts and the rest as ounces, so it would be difficult to convert measures for all types of tomatoes to a consistent unit from the available information.

We first conducted a comprehensive review of findings from experiments regarding U.S. consumer WTP published in the past 15 years (beginning in 2004) and focused on two widely studied attributes: (i) organic and (ii) those related to animal welfare. We then compared WTP values from the experiments to our estimates of WTP based on the NRSD. We were able to estimate WTP for the organic attribute for all of the three selected products and for cage-free and pasture-raised eggs as examples of WTP for animal welfare.

This study investigates whether estimates of WTP for organic and animal welfare attributes of fresh foods based on market data and on experiments align. Prior studies of U.S. consumers' WTP for organic and animal welfare attributes of foods have rarely found insignificant WTP. It remains unclear whether consumers are willing to pay price premiums for all organic products. In addition, several studies have questioned the external validity of the experiments used to estimate WTP for animal welfare because of potential social desirability bias (e.g., Norwood and Lusk, 2011). Comparing experimental results to results based on market data can provide useful information about whether consumers are willing to pay the premiums for animal welfare attributes. Last, consumer preferences can be affected by a store's design, ambient factors, and their perceptions of a store's reputation or image (Grewal et al., 1998; Baker et al., 2002). We thus explore whether store brand affects consumers' WTP premiums for organic products.

Background

We conducted a comprehensive review of experiment-based studies of U.S. consumer WTP that used either choice-based conjoint analysis or experimental auctions. We restricted the studies selected for comparison with our estimates to those in which the WTP premiums for organic and animal welfare attributes relative to conventional counterpart products were reported or could be derived. For example, some studies reported WTP premiums for the organic attribute compared organic products to "natural" products rather than to conventional products; these studies are excluded.

We did not include experiments that used contingent valuation since a meta-analysis by List and Gallet (2001) demonstrated systematic overstatements of WTP using that method and Diamond and Hausman (1994) found that WTP values conveyed by respondents in contingent valuation studies were not consistent with the consumer preferences suggested by economic theory.

In contrast, a meta-analysis by Murphy et al. (2005) demonstrated that choice-based conjoint analysis was effective in reducing bias,[1] and Carlsson and Martinsson (2001) found no significant differences between hypothetical choice experiments and nonhypothetical choice experiments. Lusk and Schroeder (2004) found that total WTP (as opposed to WTP premium) was upwardly biased in hypothetical choice experiments but that the marginal WTP (the difference in WTP for two products) was consistent. Yue and Tong (2009) examined hypothetical and nonhypothetical choice experiments and found a difference of 7.5%–9.0% in WTP, which is significantly less than the bias in most contingent valuation studies (List and Gallet, 2001). For experimental auctions, most of the recent studies were nonhypothetical and used actual products.

Table 1 presents the findings of the studies of WTP for organic products using choice experiments or auctions we have reviewed. Of the 13 studies, 6 used choice experiments and 7 used experimental auctions. Many of the studies estimated WTP for the organic attribute and other related attributes (e.g., antibiotic-free, all-natural, and free of genetically modified organisms). Most of the studies included consumer demographic characteristics as control variables. For those studies, we report only overall WTP for the entire sample with one exception: James, Rickard, and Rossman (2009), who distinguished between consumers who had never purchased organic products in the preceding year and those who had. We report only their estimates that excluded the nonpurchasers, as the WTP for organic products of nonpurchasers was nearly 0. A few other studies reported multiple estimates of WTP. Van Loo et al. (2011) estimated WTP for general organic chicken breasts and U.S. Department of Agriculture (USDA) certified organic chicken breasts; Yue and Tong (2009) estimated WTP for organic apples with different levels of cosmetic damage; and Gifford and Bernard (2011) estimated WTP for organic chicken before and after respondents were presented with information on standards for the "natural" and "organic" labels.

Naturally, the price scale and unit for different kinds of products vary. To facilitate comparison, Table 1 reports the estimated WTP premium in dollars and as a percentage of the premium of the base price. Whenever a study reported market prices for the conventional product, we used the conventional product market price as the base. For studies involving experimental auctions (with one exception), we used bids on the conventional products as base prices when market prices were not available. There is one exception: Costanigro et al. (2014) asked participants to bid on upgrades from conventional products, so the bids on the conventional product were not known.

Some of the studies that used choice experiments reported prices for conventional products (e.g., James, Rickard, and Rossman, 2009; Brooks and Lusk, 2010; Van Loo et al., 2011). When such prices were not reported, we obtained consumers' marginal utility for the conventional products from either the intercept for purchasing or the negative intercept for not purchasing, and we used the ratio of marginal utility from the attribute to marginal utility from the conventional product to derive the percentage WTP premium. Brooks and Lusk (2010) reported market prices for four types of milk with different fat percentages, and we used the median of those prices as the base.

Table 1 also reports hypothetical bias reduction approaches used in the experiment-based studies. All of the studies that used experimental auctions incorporated a randomly drawn binding scenario, and some of the studies that used choice experiments incorporated cheap talk (Van Loo et al., 2011), randomly drawn binding scenarios (Yue and Tong, 2009), or a combination of a hypothetical choice experiment and actual purchase data (Brooks and Lusk, 2010).

Table 2 summarizes the findings of the ten experiment-based studies of WTP for improved animal welfare and, as in Table 1, reports the premiums in dollars and as the premium percentages of base prices. Eight of those studies used choice experiments, and one (Elbakidze and Nayga, 2012) used an auction and a choice experiment. Attributes related to animal welfare for food products include production involving no antibiotics, recombinant bovine somatotropin (rBST), recombinant bovine growth hormone (rBGH), or crate/cage-free or pasture-access attributes and generic animal well-being certification.

[1] We refer to this type of research as a choice experiment.

Table 1. Experimental WTP Estimations for Organic Products

Authors	Method	Correction	Products	WTP Premium ($)	WTP Premium (%)
Bernard, Zhang, and Gifford (2006)	2nd-price auction	Draw binding	Potato chips	0.64	65.70
			Tortilla chips	0.42	28.40
			Milk chocolate	0.29	27.10
Bernard and Bernard (2009)	2nd-price auction	Draw binding	Milk	0.33	20.59
Hu, Woods, and Bastin (2009)	Choice experiment		Blueberry jam	0.67	11.96
			Blueberry-lime jam	0.52	17.69
			Yogurt	0.55	19.43
			Fruit rollups	0.30	24.00
			Dry muffin mix	0.18	4.35
			Raisin	0.41	7.95
James, Rickard, and Rossman (2009)	Choice experiment		Applesauce	0.35	20.00
Yue and Tong (2009)	4th-price auction	Draw binding	Apples	0.25–0.43	14–37
Yue and Tong (2009)	Choice experiment	Draw binding	Tomatoes	0.67	55.13
Brooks and Lusk (2010)	Choice experiment	Real purchase data	Milk	1.51	35.08
Bernard and Bernard (2010)	2nd-price auction	Draw binding	Potato	0.40	20.10
			Sweet corn	0.35	17.59
Gifford and Bernard (2011)	5th-price auction, before information	Draw binding	Chicken breasts	0.36	12.80
	5th-price auction, after information		Chicken breasts	0.42	14.80
Van Loo et al. (2011)	Choice experiment	Cheap talk	General organic chicken breast	1.19	34.80
			USDA certified organic chicken breast	3.55	103.50
Heng, Peterson, and Xianghong (2013)	Choice experiment		Eggs	0.10	3.72
Costanigro et al. (2014)	5th-price auction	Draw binding	Apples	0.68	
McFadden and Huffman (2017)	Random *n*th price	Draw binding	Apples	0.54	22.00
			Eggs	0.57	34.00
			Broccoli	0.52	30.00

Table 2. Experimental WTP Estimations for Animal Welfare Products

Authors	Method	Correction	Products	WTP Premium ($)	WTP Premium (%)
Lusk, Norwood, and Pruitt (2006)	Choice experiment	Actual purchase	Non-antibiotic pork	1.86	76.70
Lusk, Nilsson, and Foster (2007)	Choice experiment		Animal wellbeing certified pork	0.84	24.03
			Non-antibiotic pork	0.90	25.74
Bernard and	2nd-price auction	Draw	rBST-free milk	0.15	9.37
Bernard (2009)		binding	Antibiotic free milk	0.19	11.88
Tonsor, Olynk, and Wolf (2009)	Choice experiment	Cheap talk	Crate-free pork	2.11	59.77
Ubilava et al. (2010)	Choice experiment		Antibiotic-free pork	0.69	30.00
			Livestock well-being pork	0.99	43.04
Vander Naald and Cameron (2011)	Choice experiment		Humanely raised chicken breasts	0.34	12.93
Elbakidze and Nayga (2012)	2nd-price auction, before information	Draw binding	Humane animal care, ice cream	0.26	102.08
	2nd-price auction, after information		Humane animal care, ice cream	0.30	119.92
	Random *n*th price auction, before information		Humane animal care, ice cream	0.31	123.68
	Random *n*th price auction, after information		Humane animal care, ice cream	0.26	102.96
	Choice experiment, before information		Humane animal care, ice cream	0.61	244.40
	Choice experiment, after information		Humane animal care, ice cream	0.85	341.44
	2nd-price auction, before information		Humane animal care, cheese	0.33	65.92
	2nd-price auction, after information		Humane animal care, cheese	0.39	77.00
	Random *n*th price auction, before information		Humane animal care, cheese	0.23	46.16
	Random *n*th price auction, after information		Humane animal care, cheese	0.27	53.76
	Choice experiment, before information		Humane animal care, cheese	0.41	81.00
	Choice experiment, after information		Humane animal care, cheese	0.68	135.60

Continued on next page...

Table 2. – continued from previous page

Authors	Method	Correction	Products	WTP Premium ($)	WTP Premium (%)
Pozo, Tonsor, and Schroeder (2012)	Choice experiment		Crate-free pork	1.47	18.82
			Pasture access pork	1.53	19.59
			Antibiotic-free pork	1.62	20.74
Heng, Peterson, and Li (2013)	Choice experiment		Eggs, cage-free access to outdoor	0.21	7.81
			Eggs, cage-free no molting	0.49	18.22
Olynk Widmar and Ortega (2014)	Choice experiment	Cheap talk	Pasture access, ice cream	1.54–2.16	34–48
		attribute nonattendance	Antibiotic use, ice cream	1.02–2.27	23–51
			rbST/rbGH use, ice cream	1.00–2.35	67–52
			Pasture access, yogurt	0.47–0.63	63–84
			Antibiotic use, yogurt	0.48–0.69	64–92
			rbST /rbGH use, yogurt	0.36–0.61	48–81
			Pasture access, smoked ham	1.61–2.23	28–39
			Antibiotic use, smoked ham	2.18–2.92	38–50
			Individual crate/stall, smoked ham	0.89–1.04	15–18
			Pasture access, ham lunchmeat	1.78–1.98	26–29
			Antibiotic use, ham lunchmeat	1.59–1.95	24–29
			Individual crate/stall, ham lunchmeat	0.92–1.09	14–16

As with organic products, we report only estimates of WTP for animal welfare attributes for the entire sample with consumer demographics or backgrounds controlled. Most of the studies estimated WTP for animal welfare attributes for multiple products, but two presented multiple estimates for a single product. Pozo, Tonsor, and Schroeder (2012) designed six versions of a choice experiment and reported six estimates of WTP for a crate-free attribute, two for a pasture-access attribute, and two for an antibiotic-free attribute. Olynk Widmar and Ortega (2014) considered a correction for attribute nonattendance and estimated WTP for different levels of correction measured by coefficients of variation.

As shown in Table 1, the percentage WTP premiums for the organic attribute range from 3.72% to 103.5% with a mean of 26.8% and a median of 20.3%. The majority (about 70% estimations around the median) of the WTP premiums for organic products are 10%–40% of the base price.[2] The estimated percentage WTP premiums for the animal welfare attributes have a much wider range—from 7.81% to 341.44% with a mean of 61.3% and median of 40.8%.[3] This wide range is due in part to consumers' heterogeneous perceptions of the animal-welfare-related attributes. For

[2] For Yue and Tong (2009), we used the WTP estimates for apples without cosmetic damage.

[3] For Olynk Widmar and Ortega (2014), who reported results from multiple-choice experiment designs, we used WTP for the no-attribute nonattendance correction to maintain consistency with the other studies.

Table 3. WTP Premium Percentage for Organic vs. WTP Premium Percentage for Animal Welfare

	WTP Premium for Organic (%) All Studies	WTP Premium for Animal Welfare (%) All Studies	Excluding Antibiotic or rbST/rbGH Use	Excluding Elbakidze and Nayga (2012)	Excluding Antibiotic or rbST/rbGH Use and Elbakidze and Nayga (2012)
Min	3.72	7.81	7.81	7.81	7.81
1st QT	13.98	20.45	19.40	17.50	16.79
Mean	26.85	61.30	72.76	32.13	29.60
Median	20.35	40.78	49.96	24.89	24.03
3rd QT	33.00	76.78	102.30	44.28	40.78
Max	103.50	341.44	341.44	76.70	62.67

instance, some of the studies used broadly defined terms such as "animal well-being certified" (Lusk, Nilsson, and Foster, 2007) and "humanely raised" (Vander Naald and Cameron, 2011), while others used more concrete descriptions such as "crate-free" and "pasture access" in (Pozo, Tonsor, and Schroeder, 2012) and "access to outdoor" and "no molting" in (Heng, Peterson, and Xianghong, 2013).

Since production with no antibiotics and no rBST/rBGH are considered to be both animal welfare attributes and quality attributes associated with human health, it is useful to discuss those attributes separately. The percentage WTP premium for animal welfare from excluding no antibiotics or rBST/rBGH use has a mean of 72.76% and a median of 49.96%, and the distribution of the estimated WTP premiums is less concentrated than for the organic attribute. The interquartile range is 62.2% when including the percentage WTP premium for no antibiotics and no rBST/rBGH and 82.9% when excluding the percentage premium for no antibiotics and no rBST/rBGH. One study, Elbakidze and Nayga (2012), contributed a significant amount of the variation. When that study is excluded, the percentage WTP premiums for the animal welfare attributes have a mean of 32.1% and a median of 24.9% when WTP for no antibiotics and no rBST/rBGH use is included and a mean of 29.6% and a median of 24.0% when WTP for no antibiotics and no rBST/rBGH use is excluded. Table 3 summarizes these descriptive statistics. In sum, these descriptive statistics indicate that the premium consumers are willing to pay for animal welfare products is not smaller than the premium they are willing to pay for organic products.

In addition, there appears to be some inconsistencies in results between studies targeting the same product. Heng, Peterson, and Xianghong (2013) estimated rather small premiums for organic eggs while McFadden and Huffman (2017), estimated a premium of 34.0% ($0.57) for one dozen organic eggs. Gifford and Bernard (2011), using nonhypothetical auctions, estimated much smaller price premiums for organic chicken breasts than Van Loo et al. (2011), which used hypothetical choice experiments. And in studies of milk that used completely different approaches, Brooks and Lusk (2010) estimated the WTP premium to be about 14.5% higher than that estimated by Bernard and Bernard (2009). The inconsistencies in the results of prior studies are likely due to experimental setting, sample, and methodology differences. For example, McFadden and Huffman (2017) did not consider animal welfare attributes when estimating the WTP premium for organic attribute, while Heng, Peterson, and Xianghong (2013) estimated WTP for organic attribute with animal welfare attributes and Pozo, Tonsor, and Schroeder (2012) demonstrated that the combination of attributes has an impact on WTP estimations.

This study certainly is not the first estimation of consumer WTP premiums using market data. Allender and Richards (2010) estimated WTP for egg attributes, including organic and cage-free, using the Nielsen Homescan database and a discrete choice model. Andersen (2011) used the GfK-Denmark household grocery consumption panel, a household-level panel, and estimated consumer WTP for egg attributes using a discrete choice model. Chang, Lusk, and Norwood (2010) predicted

WTP for egg attributes using Information Resources Inc.'s retail scanner data and a hedonic price model.

Our study differs from the previously mentioned studies in two respects. First, we estimate consumer WTP based on the methods proposed by Berry (1994) and Berry, Levinsohn, and Pakes (1995) (hereafter referred to as the BLP method) to address the problem of unobservable product characteristics and endogeneity of prices. Second, unlike Chang, Lusk, and Norwood (2010), who used hedonic prices, we use the BLP method, which is similar to the random utility-based discrete choice approaches used in most WTP experiments. This approach utilizes not only information related to price and product characteristics but also market shares, which represent consumers' choices given the products' prices. The BLP method is the state-of-art approach in estimating demand for differentiated products; to reduce the computational burden, we estimate mean WTP for representative consumers at each store and form a nonparametric WTP distribution. The panel feature and the large number of stores included in the NRSD allow us to take this approach. We further discuss the BLP method and estimation procedure used in this study in the method section.

Data

This study uses Nielsen retail scanner datasets licensed via the Kilts Center for Marketing at the University of Chicago Booth School of Business.[4] The NRSD report weekly weighted-average unit prices and total sales volumes for products defined by the Universal Product Codes (UPCs) at the store level. Multiple datasets can be linked together to compute information such as market share and unit price. In terms of market shares and product characteristics, the basic product information dataset provides the number of packages sold for a given UPC-defined product and the number of units in one package. This basic product information is available for all products sold and can be linked to weekly price and sales data via the UPC. Therefore, by combining information on sales volumes and package sizes, we can calculate the total number of units sold weekly, the market share obtained by each UPC-defined product, and unit prices (adjusted to 2006 U.S. dollar values). The Nielsen data also provide information on additional product attributes that can be linked to prices and volumes via UPCs, including the key product attributes for this study, such as organic, or animal welfare (i.e., cage free, pasture raised). However, not all products have a match in the additional attribute data.

Each store in the Nielsen data is identified by a unique store code. A store file that provides the store's characteristics can be linked to the prices and sales data via the store code. The NRSD dataset identifies the type of stores (e.g., convenience stores, drug stores, mass merchandisers, food stores). Each store has a parent and is assigned a parent code that identifies the store brand or chain.[5] The key store information required for this study was the stores' locations in terms of Nielsen's designated market areas (DMAs), geographic areas updated by Nielsen that define television markets. We used the DMA information to identify the endogeneity of prices.

We selected chicken eggs (quail eggs were excluded), regular milk products (flavored milks and other milk-related drinks were excluded), and all potatoes other than sweet potatoes for analysis. We used NRSD data for 2011 through 2017 because few egg products in the dataset were identified as cage free or pasture raised prior to 2011. Since most product brands have multiple UPC-defined products, we included product brand as an attribute. For potatoes, organic and USDA-certified organic are the key product attributes. For eggs, in addition to organic and USDA-certified organic,

[4] Disclosure statement by The Nielsen Company regarding use of these datasets: "Researcher(s) own analyses calculated (or derived) based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researcher(s) and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein."

[5] According to the NRSD documentation, a store parent is either (i) the corporate parent (when the company centralizes its data releases to Nielsen across all of its retail brands) or (ii) the retail banner of the store (when the company decentralizes its data releases to Nielsen through multiple data centers representing each retail banner).

we included egg size, egg color, cage-free, and pasture-raised as attributes. For milk, in addition to organic and USDA-certified organic, we included fat content (whole milk, 2% low fat, 1% reduced fat, and fat-free), whether it was vitamin added, and container type (glass, plastic, carton). To ensure that the targeted specialty products were available for consumers to choose in addition to the conventional products, we only used markets (defined as a store by week) in which organic potato and milk products were available (had nonzero market share) and both organic and cage-free eggs were available.[6] The final sample provided 22,083,481 observations for potatoes, 12,301,734 observations for eggs, and 103,235,716 observations for milk. Each observation consisted of the brand, market share, price, and product attribute by store by week. To capture WTP premium trend across years, we obtained annual point estimates for each store in each year to construct the WTP premium distribution.

Method

This study employs a variation of the BLP method proposed by Berry (1994) and Berry, Levinsohn, and Pakes (1995). The BLP method is a random utility-based discrete choice model, which is the same approach used in most of the experiment-based studies, and requires only the market share, price, and attributes of each product, which are provided in the NRSD. The BLP method also allows for the correction of price endogeneity. However, to estimate the random parameter logit model using the standard BLP procedure, one must repeatedly evaluate a contraction mapping to solve the inverse market share equation, which is not practical for more than a few million observations. The following subsection discusses the method used in this study to reduce the computational burden while allowing for the estimation of WTP distributions.

BLP Method

We followed the notation and estimation strategies summarized by Nevo (2000). We assume that consumer i obtains indirect utility from choosing product j at market t:

$$u_{ijt} = \alpha_i (y_i - p_{ijt}) + x_{jt}\boldsymbol{\beta}_i + \xi_{jt} + \varepsilon_{ijt}, \tag{1}$$

in which y_i is consumer i's income, p_{ijt} is the price of good j in market t, and price is the unit price defined as total revenue divided by total quantity (e.g., the price per egg). We adjusted the prices to 2006 U.S. dollars using the Consumer Price Index from the U.S. Bureau of Labor Statistics. In the function, x_{jt} and ξ_{jt} are observed and unobserved product characteristics or market-specific shocks, ε_{ijt} is the random utility error term (assumed to be type-I extreme-value distributed), α_i is consumer's marginal utility from income, and $\boldsymbol{\beta}_i$ is a vector of marginal utility from product attributes.

Because ε_{ijt} is type-I extreme-value (Gumbel) distributed, the probability of consumer i choosing product j (McFadden, 1973) is

$$s_{ijt} = P_{it}\left(u_{ijt} \geq \max_{k=\{1,\ldots,J\}} u_{ikt}\right) = \frac{exp\left(v_{ijt}\right)}{1+\sum_{k=1}^{J} exp\left(v_{ikt}\right)}; \tag{2}$$

$$v_{ijt} = -\alpha_i p_{jt} + x_{jt}\boldsymbol{\beta}_i + \xi_{jt}; \tag{3}$$

or, equivalently,

$$v_{ijt} = \delta_{jt} + \mu_{ijt}; \tag{4}$$

$$\delta_{jt} \equiv -\alpha p_{ijt} + x_{jt}\boldsymbol{\beta} + \xi_{jt}. \tag{5}$$

[6] It is possible that organic and/or cage-free eggs were available in some markets that reported no sales of them in a given week. However, we could not distinguish none sold from not available. We thus defined available as having a nonzero market share.

In this specification, J is the number of choices of market t, δ_{jt} is the mean utility of all consumers for product j, and μ_{ijt} is the consumer's specific utility. Consumers can choose outside goods, and the utility of outside goods is normalized to 0. Parameters α_i and β_i are consumer i's specific price and taste parameter and are assumed to follow a distribution with a probability function of $F(\alpha,\beta|\theta)$. The aggregated market share of each product is thus

$$s_{jt} = \int s_{ijt} dF(\alpha,\beta|\theta), \tag{6}$$

where $F(\alpha,\beta|\theta)$ is the joint probability function of α_i and β_i, and θ is the distribution parameter of α_i and β_i. For example, assuming α_i and β_i are normally distributed, θ includes the mean and variance–covariance matrix of α_i and β_i. In practice, this equation is approximated by

$$s_{jt} \approx \frac{1}{R}\sum_{r=1}^{R} s_{rjt}, \tag{7}$$

in which s_{rjt} is the estimated market share of choosing product j given rth draw of actualized random taste from distribution $F(\alpha,\beta|\theta)$. The parameters α, β, and θ are estimated to fit observed market shares as closely as possible. This process is achieved using the generalized method of moment (GMM), and the GMM estimator allows us to combine the instrument variables (IVs). For the set of IVs Z, the expected value $E[Z'\xi_{jt}] = 0$. However, there is no analytical solution to $E[Z'\xi_{jt}]$ and the BLP method can estimate it by constructing a contraction mapping:

$$\delta' = \delta + (\ln(\mathrm{S}) - \ln(\mathrm{s})), \tag{8}$$

where S is the actual market share observed, s is estimated market shares using equation (7), and δ' is the next iteration of mean utility after δ beginning from some arbitrary value. This approach is referred to as the nested fixed-point (NFP) algorithm (e.g., Dubé, Fox, and Su, 2009). To facilitate convergence of the GMM's objective function, the contraction mapping function (equation 8) must be evaluated every time parameter θ is adjusted; in other words, contraction mapping is nested in the GMM objective function minimization. This process is not practical for high dimensions, especially with several million observations, because each iteration of contraction mapping in equation (8) takes a long time to converge.[7]

Instead of adopting the NFP algorithm, we estimate the representative consumer's price and taste parameter distributions. We assume that the representative consumer has mean utility δ_{jt} and do not further assume the distribution of the parameters and set $\mu_{jt} = 0$. Suppose, for a given store, k, we obtain the mean utility of the representative consumer and prepare a set of IVs represented by Z that are correlated with price while uncorrelated with the error term ξ_{jt}. We then estimate the coefficient of price as

$$\delta_{jt} = \alpha_k p_{jt} + d_{jt} + \xi_{jt}, \tag{9}$$

where d_{jt} is a set of UPC-defined product dummies and thus

$$(\alpha_k, d_j) = \left((p_{jt},d_{jt})'Z(Z'Z)^{-1}Z'(p_{jt},d_{jt})\right)^{-1}\left((p_{jt},d_{jt})'Z(Z'Z)^{-1}Z'\delta_{jt}\right), \tag{10}$$

in which (α_k, d_j) is the two-stage least squares estimator. The estimated coefficient of d_j is the mean utility of product j. By including product dummies as covariates that control for unobservable product characteristics, the error term ξ_{jt} is now product–market specific. We can thus recover the marginal utility of attributes, β_k, as

$$\beta_k = \left(X'V_d{}^{-1}X\right)^{-1}\left(X'V_d{}^{-1}d_j\right), \tag{11}$$

[7] Knittel and Metaxoglou (2014) also questioned the robustness of the NFP algorithm. However, for this study, the very large dimensionality of the data is the major factor that prevents NFP from being feasible.

where V_d is the variance–covariance matrix of the coefficients of $\{d_j\}_{j\in 1,\ldots,J}$ estimated from equation (10), X is a set of product attributes that include the brand dummies, and β_k is the generalized least square estimator weighted by the variance–covariance of product utility. This process is discussed in Nevo (2000). To obtain the distribution of α_k and β_k, we estimate equations (10) and (11) for each store k by year.

Finally, representative consumer k's WTP for attribute x when referring to the cage-free or pasture-raised attribute is defined as

$$WTP_x = -\beta_x/\alpha \tag{12}$$

and WTP for a product with USDA organic certification on the package[8] is

$$WTP_{USDAORG} = -\left(\beta_{ORG} + \beta_{USDAORG}\right)/\alpha. \tag{13}$$

In other words, WTP for USDA-certified organic is the sum of WTP for organic and additional WTP induced by USDA certification on the package.

In the first stage of our analysis (equation 10), we consider only markets in which organic milk and potato products and markets in which both organic and cage-free eggs are available. Because of a small number of outlier prices (such as, price of \$0.01[9] and a price that was ten times higher than the median price), we used only observations for which prices were within 95th percentiles around the median.[10] We also confirmed that this restriction did not significantly affect our estimation results. Further, product attribute X in equation (11) included a set of brand dummy variables to control for brand-specific characteristics.

Two approaches can be used to obtain mean utility δ_{jt}. First, we can use contraction mapping (equation 8) to solve for δ_{jt} for each product. Alternatively, we can set $\mu_{jt} = 0$ so that $\delta_{jt} = \log\left(S_{jt}\right) - \log\left(S_{0_{jt}}\right)$, where $S_{0_{jt}}$ is the market share of outside goods (goods without product attribute information in the NRSD). The first approach normalizes the utility of nonpurchase to 0, the second normalizes the utility of outside goods to 0. To maintain consistency in the results, we use the second approach for all three products since—when the number of stores by year is very large, as is the case for milk—evaluating contraction mapping for all stores becomes computationally burdensome.

Identification

Given our estimation method, a set of appropriate exogenous variables, Z in equation (10), is required. We use the panel feature of the NRSD to construct the IVs and assume that the product attributes are predetermined and thus exogenous. Exogeneity of product attributes is also an assumption in Berry, Levinsohn, and Pakes (1995). With the predetermined attributes, stores and consumers interactively reach market equilibrium by adjusting price. Thus, price is likely to be endogenous, as it includes both marginal cost and market specific markups. Since equation (10) includes a dummy for UPC-defined products, the unobservable product characteristics are controlled, and the error term should be interpreted as unobservable market conditions. Assuming that conditions in two distant markets are independent, average prices for stores in different DMAs would be correlated with the product marginal cost and uncorrelated with unobservable market-specific conditions. Nevo (2001) used the average price for stores in different markets as an IV. Since the product attributes are assumed to be exogenous, the product dummy

[8] Throughout the paper, we refer to products with USDA organic certification on the package as USDA-certified organic. All organic products sold in the United States must follow USDA's organic standards, but they do not all list USDA certification on the package.

[9] The Nielsen scanner datasets do not allow a price of \$0 so a \$0.01 price indicates a potential imputed price of \$0.

[10] In other words, the observations have matched product characteristics, but those with prices lower than the 0.025 percentile and higher than 0.975 percentile are considered to be outliers.

Table 4. Summary Statistics, Price and Type of Products

Panel A. Egg	Conventional	Organic	USDA Organic	Cage-Free	Pasture-Raised
No. of products	1,006	206	163	250	53
Percentage	83.00	17.00	13.45	20.63	4.37
Price					
1st QT	0.204	0.320	0.320	0.258	0.307
Mean	0.239	0.357	0.359	0.300	0.372
Median	0.242	0.369	0.371	0.312	0.365
3rd QT	0.277	0.414	0.417	0.353	0.408

Panel B. Milk	Conventional	Organic	USDA Organic
No. of products	2,268	910	719
Percentage	71.37	28.63	22.62
Price			
1st QT	0.036	0.052	0.052
Mean	0.049	0.058	0.058
Median	0.048	0.057	0.057
3rd QT	0.056	0.064	0.064

Panel C. Potato	Conventional	Organic	USDA Organic
No. of products	1,090	267	233
Percentage	80.32	19.68	17.17
Price			
1st QT	0.552	0.838	0.840
Mean	1.270	1.083	1.096
Median	1.370	1.245	1.278
3rd QT	2.004	1.386	1.390

variable is also a candidate for use as an IV, representing a nonparametric approach for using all product attributes (Nevo, 2000). To ensure adequate variation in average weekly prices, we use the average price in other DMAs for the same product in the same week and a set of UPC-defined product dummies as IVs.

Results

We included all store chains in the NRSD for each product in our analysis. Due to the varying availability of products in each store, the number of stores that contribute to the estimation of each product varies. Additionally, some stores lacked an adequate number of observations after we restricted the data to weeks when both organic/animal-welfare and conventional products were available, and other stores lacked adequate variation in product attributes. Therefore, the actual number of stores that contributed to the parameter distributions also varied. The summary tables report the number of stores that contributed to each distribution.

Table 4 provides summary statistics for the product attributes and prices. A product is identified as organic when it has USDA or a third-party organic certification on package. Most of the organic products analyzed had USDA certification on their packages—79.13% for organic eggs, 87.27% for organic potatoes, and 79.01% for organic milk—and thus our organic WTP premium presents the premium induced by USDA organic certification on the package.

The prices reported in Table 4 are weekly averages calculated as the ratio of total revenue to total sales volume by week and store and adjusted to 2006 U.S. dollars and are expressed as per egg, per ounce of milk, and per pound of potatoes. The table shows that organic eggs and organic milk are consistently higher in price than their nonorganic counterparts. Specifically, both organic products have higher first-, second-, and third-quantile and mean prices compared to the conventional counterparts. However, that pattern is not observed for potatoes. Organic potatoes have a higher first-quantile and mean price but not a higher median or third-quantile price.

Figure 1 presents price distributions for the organic and nonorganic egg, milk, and potato products. We find that prices for organic eggs and milk are shifted to the right compared to prices for the nonorganic products, and the Mann–Whitney test confirms the shift is significant at the 1% significance level. However, for potatoes, the relationship is reversed. The Mann–Whitney test suggests that the price of nonorganic potatoes is shifted to the right compared to the price of organic potatoes, and the shift is significant at the 1% level. Further, the price distributions shown in Figure 1 and Table 4 indicate that the differences in price between organic and nonorganic products are highest for eggs; the median organic egg price is 52.04% higher than the median price for nonorganic eggs. The differences in median prices for milk and potatoes are significantly smaller at 19.36% and −7.18%, respectively.

To recover the consumer's utility, we require information about the products' market shares. Figure 2 presents market share distributions for the three products. We find that the market share distribution of nonorganic eggs is shifted to the right compared to the distribution for organic eggs. However, the market share distributions for organic and nonorganic milk and potatoes are almost identical.[11] When we combine the price distributions with market share distributions, we should find that consumers are not likely to be willing to pay a significant premium for organic potatoes.

We next present estimated consumer WTP for the products. Since the estimated distribution is nonparametric, we use Mann–Whitney tests of significance and summarize the median and mean values. The magnitude of mean utility, $\delta_{jt} = \log\left(S_{jt}\right) - \log\left(S_{0_{jt}}\right)$, varies by markets and thus we focus on the WTP estimates, which represent the marginal utility of the attributes normalized with respect to the marginal disutility of the prices. To eliminate the influence of a small number of outliers, we evaluated the mean WTP values from middle-90% point estimations around the median.

We focus first on WTP for eggs, which allows us to estimate both organic and animal welfare attributes (cage-free and pasture-raised). Panel A of Table 5 summarizes those coefficients and WTP estimates in terms of the minimum, first quantile, median, mean, third quantile, maximum, *p*-value from two-tail Mann–Whitney tests, and the number of stores used in the estimation (*N*).

The median WTP premium for organic eggs (labeled as USDA-certified) is \$0.034 per egg (\$0.41/dozen). Given that the median market price for conventional eggs was \$2.66/dozen, the estimated WTP premium percentage for organic eggs is 15.32%. This premium is smaller than the one calculated by McFadden and Huffman (2017), who estimated a \$0.57 price premium per dozen eggs. However, there is no evidence that McFadden and Huffman overestimated the premium. They estimated a mean WTP premium, and the overall mean WTP premium for organic eggs in our analysis is about \$0.50. After adjusting the \$0.50 WTP premium to the year of their experiment (2013), we find that our WTP premium is roughly \$0.58, which is quite close to their estimate.[12] Also, we observed that some store chains, such as those with a parent code of 32, one of the largest food store chains in the dataset in terms of the number of stores, reported higher WTP premiums for the organic attribute. Panel B in Table 5 summarizes the estimated distribution for the stores with parent code 32. In that case, the estimated median and mean WTP premiums for organic eggs are 0.040 per egg (\$0.48/dozen) and 0.052 per egg (\$0.62/dozen), respectively. Thus, McFadden and

[11] The market share density has a long tail, so we restricted the graphs to density functions that are distinguishable from the *x*-axis.

[12] When we use our estimates for 2013 to match McFadden and Huffman (2017), our median WTP premium for organic eggs is \$0.033/ounce and \$0.46/dozen in 2013 U.S. dollars. The median premium for organic eggs for store 32 is \$0.040, which equates to \$0.55/dozen in 2013 U.S. dollars and is also quite close to McFadden and Huffman's estimate.

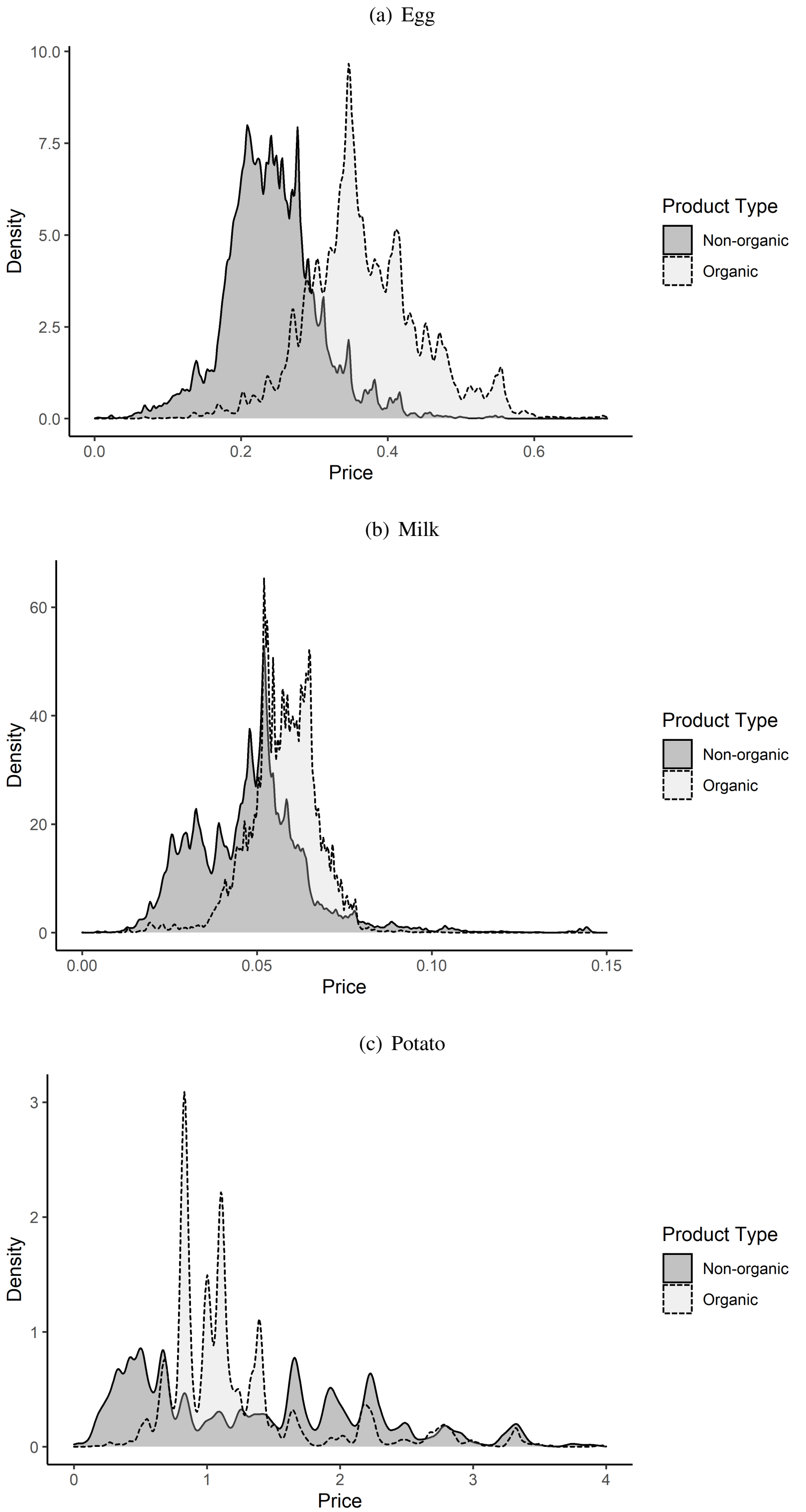

Figure 1. Price Density

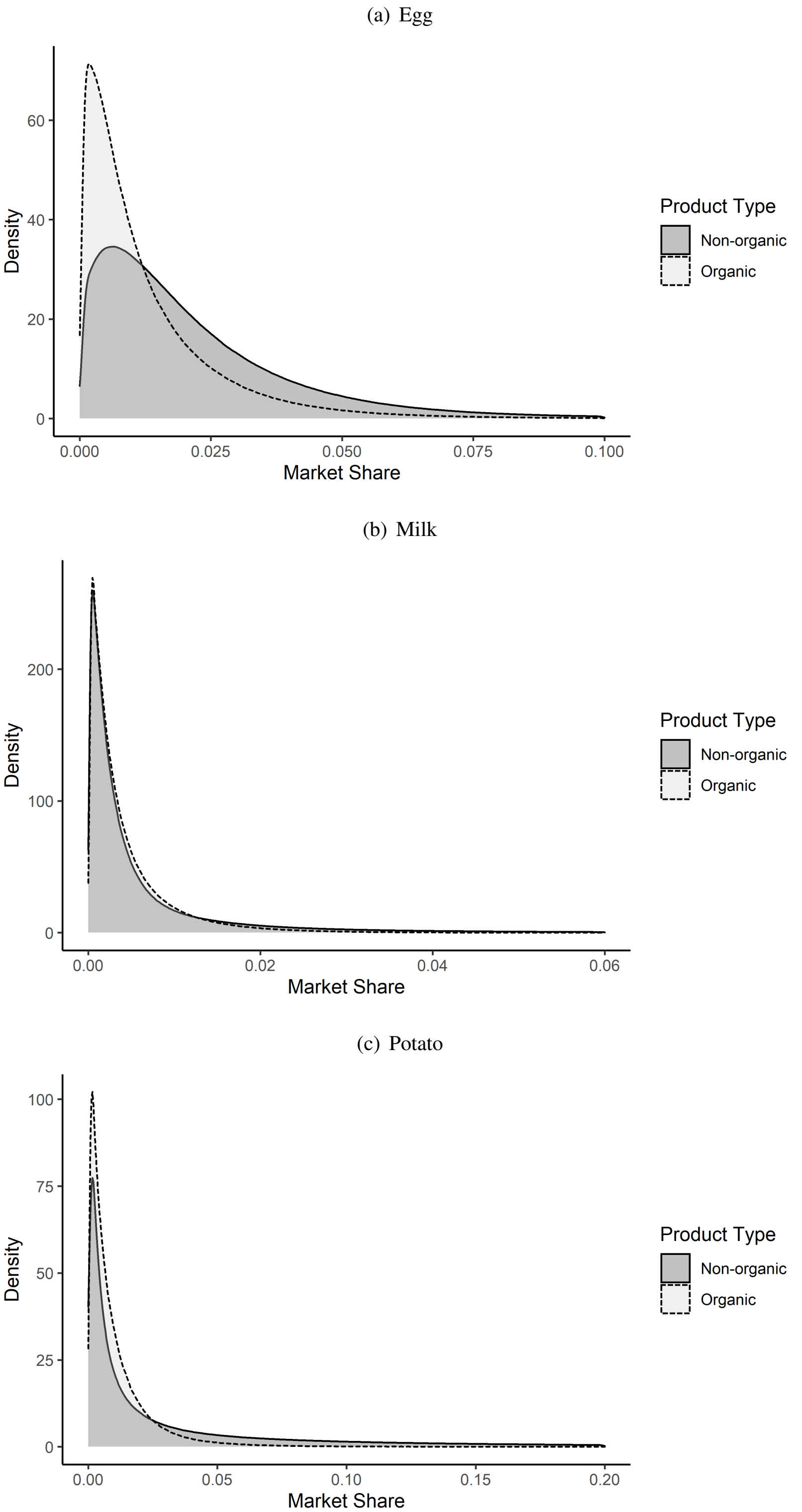

Figure 2. Market Share Density

Table 5. BLP Estimation Results per Egg

Panel A. Sample: All Food Chain Stores	1st QT	Median	Mean	3rd QT	p-Value	N
Coefficients						
Intercept	−4.805	−3.054	−3.083	−1.319	0.000	46,889
Price	−10.961	−4.568	−5.093	0.597	0.000	47,877
Organic	−0.402	0.284	0.283	1.020	0.000	46,597
USDA organic	−0.766	−0.195	−0.085	0.481	0.000	16,272
Cage-free	−0.650	−0.063	−0.118	0.453	0.000	45,607
Pasture Raised	−1.368	−0.177	−0.324	0.622	0.000	6,231
WTP						
Organic (with USDA certification)	−0.028	0.034	0.039	0.108	0.000	46,597
Cage-free	−0.062	0.004	0.001	0.067	0.000	45,607
Pasture raised	−0.208	−0.017	−0.042	0.112	0.000	6,231

Panel B. Sample: Parent Code 32	1st QT	Median	Mean	3rd QT	p-Value	N
Coefficients						
Intercept	−4.697	−2.929	−3.171	−1.513	0.000	4,888
Price	−10.240	−5.022	−5.114	−0.587	0.000	4,928
Organic	−0.382	0.198	0.172	0.746	0.000	4,776
USDA organic	−0.472	0.051	0.110	0.624	0.000	2,504
Cage-free	−0.593	−0.046	−0.093	0.456	0.000	4,641
Pasture-raised	−1.125	−0.353	−0.331	0.468	0.000	971
WTP						
Organic (with USDA certification)	−0.016	0.040	0.052	0.112	0.000	4,776
Cage-free	−0.055	0.011	0.021	0.085	0.000	4,641
Pasture raised	−0.136	−0.012	0.002	0.126	0.276	971

Notes: Estimated year by year from 2011 to 2017; results are pooled.

Huffman's estimate falls between the mean and median WTP premiums at stores with parent code 32.

The estimated WTP premium for cage-free eggs is marginal. Besides, the first quantile, median, and third quantile clearly show that overall WTP for organic eggs is shifted to the right of overall WTP for cage-free eggs. The Mann–Whitney test confirms that the organic premium distribution is shifted to the right relative to the distribution for cage-free and pasture-raised eggs. Even for the stores with parent code 32, in which consumers are willing to pay more than the average premium for organic eggs, the premiums for cage-free and pasture-raised eggs are still small or insignificant. Figure 3(a) compares the WTP premiums for organic and cage-free eggs by year and indicates that the higher premium for organic eggs is robust for all years. This finding differs from the pattern identified by Heng, Peterson, and Xianghong (2013), who found that WTP for products animal-welfare attributes was not smaller than WTP for organic products. The market data used in our analysis indicate that consumers have no strong incentive to pay a price premium for improved animal welfare.

Panel A in Table 6 presents the results of our overall estimates of WTP premiums for milk. The median premium is \$0.008/ounce (\$1.024/gallon). Since the median market price for conventional milk (not organic, no vitamins added) is \$5.82/gallon, the premium percentage is 17.56%. On the other hand, the mean WTP premium for organic milk is about \$1.54/gallon. Our median estimate falls between the results of Bernard and Bernard's (2009) estimated \$0.33 premium per half-gallon and Brooks and Lusk's (2010) estimated premium of \$1.51/gallon, while our mean estimate is

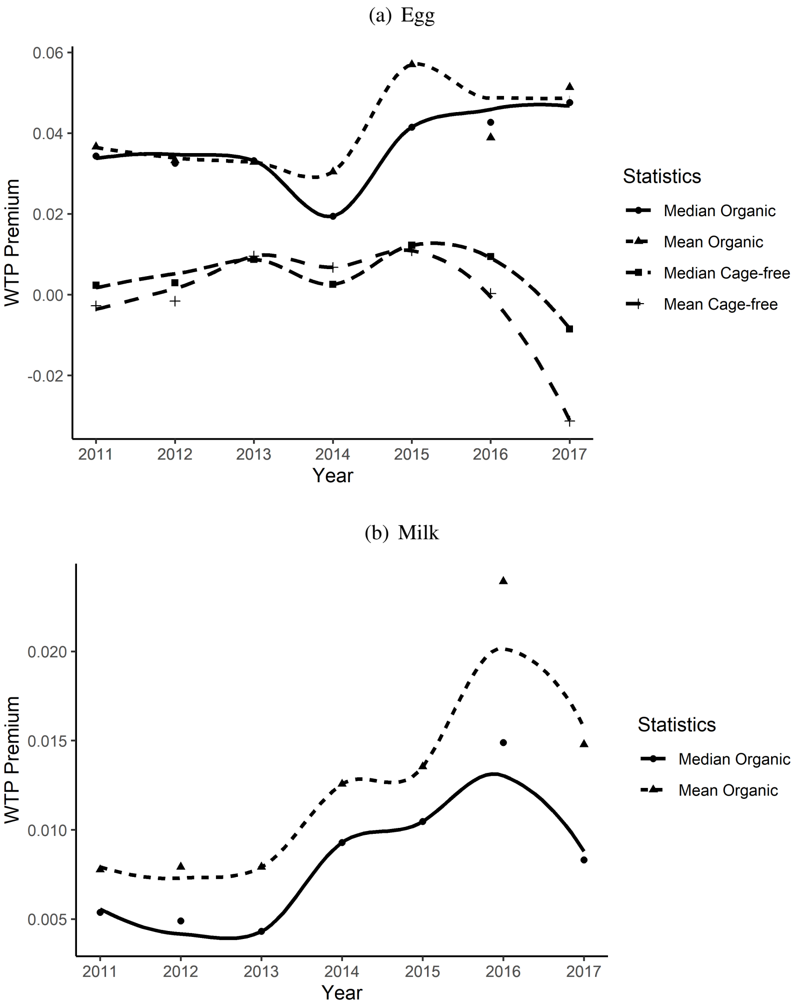

Figure 3. Estimated WTP by Year

slightly higher than that in Brooks and Lusk (2010).[13] Since Brooks and Lusk combined choice experiments with market data, it is not surprising that our results are similar to theirs. Figure 3(b) compares our estimates of the organic premium by year and shows that the premiums in 2014–2017 were higher than the premiums in earlier years (2011–2013). Our slightly higher estimated premium could be due to changes in consumer preferences over time. For vitamin-added milk, the median premium is approximately the same as and the mean premium is slightly less than the premiums for organic milk.

Stores with a parent code of 32 reported greater WTP premiums for organic milk as well. As shown in Panel B of Table 6, the overall median WTP premium for those stores is approximately \$0.015/ounce (\$1.92/gallon), and the premium for organic milk is higher than the premium for vitamin-added milk. In fact, the mean and median premiums are much higher than the premiums estimated in Bernard and Bernard (2009) and Brooks and Lusk (2010).

Our estimates of premiums for potatoes suggest that consumers are not always willing to pay a significant price premium for an organic product. As shown in Figure 1(c), unlike the distributions for organic eggs and milk, the price distribution for organic potatoes does not shift to the right of the

[13] Brooks and Lusk (2010) conducted the experiment in 2008. When adjusted to 2008 U.S. dollars, the mean WTP premium is \$1.64/gallon, which is 8.61% higher than their estimate.

Table 6. BLP Estimation Results for Milk (per ounce)

Panel A. Sample: All Food Chain Stores	1st QT	Median	Mean	3rd QT	*p*-Value	*N*
Coefficients						
Intercept	−5.453	−4.029	−4.050	−2.540	0.000	57,088
Price	−49.315	−28.502	−28.229	−8.512	0.000	57,557
Vitamin added	0.148	0.413	0.434	0.708	0.000	42,012
Organic	−0.226	0.489	0.528	1.244	0.000	57,064
USDA organic	−0.372	0.015	0.096	0.503	0.000	30,852
WTP						
Vitamin added	0.000	0.008	0.010	0.019	0.000	42,012
Organic (with USDA certification)	−0.008	0.008	0.012	0.031	0.000	57,064

Panel B. Sample: Parent Code 32	1st QT	Median	Mean	3rd QT	*p*-Value	*N*
Coefficients						
Intercept	−4.999	−3.726	−3.708	−2.377	0.000	5,668
Price	−50.086	−29.758	−32.136	−13.526	0.000	5,670
Vitamin added	0.194	0.398	0.410	0.613	0.000	5,567
Organic	0.169	0.703	0.705	1.237	0.000	5,667
USDA organic	−0.264	0.070	0.121	0.467	0.000	3,006
WTP						
Vitamin added	0.001	0.008	0.011	0.018	0.000	5,567
Organic (with USDA certification)	0.000	0.015	0.020	0.036	0.000	5,667

Notes: Estimated year by year from 2011 to 2017; results are pooled.

Table 7. BLP Estimation Results for Potato (per pound)

Panel A. Sample: All Food Chain Stores	1st QT	Median	Mean	3rd QT	*p*-Value	*N*
Coefficients						
Intercept	−3.232	−2.381	−2.252	−1.400	0.000	32,058
Price	−2.462	−0.958	−1.136	0.209	0.000	32,076
Organic	−1.390	−0.863	−0.856	−0.322	0.000	32,054
USDA organic	−0.381	−0.038	−0.037	0.309	0.000	17,570
WTP						
Organic (with USDA certification)	−0.546	−0.101	−0.237	0.077	0.000	32,054

Panel B. Sample: Parent Code 32	1st QT	Median	Mean	3rd QT	*p*-Value	*N*
Coefficients						
Intercept	−2.914	−2.305	−2.250	−1.604	0.000	4,364
Price	−1.426	−0.351	−0.495	0.841	0.000	4,369
Organic	−1.212	−0.766	−0.762	−0.311	0.000	4,363
USDA organic	−0.182	0.088	0.068	0.338	0.000	2,281
WTP						
Organic (with USDA certification)	−0.388	−0.004	−0.093	0.204	0.000	4,363

Notes: Estimated year by year from 2011 to 2017; results are pooled.

distribution for conventional potatoes. Panel A of Table 7 presents our estimates of WTP premiums for potatoes. The mean and median premiums indicate that consumers are not willing to pay more for organic potatoes than for conventional ones. This holds for stores with parent code 32 as well, as shown in Panel B.

Discussion and Conclusions

In this study, we conducted a comprehensive review of studies that estimated WTP premiums for organic and animal welfare attributes using experiments and compared those results to our estimates using NRSD market data. We do not draw causal conclusions that the discrepancies between experiment-based results and our market-data based estimates are due to certain type of biases. We find that the WTP premium estimated for organic eggs is consistent with experimental results. In contrast, the estimated WTP premiums for animal welfare attributes (cage-free and pasture-raised eggs) are significantly less than experimental findings. The results suggest the importance of considering biases (e.g., social desirability bias) when estimating the price premium for animal welfare attributes in experiments.

Signaling little interest in animal-welfare-friendly attributes goes against social norms. However, many researchers have found that beliefs about organic foods as healthier primarily motivate consumers' purchases of organic products (Padel and Foster, 2005; Hughner et al., 2007). Though organic tends to be viewed as environmentally friendly and socially favorable because it is associated with less use of chemicals and pesticides (Jolly, 1991; Ott, 1990; Wilkins and Hillers, 1994), it is less relevant to egg production, and research has shown that environmental concerns are less likely to be the driving force of organic product purchase compared to health and taste concerns (Zanoli and Naspetti, 2002; Magnusson et al., 2003).

We also find that the presence of the organic attribute does not necessarily always lead to price premiums. Our analysis of potatoes indicates that consumers generally are not willing to pay a significant premium for the organic version. This finding is at odds with the results of most of the experiment-based studies.

Some of the discrepancies between prior results based on experiments and our results based on nationally representative market data are likely due to the experiment samples' representativeness and/or different shopping-decision contexts (such as perceived store image and store environments). We find that stores identified by code 32 reported consistently higher WTP premiums for organic products for eggs and milk. This greater WTP may be related to organic consumers preferring particular chains of stores and/or store characteristics inducing higher premiums for organic products. As noted by Levitt and List (2007), experimental economic studies should look beyond monetary incentives and take factors such as "the context in which the decision is embedded" into account. Future research can consider the impacts of shopping contexts on consumers' WTP premiums and the store-choice decision-making process.

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