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The Organic Food Price Premium and its Susceptibility to News Media Coverage: Evidence from the U.S. Milk Industry

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Abstract

This paper investigates the extent to which media coverage on organic dairy issues influences consumers' willingness to pay (WTP) for the organic attribute of milk. We find that news with contents most often viewed as negative toward organic dairy are more powerful in decreasing consumers' WTP for the organic attribute of milk compared to the positive WTP impact of news articles with contents most often viewed as positive toward organic dairy. Interestingly, consumers' increasing exposure to organic dairy news that even take a neutral stance on the organic attribute also increases their WTP for the organic attribute.

Keywords: Organic Food; Organic Price Premium; Newspaper Coverage; Milk Industry

JEL classification codes: L13; L15; Q00; M30; L82; D10

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1. Introduction

Consumer demand for organic food has been growing very fast in recent years. According to Organic Trade Association (OTA), the U.S. sales of organic food increased from $17 billion in year 2007 to $44 billion in year 2016. The annual growth rate of organic food sales reached 8.4 percent in 2016, handily outpacing the stagnant 0.6 percent grow rate of overall U.S. food market sales. The organic sector now accounts for almost 5.3 percent of total food sales in the United States, and its market share is expected to continue to expand over the next few years.[1]

The burgeoning consumer interest in organic commodities and the associated substantial market opportunities available have urged economic researchers to study the driving forces behind this growing segment of markets. There are a variety of reasons for the growing popularity of organic food, one being that more and more consumers are becoming aware of the benefits of eating organic food. Compared with conventionally-grown food, organic food is grown or processed with less or no use of pesticides, antibiotics and growth hormones. "People with allergies to foods, chemicals, or preservatives often find their symptoms lessen or go away when they eat only organic foods. Besides, organic farming practices are better for the environment as they reduce pollution, conserve water and increase soil fertility." [2] As people learn more about the benefits of consuming organic food on health as well as the environment, they are more likely to purchase from the organic sector. Furthermore, consumers' perception of the marginal quality difference between organic and conventional products allows firms to charge a price premium associated with the perceived quality difference.

In this paper, we address the question of how the quantity of media coverage on organic-related issues impacts the price premium associated with the perceived quality difference between organic and conventional milk. Milk is a major consumer product in the U.S. and 58 percent of Americans use it as a high-quality protein source.[3] The usage of antibiotics is common in traditional milk production. Zwald et. al. (2004) found only 5.1% of conventional dairy herds had not used antibiotics in a sixty-day period, while 90.6% of organic operations had not. In addition, many conventional milk farms use a genetically engineered hormone, rBGH, on cows to increase

[1] https://ota.com/news/press-releases/20236.
[2] Robinson et. al. (2018, March). "Organic Foods: What You Need to Know." Retrieved from https://www.helpguide.org/articles/healthy-eating/organic-foods.htm
[3] https://www.statista.com/statistics/251602/us-consumers-sources-of-protein/

milk production. The usage of antibiotics and hormones, which are widely reported by mainstream media and press, raises consumers' concerns about the safety of conventional milk and often steer them to healthier options, such as organic milk.[4] As such, we are not surprised by the finding that "People who don't buy any other organic products are purchasing organic milk" (DuPuis (2000)).

However, there has been opposing voices in the media about organic milk. For instance, an investigative report published by The Washington Post points out that some 'organic' milk products may not actually be organic at all [Whoriskey (2017)]. The Post reporter visited Colorado's Aurora Organic Dairy in 2016 and found that cows were not grazing in accordance with USDA organic standards. After putting the organic milk produced in that facility through a battery of chemical tests, it was determined that the milk produced in that facility is not dramatically different from conventional milk. These ongoing debates in media sources make organic milk an interesting setting to study the influence of information dissemination on consumer shopping behavior, and the extent to which firms are able to exploit such shopping behavior as measured by an organic price premium.

We first use a theoretical model to illustrate how media information may influence the price premium associated with consumers' perception of the marginal difference between organic and conventional attributes of milk products. It provides a theoretical foundation for the subsequent empirical analysis in which we use milk sales and media data to estimate the relationship between consumers' willingness to pay for the organic feature of milk products and the intensity of organic-related news coverage.

The empirical analysis comprises two steps. In the first step, we estimate a random utility discrete choice model (Nevo 2003) to quantify consumers' time-specific mean valuation of the organic feature of milk products. After controlling for the marginal impacts of price, time, location and other product characteristics, our estimation shows that on average consumers are willing to pay more for a milk product if it is labeled as organic. To be precise, we find that the average consumers' willingness to pay for the organic feature of milk products is a mean \$1.19/gallon, which corresponds to 19.07% of the mean price per gallon of organic milk. We interpret the \$1.19/gallon as the average organic milk price premium.

[4] Hwang et. al. (2005) show that consumers selected pesticides and hormones and the use of antibiotics as their three highest food technology concerns.

In the second step of the empirical analysis, we study how time-varying intensity of media coverage of organic milk affects consumers' time-varying willingness to pay for the organic feature of milk. We combine the estimates of consumer valuation of the organic feature of milk with news information data collected from the LexisNexis Academic database. The empirical results reveal that news articles with contents most often viewed as negative toward organic dairy are more powerful in decreasing consumers' willingness to pay for the organic attribute of milk compared to the positive willingness to pay impact of news articles with contents most often viewed as positive toward organic dairy. Interestingly, we find that consumers' increasing exposure to organic dairy news items systematically increases their willingness to pay for the organic attribute of milk as long as the contents of the news items do not take a negative stance on the desirability of the organic attribute. In other words, consumers' willingness to pay for the organic attribute even increases with increasing exposure to organic dairy news items that have a neutral stance on the desirability of the organic attribute.

This paper joins the general literature studying the impacts of information disclosure on consumer food choices. Many studies in this literature focus on health or nutrition labelling, a policy that is widely used by states and federal governments to promote healthier food, and examine its impact on consumer behavior [Ippolito and Mathios (1990); Mathios (2000); Ippolito and Pappalardo (2002); Jin and Leslie (2003); Teisl and Roe (1998); Teisl et. al. (2001); Teisl et. al. (2002); Kiesel and Villas-Boas (2013); Katz et. al. (2019); Asioli et. al. (2021); and Huang and Liu (2017)]. For example, Jin and Leslie (2003) show that a policy by LA County that requires restaurants to display hygiene grade cards causes consumers to become sensitive to restaurant hygiene and reduces the incidence of foodborne illness hospitalizations. Teisl, Roe and Hicks (2002) find that the dolphin-safe label increased the market share of canned tuna.

Within the category of studies described above, there are studies that are specifically centered on the organic fluid milk market. For example, Kiesel et. al. (2005) indicate that voluntary labeling of the use of rBGH in retail fluid milk increases consumer demand for rBGH-free milk and the estimated effects appear to have increased over time. Kiesel and Villas-Boas (2007) show that USDA organic seal increases the probability of purchasing organic milk. Katz et.al. (2019) find consumers will pay a higher premium for organic text label. Asioli et.al. (2021) indicate that

information on naming and labeling shape U.S. consumers' preferences and marginal willingness to pay for agricultural products.[5]

Aside from examining the impacts of labeling policies, there are also studies analyzing consumer responses to food-related information circulated in various media sources. According to Wakefield et. al. (2010), media coverage exposes large proportions of populations to messages through routine uses of existing media, such as newspapers; and Narayanan et. al. (2005) point out that a major source of information for marketing communication include journal and newspaper information. Shimshack et. al. (2007) use both parametric and non-parametric methods to examine consumer response to a national FDA advisory to limit store-bought fish consumption due to the dangers of methyl-mercury. They find education and newspaper readership are important determinants of consumer response. Schlenker and Villas-Boas (2009) study the reactions of consumer buying habits and financial markets to two health warnings about mad cow disease: The first discovery of an infected cow in December 2003 as well as health warnings about the potential effects aired in the highly watched Oprah Winfrey show seven years earlier. They find a sharp drop in beef consumption and cattle futures following both warnings. Using a differences-in-differences empirical analysis, Kiesel (2012) shows average increases of 5% in organic milk sales relative to conventional milk sales during weeks for which news coverage on organic food production is observed. A key difference of our research from Kiesel (2012) lies in that we first use a structural random utility discrete choice model to directly estimate consumers' time-specific mean valuation of the organic feature of milk products, and then recover how this time-specific mean valuation is influenced by the intensity of newspaper coverage of organic dairy issues. Last, Huang and Liu (2017) examine the impact of consumer learning of health-related information from media coverages (TV, radio, and newspaper) and find that consumers can learn about the health qualities of bottled water from mass media over time.

Our paper also adds to the literature which studies consumers' purchase behavior for organic and conventional milk. Bernard and Bernard (2009) use auction experiments to examine demand relationships and willingness to pay (WTP) for organic, rBST-free, no antibiotics used, and conventional milk. They find there exists strong substitute and complement relationships between organic, rBST-free, and no antibiotics varieties, and the WTP premiums for the varieties

[5] See Bonnet and Bouamra-Mechemache (2016) for an analysis of how the value-added created by an organic label is shared in a vertical chain among manufacturers and retailers.

differ significantly by demographics and beliefs regarding the conventional version of milk. Alviola and Capps (2010) investigate the role of demographic factors in the household choice of purchasing organic and conventional milk. They also calculate own-price, cross-price, and income elasticities for the demand of the two types of milk and compare the magnitudes. Choi et.al.(2013) use a discrete choice model to estimate consumers' demand for milk products and evaluate the distribution of welfare effects from introducing organic milk across households with different demographic characteristics. They find that price effects of introducing organic milk are larger for low-income households than for high-income households; and the differences in the variety effects of introducing organic milk among households with different education levels are larger than the differences in the variety effects among groups that differ according to income level. The results of our paper show that, besides demographic factors, media coverage on organic diary issues also plays an important role in determining consumers' willingness to pay for organic milk.

The paper proceeds as follows. In the next section, we present a theoretical model to lay the theoretical foundation for the subsequent empirical analysis. Section 3 describes the data used for analysis. Section 4 outlines the empirical model and estimation procedure used to analyze the newspaper coverage effect on consumers' willingness to pay for the organic attribute of milk. Results are presented and discussed in Section 5, and Section 6 contains concluding remarks.

2. Theoretical Insights

We use a theoretical model to show that media information may influence the price premium associated with consumer's perception of the marginal difference between organic and conventional attributes of milk products. Consider duopoly competition between two single-product firms: one firm sells one-gallon package size of organic milk, while the other firm sells conventional milk of the same package size. Therefore, we make the simplifying assumption that the two milk products are differentiated only by their organic/conventional feature. A consumer's indirect utility obtained from purchasing one unit of product j is given by:

$$u_j = \theta q_j - p_j \qquad (1)$$

where $j = \{organic\ (o); conventional\ (c)\}$ denotes the type of milk; q_j measures the consumer's perceived quality of milk product j; and p_j represents the price of milk product j. θ represents consumer's preference for quality, which we assume is a random draw from a uniform

distribution on interval $[0, 1]$. The closer a consumer's draw of θ is to 1, the more the consumer values quality of the milk product.

Suppose $q_o \geq q_c$, that is, a consumer perceives organic milk of higher quality than the conventional one. A consumer chooses organic milk if her preference for quality, captured by θ, satisfies $\theta \geq \frac{p_o - p_c}{q_o - q_c}$. The demands for organic and conventional milk are respectively:

$$D_o(p_o, p_c; q_o, q_c) = 1 - \frac{p_o - p_c}{q_o - q_c} \quad and \quad D_c(p_o, p_c; q_o, q_c) = \frac{p_o - p_c}{q_o - q_c}, \tag{2}$$

and the variable profit functions of the two firms are:

$$\pi_o = D_o(p_o, p_c; q_o, q_c)\,(p_o - c_o) \quad and \quad \pi_c = D_c(p_o, p_c; q_o, q_c)\,(p_c - c_c), \tag{3}$$

where c_j is the pre-unit cost of type-j milk. We assume $c_o > c_c$ based on the fact that the production of organic milk is required to comply with more stringent standards. Firms non-cooperatively and simultaneously choose price, p_j, to maximize their own profit. Nash equilibrium prices are:

$$p_o^* = \frac{2(q_o - q_c)}{3} + \frac{2c_o + c_c}{3} \quad and \quad p_c^* = \frac{q_o - q_c}{3} + \frac{c_o + 2c_c}{3} \tag{4}$$

Therefore, the theoretical model yields the following expression for the difference in equilibrium prices of organic and conventional milk:

$$p_o^* - p_c^* = \frac{(q_o - q_c)}{3} + \frac{(c_o - c_c)}{3} \tag{5}$$

Equation (5) reveals that the difference in equilibrium prices of organic and conventional milk depends on two key components: (*i*) the difference in consumer's perception of the attributes of organic and conventional milk products, $(q_o - q_c)$; and (*ii*) the difference in marginal cost of producing the two types of milk products, $(c_o - c_c)$. We define the organic price premium as the portion of the equilibrium price difference attributable to consumer's perception of the marginal difference between organic and conventional attributes of milk products. In other words, in equation (5) the organic price premium is captured by $\frac{(q_o - q_c)}{3}$.

The consumer's perceived quality difference between organic milk and conventional milk, $(q_o - q_c)$, is influenced by the intensity of media coverage of organic milk according to the following function:

$$q_o - q_c = g(f_o) \tag{6}$$

where $g(\cdot)$ represents a function with slope and curvature properties we subsequently discuss; and f_o is a measure of the intensity of news coverage (perhaps measured by news item counts) about

organic milk. Note that the slope and curvature properties of function $g(\cdot)$ determine the impact of relevant news media coverage intensity on consumer's perceived quality difference between organic and conventional milk products. The first-order derivative, $g'(\cdot)$, can either be positive or negative, depending on the stance the news takes about organic milk, and how a consumer interprets the news. Furthermore, equations (5) and (6) reveal that the impact of the intensity of news media coverage on the organic price premium is captured by the following derivative:

$$\frac{\partial\left[\frac{(q_O - q_C)}{3}\right]}{\partial f_o} = \frac{1}{3} g'(f_o) \tag{7}$$

The theoretical model reveals that the impact of the intensity of news media coverage on the organic price premium, $\frac{\partial\left[\frac{(q_O - q_C)}{3}\right]}{\partial f_o}$, directly depends on the impact of the intensity of news media coverage on consumer's perceived quality difference between organic and conventional milk, $g'(f_o)$. A key objective of the subsequent empirical analysis is to use data on consumers' purchases of organic and conventional milk products to first generate dollar value time-varying estimates of consumers' perceived quality difference between organic and conventional milk products, i.e., dollar value time-varying estimates of $(q_o - q_c)$. Dollar value time-varying estimates of $(q_o - q_c)$ are effectively time-varying estimates of consumers' willingness to pay (WTP) for the organic feature of milk products. We then use a secondary estimator to recover how the time-varying intensity of news media coverage on organic milk influences the dollar value time-varying estimates of consumers' perceived quality difference between organic and conventional milk products, which effectively reveals $g'(f_o)$ and $\frac{\partial\left[\frac{(q_O - q_C)}{3}\right]}{\partial f_o}$.

3. Data

The empirical analysis uses Information Resources Inc. (IRI) retail point-of-sale scanner data. Information Resources Inc. is a Chicago-based marketing firm that uses scanning devices to collect point-of-sale retail data across 50 geographically distinct markets located in the United States [see Bronnenberg et. al. (2008); Kruger and Pagni (2008); and Muth et.al. (2016)]. Fluid milk is one of the 30 product categories covered by IRI data and is the product category of interest for this research. The point-of-sale data are weekly and compiled according to Universal Product Code (UPC) transactions in retail stores. Since one gallon is one of the most popular package sizes of fluid milk purchased weekly, we focus on this package size sold in 187 retail stores that are

spread across 5 distinct IRI markets located in the states of Illinois, Michigan and Wisconsin. The period examined spans from January 2006 to December 2012 as the most recent update of IRI data is year 2012. We define a product as the unique combination of non-price characteristics and retail store, where the measured non-price characteristics are: brands, type of milk (full lactose versus Soy milk), flavor, fat content, organic versus non-organic classification, and package type materials.

Milk consumption is measured by monthly aggregate quantity of each uniquely defined product purchased in a retail store located within an IRI designated geographic area. For each product, price is computed as the average revenue (in dollars per gallon) obtained from sales of the uniquely defined product during the relevant month. A distinct market is defined as the combination of period (year-month) and IRI designated geographic area.

For dairy processors, electricity is a major input in the production of fluid milk suitable for the retail market. Electricity is intensively used in the processing of fluid milk due to the need for water heating, cooling and refrigeration. As such, to capture a measurable determinant of production cost, we collected state level industrial electricity price data from U.S. Energy Information Administration. All price data are deflated by the consumer price index (index base year January, 2008 =100).

Several non-price product characteristic zero-one dummy variables were constructed to facilitate the empirical analysis. Table 1 reports summary statistics on product characteristic variables used in the empirical analysis. One of the product characteristic dummy variables relates to milk type, where the two milk types in our data set are full lactose and soy. Specifically, the variable takes the value one if the milk is full lactose (92.55% of the milk products), but zero if the milk is soy (7.45% of the milk products). There are three types of milk flavor in the dataset, 92.55% of which is the regular white milk, followed by the flavor of vanilla (1.28%), and original (6.17%). We classify the fat content of dairy milk into two categories, whole milk (44.36% of the milk products) and non-whole milk. In addition, we put plant-based milk products, such as soy milk, into the fat content category of non-whole milk.

There is no single variable in the IRI dataset that is constructed with the purpose of identifying milk products that are organic. As such, in order to identify organic milk products in the data we examine variables with various descriptive information on each product and classify the relevant product as organic if: (*i*) the brand description includes the word “organic”; or (*ii*) the

process description includes the phrases, “organic”, “organic homogenized”, “organic pasteurized”, “organic ultra-pasteurized”, or “organic pasteurized and homogenized”. Based on this organic classification methodology, we then constructed a zero-one dummy variable that takes a value of one only when the relevant product is classified as “organic”. Organic milk products account for 20.08% of the milk products in our sample.

Since materials used for making milk containers differ, we create a set of dummy variables to capture the range of container materials. Plastic, Carton, and Glass account for 92.37%, 7.53% and 0.10% of the container packages, respectively. Consumer demographic information, such as income and age, are drawn from Public Use Microdata Sample database (PUMS).

We assume that consumers learn information about organic dairy from the mass media. Although organic milk has been available for more than two decades, the sales of organic milk have become one of the fastest growing market segments as consumers who do not buy any other organic products nonetheless purchase organic milk [DuPuis (2000)]. It is argued that the rapid and impressive rise in the sales of organic milk is linked to mainstream media coverage on the use of antibiotics and hormones such as rBGH in conventional milk production [DuPuis (2000); Bernard and Bernard (2009)]. To retrieve the volume of news related to organic dairy, we keyword search news related to organic dairy on LexisNexis Academic database. LexisNexis Academic database provides access to more than 3,000 worldwide newspapers and we consider all national and local newspapers to measure the volume of media coverage related to organic dairy. The numbers of searched-recovered articles within each period are used as time-varying measures of news intensity. To distinguish between the positive, neutral, and negative media portrayal of organic dairy, we conduct a survey to review articles from January 2009 to December 2012 and collect survey participants’ opinions with respect to each article. We then organize the monthly newspaper article counts from 2009 to 2012 based on their informational content being most often viewed as positive, neutral, or negative media portrayal of organic dairy, respectively. A detailed description of the survey is included in Appendix B.

Table 1 not only reports summary statistics of the organic dairy-relevant news coverage data from Newspapers, but also the monthly newspaper article counts from 2009 to 2012 with informational content being most often viewed as positive, neutral, or negative media portrayal of organic dairy, respectively. As shown in Table 1, the average number of organic dairy news articles from newspapers is 56 per month. From 2009 to 2012, the average number of newspaper articles

with informational content being most often viewed as a positive portrayal of organic dairy is 14, and the average number of articles with informational content being most often viewed as neutral and negative portrayals of organic dairy is 29 and 7, respectively.

Figure 1 shows a time series plot of the intensity (measured by news counts) on organic dairy from newspapers. Figure 2 presents the intensity of news articles counts organized by informational content being most often viewed as positive, neutral, or negative media portrayal of organic dairy.

Table 1: Summary Statistics

Description	Mean	Standard deviation	Min	Max	Obs
Real Milk Price (dollars per gallon)[1]	4.0205	1.4562	0.9786	10.3600	45,267
Mean Personal Income (dollars per year)	36,042.13	3823.19	24806.06	41743.07	45,267
IRI Market Population (per year)	5,239,710	3,513,091	96,527	9,108,058	45,267
Age	45.2451	18.0210	15	95	45,267
Real Electricity Price (cents per kWh)	6.1889	0.8065	4.2471	7.8745	45,267
Milk Type Dummy Variables:					
Full Lactose Milk	0.9255	0.2626	0	1	45,267
Soy Milk	0.0745	0.2626	0	1	45,267
Flavor Type Dummy Variables:					
Regular White	0.9255	0.2626	0	1	45,267
Vanilla	0.0128	0.1125	0	1	45,267
Original	0.0617	0.2406	0	1	45,267
Fat Content Dummy (=1 if whole milk)	0.4436	0.4968	0	1	45,267
Organic milk Dummy (=1 if organic)	0.2008	0.4006	0	1	45,267
Package Type Dummy Variables:					
Carton Package	0.0753	0.2639	0	1	45,267
Plastic Package	0.9237	0.2655	0	1	45,267
Glass Package	0.0010	0.0322	0	1	45,267
Newspaper Coverage Data					
Number of organic-related news items reported in Newspapers (counts per month, from January, 2006 to December, 2012)	56.63	12.99			
Monthly newspaper article counts from 2009 to 2012 with news content most often viewed to **increase** the likelihood an individual purchases organic milk instead of non-organic milk.	14.67	7.36			
Monthly newspaper article counts from 2009 to 2012 with news content most often viewed to **decrease** the likelihood an individual purchases organic milk instead of non-organic milk.	7.92	4.00			
Monthly newspaper article counts from 2009 to 2012 with news content most often viewed as **not likely to influence** the likelihood an individual purchases organic milk instead of non-organic milk.	29.67	12.24			

1. Prices to real dollars using the Consumer Price Index, with 2008 as the base year.

Figure 1: **Intensity of organic dairy news coverages from newspapers over time**

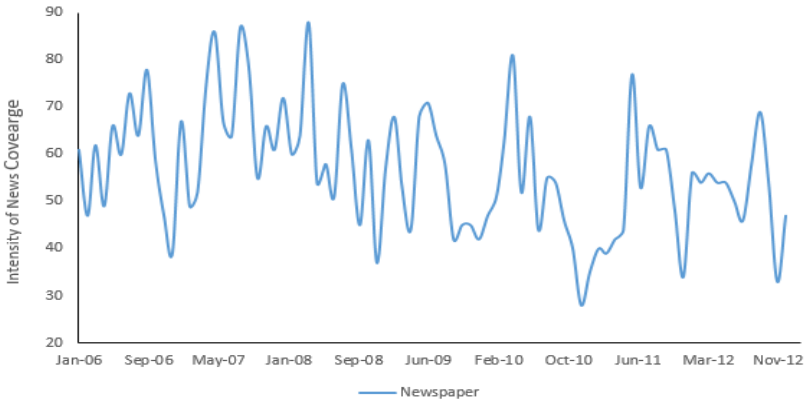
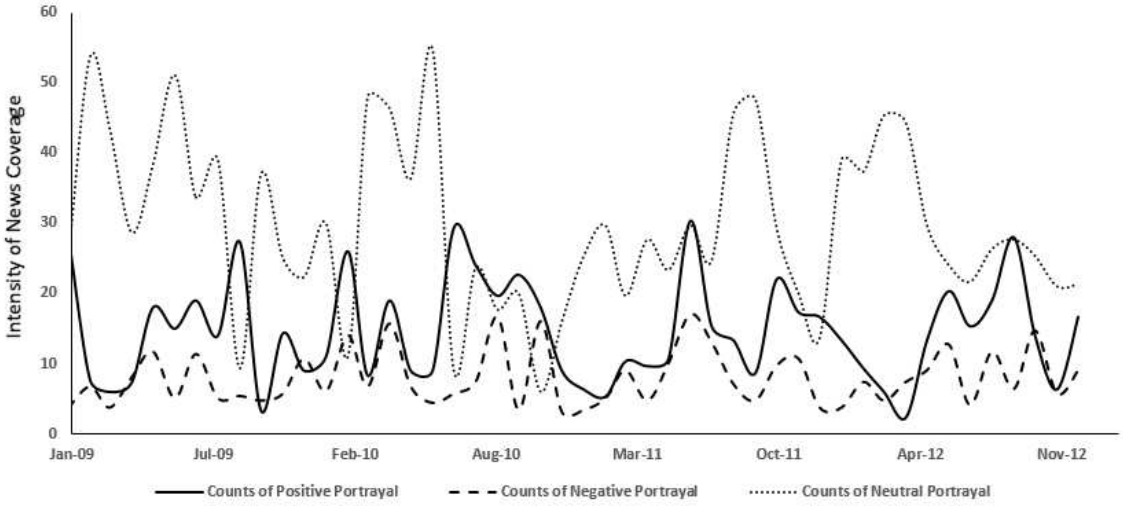


Figure 2: **Intensity of organic dairy news coverages broken down by their informational content being most often viewed as positive, neutral, or negative media portrayal of organic dairy (2009 to 2012)**



4. The Empirical Models

4.1 Demand for differentiated fluid milk products

We model the demand for fluid milk using a random coefficients logit model [Berry (1994); Berry et. al. (1995) and Nevo (2000)]. Incorporating consumer demographics into the random coefficients logit model allows us to account for consumers' taste heterogeneity for product attributes, thus enabling more accurate computation of consumers' willingness to pay for the organic attribute.

The indirect utility consumer *i* obtains from purchasing milk product *j* in market *t* is specified as:

$$U_{ijt} = x_{jt}\beta_i + \omega_i Organic_{jt} + \alpha_i p_{jt} + \rho_{year} + \tau_{month} + \gamma_{geographic\ area} + \xi_{jt} + \varepsilon_{ijt} \quad (8)$$

where x_{jt} is a vector that includes several measured non-price product characteristics with the exception of the organic characteristic; and β_i is the vector of consumer-specific taste parameters, i.e., marginal utilities, associated with the corresponding product characteristic variables in x_{jt}. $Organic_{jt}$ is a zero-one dummy variable that equals to one only if milk product *j* is classified as organic; and ω_i is a consumer-specific taste parameter, which measures the consumer's valuation of the organic characteristic of milk relative to the product being non-organic. Note that $(q_o - q_c)$ in the simple theoretical model specified earlier, is effectively measured by ω_i in this more flexible empirical random utility model. p_{jt} is the price of product *j* in market *t*; and α_i is the consumer-specific taste parameter that measures the consumer's marginal utility of price. ρ_{year}, τ_{month} and $\gamma_{geographic\ area}$ represent fixed effect controls for year, month, and geographic location of IRI designated market area, respectively. ξ_{jt} represents product characteristics that are unobserved by us the researchers, but observed by consumers; and ε_{ijt} represents the random component of utility that is assumed independent and identically distributed across consumers, products, and markets.

The random coefficients α_i, β_i and ω_i are allowed to vary across consumers according to:

$$\begin{pmatrix} \beta_i \\ \omega_i \\ \alpha_i \end{pmatrix} = \begin{pmatrix} \beta \\ \omega \\ \alpha \end{pmatrix} + \Gamma D_i + \Sigma v_i \quad (9)$$

where D_i is an *m*-dimensional column vector of demographic variables (assuming there are *m* distinct demographic variables), and each demographic variable enters the vector in the form of deviation of individual *i*'s demographic variable from the mean of the market sample of individuals;

Γ is a *L*-by-*m* dimension matrix of parameters (*L* is the number of random taste parameters in $\begin{pmatrix}\beta_i\\ \omega_i\\ \alpha_i\end{pmatrix}$), where the parameters measure how taste characteristics vary with demographics; v_i is a *L*-dimensional column vector of unobserved random shocks to consumer taste for respective product characteristics; and Σ is a *L*-by-*L* diagonal matrix, where elements on the main diagonal are parameters that measure variation in taste due to the random shocks in v_i.

In the demand estimation, demographic variables in D_i are income and age. Since variables in D_i enter in deviations from mean, the mean of each variable in D_i is zero. Following Nevo (2000), we assume that v_i has a standard multivariate normal distribution, $v_i \sim N(0, I)$. Given that the mean of D_i and v_i each equal to zero, then the mean of $\begin{pmatrix}\beta_i\\ \omega_i\\ \alpha_i\end{pmatrix}$ is $\begin{pmatrix}\beta\\ \omega\\ \alpha\end{pmatrix}$ and the variance is equal to the square of the elements on the main diagonal of Σ.

The mean utility across consumers obtained from consuming product *j* in market *t*, δ_{jt}, is given by:

$$\delta_{jt} = x_{jt}\beta + \omega Organic_{jt} + \alpha p_{jt} + \rho_{year} + \tau_{month} + \gamma_{market} + \xi_{jt} \qquad (10)$$

Consumer-specific deviations from the mean utility is given by:

$$\mu_{ijt} = \left(x_{jt}\ \ Organic_{jt}\ \ p_{jt}\right) \times (\Gamma D_i + \Sigma v_i) \qquad (11)$$

Therefore, as in Nevo (2000), the indirect utility consumer *i* obtains from purchase of product *j* in market *t* can be rewritten in terms of mean utility obtained across all consumers in the market, and consumer *i*'s deviation from the mean utility, that is,

$$U_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt} \qquad (12)$$

where δ_{jt} is the mean utility, and $(\mu_{ijt} + \varepsilon_{ijt})$ is the consumer-specific deviation from the mean utility. The consumer-specific utility deviations capture heterogeneous preferences across consumers, but these deviations by construction and assumptions have a mean of zero.

The specification of the demand model is completed with the inclusion of an outside option/good denoted by good zero. The outside good allows for the possibility that consumer *i* may not purchase any of the products in a given market, and the mean utility of the outside good is normalized to be zero and constant over time. The indirect utility from this outside option is $U_{i0t} = \varepsilon_{i0t} = 0$. Assuming that ε_{ijt} is independent and identically distributed with an extreme value type *I* density, the predicted market share of product *j* in market *t* is given by:

$$s_{jt} = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt} + \mu_{ijt})}{1 + \sum_{l=1}^{J} \exp(\delta_{lt} + \mu_{ilt})} \right) d\hat{F}(D) \mathrm{d}\Phi(v_i) \quad (13)$$

where A_{jt} represents the set of consumers who choose product *j* in market *t*; $\hat{F}(D)$ is the empirical distribution of demographic variables (income, age, etc.) in the market; and $\Phi(\cdot)$ is the standard normal distribution function. Since there is no closed-form solution for the integral in equation (13), this integral must be approximated numerically using random draws from $\hat{F}(D)$ and $\Phi(\cdot)$.[6]

Based on the discrete choice model described above, the demand for product *j* in market *t* is simply given by:

$$d_{jt} = s_{jt}(x_{jt}, Organic_{jt}, p_{jt}, \xi_{jt}; \Theta) \times M_t \quad (14)$$

where Θ is the vector of demand parameters to be estimated; and M_t is a measure of the potential market size of market *t*. Specifically, $\Theta = (\theta_1, \theta_2)$, where $\theta_1 = (\beta, \omega, \alpha, \rho, \tau, \gamma)$ and $\theta_2 = (\Gamma, \Sigma)$.

We construct the potential market size measure, M_t, in each market using the following procedure. First, we obtained data on annual per capita dairy fluid milk consumption from United States Department of Agriculture Economic Research Service (USDA ERS).[7] Since USDA ERS per capita dairy fluid milk consumption data are measured in liquid pounds, we converted the unit of measurement of these data to gallons, and divide by 12 to obtain average monthly per capita consumption of dairy fluid milk in gallons. Monthly consumption of dairy fluid milk in gallons is consistent with the unit of measurement of milk products' sales data we use. Second, even though we were not able to obtain per capita consumption of soy milk directly, we sourced data on annual total sales of soy milk in gallons,[8] and divide these unit sales data by population size to obtain average annual per capita soy milk consumption. We then convert these average annual per capita soy milk consumption data to average monthly per capita soy milk consumption. Third, monthly per capita milk (dairy and soy) consumption is obtained by summing monthly per capita consumption of dairy fluid milk and soy milk. Last, potential market size measure, M_t, in each market is computed by using the population size of the relevant geographic market multiplied by monthly per capita milk consumption.

[6] We use 300 random draws from $\hat{F}(\cdot)$ and $\Phi(\cdot)$ for the numerical approximation of $s_{jt}(\cdot)$. Consumer demographic information, such as income and age, are randomly drawn from Public Use Microdata Sample database (PUMS).

[7] https://www.ers.usda.gov/data-products/dairy-data/

[8] https://www.statista.com/statistics/552967/us-soy-milk-sales/

4.2 Demand estimation and instruments

Parameters of the demand model are estimated using a Methods of Simulated Moments (MSM) algorithm outlined in Nevo (2000). We construct the MSM estimator by using instrumental variables that are orthogonal to product characteristics captured in ξ_{jt} that are unobserved to us, but observed by firms and consumers. Instrumental variables for the product price of milk are needed because it is likely that ξ_{jt} is correlated with milk price.

The variables used to instrument milk price are state-level electricity price for the industrial sector interacted with milk brand dummies. It is reasonable to assume that an input price such as electricity price is uncorrelated with ξ_{jt}, but highly correlated with milk price. For example, an unmeasured product-specific characteristic such as brand loyalty is most likely uncorrelated with state-level electricity price, but changes in the price of electricity would definitely influence milk prices. In fact, in year 2006, electricity consumption in the dairy industry accounted for nearly 13% of the entire food industry electricity usage (U.S. DOE 2006b). Furthermore, electrical energy use is increasing as milk manufacturers become highly automated. Monthly state-level electricity price variable for the industrial sector is collected from U.S. Energy Information Administration.

The underlying intuition to interact the electricity price with milk brand dummies is to capture the likelihood that different milk products differentially use electricity to arrive at the final milk product purchased by consumers, which in turn suggests that changes in electricity price should differentially affect final milk product prices. For example, the brand "Silk" focuses on soy milk production, which is likely to consume less electricity than processing cow's milk. Another example is that the shelf life of organic milk is longer than conventional milk because organic milk usually undergoes ultra-high temperature (UHT) processing or treatment, and conventional milk generally uses a standard preservation process. UHT requires higher electricity consumption, as such, electricity usage required by the production process is different across organic milk brands and conventional milk brands. Yet another example in which electricity usage required by the production process likely differ across various brands of milk products is based on the fat content present in the final milk product.

4.3 Measuring the influence of newspaper coverage on consumers' willingness to pay for the organic attribute

The primary objective of this paper is to evaluate if more media coverage related to organic dairy in newspapers influence the organic milk price premium, or equivalently, influence consumers' willingness to pay (WTP) for the organic attribute of milk. From the demand estimation we can obtain an estimate of the average consumer's WTP for the organic attribute by dividing the estimate of the parameter, ω, on the organic dummy variable by the estimate of the parameter, α, on price, i.e., $WTP_t = \frac{\omega_t}{\alpha}$, where ω_t is a time-specific estimate of the parameter on the organic dummy variable. We then apply a minimum-distance estimation procedure discussed in Nevo (2000) to recover how time-varying growth in the counts of media coverage related to organic dairy news influence WTP_t. The minimum-distance estimation procedure effectively implements a feasible generalized least squares estimator of the following equation:

$$WTP_t = \phi_0 + \phi_1 WTP_{t-1} + \phi_2 \log(I_t) + \varepsilon_t^{wtp} \quad (15)$$

where WTP_t is our demand model estimate of consumers' willingness to pay for the organic attribute of milk during period *t*; I_t measures the number of organic dairy news articles from newspapers during period *t*; and ε_t^{wtp} is a mean zero random error term that is a composite of non-media influences on consumers' time-specific willingness to pay for the organic attribute of milk.

There are two features of the WTP_t equation specification that are worth pointing out. First, we allow the WTP_t equation to capture the possibility that consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay, thus capturing potential persistence in consumers' willingness to pay for the organic attribute of milk. Persistence in consumers' willingness to pay for the organic attribute of milk may exist due to their preferences being rooted in a history of relevant information.

4.3.1 Alternative model specification to account for information content of news articles

We recognize that variable I_t in equation (15) only indexes the volume of organic dairy news articles without any account for the information content of these news articles. However, it is reasonable to conjecture that the influence of these news articles on consumers' willingness to pay (WTP) for the organic attribute of milk depends on the information content of the news articles. Subsequent to reading a news article related to organic dairy, the news content may: (*i*) be sufficiently persuasive to increase the likelihood that the consumer purchases organic milk instead

of conventional milk; (*ii*) be sufficiently persuasive to decrease the likelihood that the consumer purchases organic milk instead of conventional milk; or (*iii*) have no impact on the consumers' choice between organic and non-organic milk.

A challenge we face in accounting for the informational content of organic dairy news items in analyzing the relationship between consumers' WTP for the organic attribute of milk and the volume of these news items, is that our data do not provide information on the news opinions of consumers who purchased the milk products in our sample. We attempt to work around this challenge by surveying a number of individuals, to discern their opinions on the contents of the news articles counted in I_t. Each surveyed individual is asked to read the contents of a given news article and offer their opinion on whether the contents of the article: (*i*) increases the likelihood that they would purchase organic milk instead of non-organic milk; (*ii*) decreases the likelihood that they would purchase organic milk instead of non-organic milk; or (*iii*) has no impact on their choice between organic and non-organic milk.

A given article is assigned to be read by multiple survey respondents. Based on the majority opinion of the respondents, we then assign each article to one of three categories: (*i*) the content is most often viewed to increase the likelihood that consumers would purchase organic milk instead of non-organic milk; (*ii*) the content is most often viewed to decrease the likelihood that consumers would purchase organic milk instead of non-organic milk; and (*iii*) the content is most often viewed as not likely to influence consumers' choice between organic milk and non-organic milk. Appendix B provides a detailed discussion of the survey we conducted.

Based on the survey evidence provided by 144 respondents, we are able to decompose our initial aggregated news article count measure, I_t, into three distinct categories of news article counts, $I_t^{increase}$, $I_t^{decrease}$ and $I_t^{no\ impact}$, where $I_t = I_t^{increase} + I_t^{decrease} + I_t^{no\ impact}$. $I_t^{increase}$ is a count of the number of organic dairy news articles from newspapers in period *t* with news content most often viewed to increase consumers' likelihood to purchase organic milk instead of conventional milk; $I_t^{decrease}$ is a count of the number of organic dairy news articles from newspapers in period *t* with news content most often viewed to decrease consumers' likelihood to purchase organic milk instead of conventional milk; and $I_t^{no\ impact}$ is a count of the number of organic dairy news articles from newspapers in period *t* with news content most often viewed as not likely to influence consumers' choice between organic milk and conventional milk. This decomposition of I_t allows us to estimate the following modified version of equation (15):

$$WTP_t = \rho_0 + \rho_1 WTP_{t-1} + \rho_2 \log\left(I_t^{increase}\right) + \rho_3 \log\left(I_t^{decrease}\right) + \rho_4 \log\left(I_t^{no\ impact}\right) + \varepsilon_t^{wtp} \quad (16)$$

5. Results from Econometric Estimation and Inferences

We first present and discuss the demand estimation results, which include estimates of the average consumer's WTP for the organic attribute of milk. We then present and discuss estimation results on the relationship between consumers' WTP for the organic attribute of milk and the intensity of newspaper coverage related to organic dairy.

5.1 Results of demand estimation

Demand model parameter estimates are reported in Table 2. The second and third columns in the table report ordinary least squares (OLS) and two-stage least squares (2SLS) estimation results of the standard logit version of the demand model, while the other columns report method of simulated moments (MSM) estimation results of the random coefficients logit version of the demand model. Consistent with economic theory, the OLS and 2SLS coefficient estimates on price are negative and statistically significant. However, a Wu-Hausman test is performed to examine the endogeneity of price, and the result of this test, which is also reported in the table, provides strong evidence that price is endogenous. As such, instruments are needed for price. The remainder of the discussion focusses on results from the random coefficients logit version of the demand model rather than the standard logit version since the random coefficients logit is better able to capture heterogeneity in consumers' preferences.

The negative and statistically significant coefficient estimate on price reveals that, on average, consumers' level of utility is inversely related to the price of the product. As such, consistent with expectation, if non-price product characteristics across competing products are equal, then our estimated price effect suggests that consumers will choose the milk product that has the lower price.

The coefficient estimate on the soy milk dummy variable is positive and statistically significant, suggesting that after controlling for other factors that may influence milk demand, the average consumer obtains higher utility by purchasing soy milk compared to dairy milk. The coefficient estimate on the fat content dummy variable is statistically insignificant at conventional

levels of statistical significance, suggesting that, on average, consumers seem to be indifferent between whole milk and non-whole milk. The coefficient estimate on the milk flavor dummy variable is negative and statistically significant, suggesting that compared with vanilla flavor, consumers prefer regular white milk and original milk. The vanilla flavoring added to milk can either be artificial or real, and vanilla extract often contains alcohol. As such, this result is consistent with the argument that consumers may prefer to avoid milk products with added vanilla flavoring for health reasons. The statistically insignificant coefficient estimate on the container package material dummy variable suggests that consumers are indifferent between milk package materials (plastic, glass, or carton) when choosing between milk products.

The parameter estimates that capture taste heterogeneity across consumers are statistically insignificant at conventional levels of statistical significance. We may interpret these results as suggesting that heterogeneity across consumers does not play a significant role in explaining consumer choice behavior across various milk products. This narrative on the apparent inconsequential role that consumer heterogeneity plays in milk demand is not surprising since product differentiation across milk products is relatively small compared to products in many other industries.

The most important milk product attribute for this research is whether or not the product is organic. The coefficient estimate on the organic dummy variable is positive and statistically significant suggesting that, on average, consumers prefer organic milk products to other milk products.

Consumers' WTP for the organic attribute of milk is computed by dividing the coefficient estimate of the organic dummy variable by the price coefficient estimate. The division of these coefficient estimates suggests that the average consumer is willing to pay $1.19/gallon extra for the organic attribute of milk products, which corresponds to 19.07% of the mean price per gallon of organic milk. In other words, parameter estimates from our demand model suggest that the average organic price premium for milk is $1.19 per gallon.

Table 2: Results from Demand Model Estimation

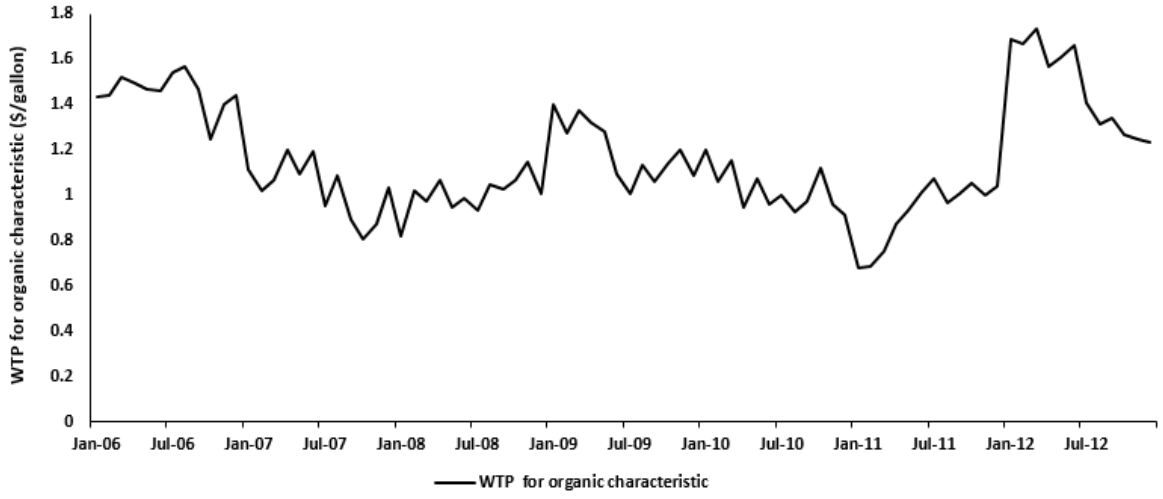
	Standard Logit		Random Coefficients Logit			
Estimation method	OLS	2SLS	MSM			
Variables	Mean β	Mean β	Mean β	Standard Deviations σ	Interactions with Demographic Variables: Age	Interactions with Demographic Variables: Income
Panel A						
Real Milk Price	-46.8762**	-219.2512**	-219.1708**	-0.9254		-0.6994
	(0.8798)	(13.3530)	(24.8725)	(211.5801)		(59.8531)
Constant	-14.6920**	-6.5369**	-6.5361**	-0.0195		
	(0.4389)	(0.8666)	(1.2914)	(5.7693)		
Fat Content	-1.5001**	-1.3122**	-1.5386	0.6748	0.5572	
	(0.0089)	(0.0189)	(5.0515)	(7.5485)	(14.9429)	
Milk type: soy milk	4.1794**	6.5263**	6.5185**			
	(0.4306)	(0.6119)	(0.8090)			
Flavor: Vanilla	-0.0243	-0.2433**	-0.2426**			
	(0.0423)	(0.0599)	(0.0750)			
Package: Plastic	3.3937**	-0.0051	-0.0046			
	(0.1523)	(0.3340)	(0.4808)			
Organic	-1.7292**	2.0628**	2.6003**			
	(0.0330)	(0.3372)	(0.5487)			
Time fixed effects	YES	YES	YES			
Brand fixed effects	YES	YES	YES			
Retail store fixed effects	YES	YES	YES			
Market fixed effects	YES	YES	YES			
R^2	0.8726					
Wu-Hausman (χ^2)		311.703 (p-value = 0.0000)				
MSM Objective					0.0109	
Panel B						
Real Milk Price	-47.2352**	-228.0709**	-232.0716**	-7.8708		-0.7999
	(0.8991)	(13.5527)	(32.3602)	(36.8281)		(68.4076)
Constant	-14.7847**	-5.9703**	-6.4608**	0.7785		
	(0.4374)	(0.8860)	(1.2651)	(1.5107)		
Fat Content	-1.5011**	-1.2955**	-3.1124	1.9979	-1.0437	
	(0.0089)	(0.0196)	(2.7885)	(1.5448)	(5.4170)	
Milk type: soy milk	4.2554**	6.7418**	6.7972**			
	(0.4289)	(0.6177)	(0.7024)			
Flavor: Vanilla	-0.0311	-0.0680	-0.0602			
	(0.0426)	(0.0585)	(0.0667)			
Package: Plastic	3.4533**	-0.1300	-0.1628			
	(0.1519)	(0.3392)	(04303)			
Organic * time periods	YES	YES	YES			
Time fixed effects	YES	YES	YES			
Brand fixed effects	YES	YES	YES			
Retail store fixed effects	YES	YES	YES			
Market fixed effects	YES	YES	YES			
R^2	0.8738					
Wu-Hausman (χ^2)		341.257 (p-value = 0.0000)				
MSM Objective					0.0125	
Observations	45,267	45,267			45,267	

Note: All regressions include yearly dummies, monthly dummies, geographic market location dummies, brand dummies and retail store dummies. Standard errors are in parenthesis. *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level

To facilitate the next portion of our empirical analysis we need to obtain time period-specific estimates of consumers' WTP for the organic attribute of milk. As such, we re-estimate a modified specification of the demand model, where the key modification is to replace the organic dummy variable with interactions of the organic dummy variable with 84 period dummy variables. The results of this modified demand model estimation are shown in the lower panel (Panel B) of Table 2. Importantly, a comparison of the estimation results across Panel A and Panel B of Table 2 reveals that moving to time-specific controls of the organic attribute has not changed the qualitative results of the other demand variables previously discussed.

The coefficient estimates of the interactions of organic dummy with 84 time periods dummy variables are reported in Appendix A, and all these coefficient estimates are positive and statistically significant at the 5% level. These 84 coefficient estimates are divided by the coefficient estimate on price to obtain time period-specific estimates of consumers' WTP for the organic attribute of milk. Figure 3 plots the time period-specific estimates of consumers' WTP for the organic attribute of milk over the periods January 2006 to December 2012. The figure does show evidence of fluctuations in consumers' WTP for the organic attribute of milk. We now evaluate the extent to which these fluctuations are influenced by fluctuations in the intensity of newspaper coverage on organic dairy issues.

Figure 3: Consumers' WTP for organic characteristic



5.2 Media effects on consumers' willingness to pay for the organic attribute of milk.

Once time varying estimates of consumers' WTP for the organic attribute of milk are obtained, facilitated by equations (15) and (16), we use the minimum-distance estimation procedure outlined in Nevo (2000) to recover how the WTP estimates are influenced by fluctuations in the intensity of newspaper coverage on organic dairy issues. Table 3 reports parameter estimates based on regression model specifications in equation (15) and equation (16). The positive and statistically significant coefficient estimate on the lagged dependent variable provides evidence of habit persistence in consumers' willingness to pay for the organic characteristic of milk, i.e., consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay.

The first column of Table 3 reports estimation results based on the specification in equation (15) for the entire sample period, 2006 to 2012. The coefficient estimate on $\log(I_t)$ is negative but not statistically significant, therefore, for this empirical specification we do not find evidence of a statistically significant relationship between consumers' WTP for the organic characteristic and the intensity of newspaper coverage on organic dairy issues.

The survey that we conducted to ascertain individuals' opinions on the information contents of the I_t news articles only span articles published from 2009 to 2012, i.e., 48 monthly time periods. Accordingly, our analysis that explores a decomposition of I_t into $I_t^{increase}$, $I_t^{decrease}$ and $I_t^{no\ impact}$ can only be done over the 2009 to 2012 period. Therefore, results reported in columns two and three in Table 3 focus on the 2009 to 2012 period.

From the second column of Table 3, which again focuses on the specification in equation (15) that uses the aggregated news intensity measure, I_t, but for the period 2009 to 2012, we still do not find a statistically significant impact of the intensity of news related to organic dairy issues on consumers' WTP for the organic attribute of milk. However, during the 2009 to 2012 time period when we decompose the news intensity measure based on surveyed opinions on contents of the news articles, and re-estimate the model based on the empirical specification in equation (16), we do find evidence that the intensity of news related to organic dairy issues impacts consumers' WTP for the organic attribute of milk. In particular, the coefficient estimate on $\log\left(I_t^{increase}\right)$ is positive and statistically significant, and its estimate indicates that a 10% increase in the number of news articles with information content that is most often viewed to increase the likelihood an individual purchases organic milk over conventional milk, is associated with a 0.36

cents increase in consumers' WTP for the organic attribute of milk. On the contrary, the coefficient estimate on $\log(I_t^{decrease})$ is negative and statistically significant, and its estimate reveals that a 10% increase in the number of news articles with information content that is most often viewed to decrease the likelihood an individual purchases organic milk over conventional milk, is associated with a 0.48 cents decrease in consumers' WTP for the organic attribute of milk. Apparently, news articles with contents most often viewed as negative toward organic dairy are more powerful in decreasing consumers' WTP for the organic attribute of milk compared to the positive WTP impact of news articles with contents most often viewed as positive toward organic dairy.

Interestingly, the coefficient estimate on $\log(I_t^{no\ impact})$ is positive and statistically significant. This coefficient estimate indicates that a 10% increase in the number of organic dairy news articles with information content most often viewed as not likely to influence an individual's purchase of organic milk over conventional milk, nevertheless is associated with a 0.39 cents increase in consumers' WTP for the organic attribute of milk.

In summary, the results suggest that consumers' increasing exposure to organic dairy news items systematically increases their willingness to pay for the organic attribute of milk as long as the contents of the news items do not take a negative stance on the desirability of the organic attribute. In other words, consumers' willingness to pay for the organic attribute even increases with increasing exposure to organic dairy news items that have a neutral stance on the desirability of the organic attribute.

Table 3: Influence of Newspaper Coverage on Consumers' WTP for the Organic Attribute of Milk

Dependent Variable: Consumers' time-specific WTP for the Organic Attribute of Milk			
	(1)	(2)	(3)
One period lag of the dependent variable	0.104** (0.016)	0.066** (0.022)	0.084** (0.022)
$\text{Log}(I_t)$: Monthly newspaper article counts from 2006 to 2012 with news content on organic dairy issues.	-0.019 (0.024)		
$\text{Log}(I_t)$: Monthly newspaper article counts from 2009 to 2012 with news content on organic dairy issues.		0.046 (0.036)	
$\text{Log}(I_t^{increase})$: Monthly newspaper article counts from 2009 to 2012 with news content most often viewed to **increase** the likelihood an individual purchases organic milk instead of non-organic milk.			0.036** (0.016)
$\text{Log}(I_t^{decrease})$: Monthly newspaper article counts from 2009 to 2012 with news content most often viewed to **decrease** the likelihood an individual purchases organic milk instead of non-organic milk.			-0.048** (0.018)
$\text{Log}(I_t^{no\ impact})$: Monthly newspaper article counts from 2009 to 2012 with news content most often viewed as not likely to influence the likelihood an individual purchases organic milk instead of non-organic milk.			0.039** (0.019)
Constant	-0.492** (0.106)	-0.668** (0.146)	-0.588** (0.105)
Number of observations	83	48	48

Notes: The data used for estimating regressions in this table are monthly time-series. The values of the dependent variable in these regressions are the time-specific willingness to pay (WTP) estimates of the organic attribute of milk computed from parameter estimates from the discrete choice demand model for milk. The regressions are estimated using feasible generalized least squares (FGLS). Standard errors are in parenthesis. * indicates statistical significance at the 10% level, ** indicates statistical significance at the 5% level.

6. Conclusion

Consumers' perception of the marginal quality difference between organic and conventional products allows firms to charge a price premium associated with the perceived quality difference. We refer to this price premium as the organic price premium. The organic price premium is equivalent to consumers' willingness to pay for the organic attribute. In this paper, we address the question of how the quantity of newspaper coverage on organic dairy issues influences the organic milk price premium.

We first use a theoretical model to illustrate how media information may influence the organic price premium, which provides a theoretical foundation for the subsequent empirical analysis in which we use milk sales and media data to estimate the relationship between consumers' willingness to pay for the organic feature of milk products and the intensity of organic-related news coverage.

First, our empirical analysis reveals that, on average, consumers are willing to pay \$1.19/gallon more for the organic attribute of milk, which corresponds to 19.07% of the mean price per gallon of organic milk. In other words, we estimate that, on average, the organic price premium for milk products is approximately 19% of the price per gallon.

Second, we find that a 10% increase in the number of news articles with information content that is most often viewed to increase the likelihood an individual purchases organic milk over conventional milk, is associated with a 0.36 cents increase in consumers' WTP for the organic attribute of milk. On the contrary, a 10% increase in the number of news articles with information content that is most often viewed to decrease the likelihood an individual purchases organic milk over conventional milk, is associated with a 0.48 cents decrease in consumers' WTP for the organic attribute of milk. As such, news articles with contents most often viewed as negative toward organic dairy are more powerful in decreasing consumers' WTP for the organic attribute of milk compared to the positive WTP impact of news articles with contents most often viewed as positive toward organic dairy.

Third, and perhaps most interesting, a 10% increase in the number of organic dairy news articles with information content most often viewed as not likely to influence an individual's purchase of organic milk over conventional milk, nevertheless is associated with a 0.39 cents increase in consumers' WTP for the organic attribute of milk.

In summary, the results suggest that consumers' increasing exposure to organic dairy news items systematically increases their willingness to pay for the organic attribute of milk as long as the contents of the news items do not take a negative stance on the desirability of the organic attribute. In other words, consumers' willingness to pay for the organic attribute even increases with increasing exposure to organic dairy news items that have a neutral stance on the desirability of the organic attribute.

Last, we find evidence of habit persistence in consumers' willingness to pay for the organic characteristic of milk, i.e., consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay. Such habit persistence is likely influenced by, among other things, the history of news media coverage on organic dairy issues.

Appendix A: Coefficient estimates of the interactions of organic dummy with time periods dummy variables.

Table A1: The coefficient estimates of the interactions of organic dummy with time periods dummy variables from Jan 2006 to Dec 2012

Variables	Coefficient	Standard Error
Organic dummy *Jan_2006	3.2431**	0.6295
Organic dummy *Feb_2006	3.2360**	0.5178
Organic dummy *Mar_2006	3.4204**	0.6304
Organic dummy *Apr_2006	3.3702**	0.6258
Organic dummy *May_2006	3.2925**	0.5463
Organic dummy *Jun_2006	3.1909**	0.6111
Organic dummy *Jul_2006	3.4782**	0.6021
Organic dummy *Aug_2006	3.4908**	0.5919
Organic dummy *Sep_2006	3.3830**	0.6031
Organic dummy *Oct_2006	2.7897**	0.4604
Organic dummy *Nov_2006	3.1008**	0.5545
Organic dummy *Dec_2006	3.2483**	0.5533
Organic dummy *Jan_2007	2.5250**	0.5446
Organic dummy *Feb_2007	2.2508**	0.5269
Organic dummy *Mar_2007	2.3894**	0.5040
Organic dummy *Apr_2007	2.6048**	0.6568
Organic dummy *May_2007	2.4256**	0.4633
Organic dummy *Jun_2007	2.5812**	0.5179
Organic dummy *Jul_2007	2.0173**	0.5462
Organic dummy *Aug_2007	2.4794**	0.5304
Organic dummy *Sep_2007	2.0256**	0.5945
Organic dummy *Oct_2007	1.7563**	0.4703
Organic dummy *Nov_2007	1.8608**	0.5005
Organic dummy *Dec_2007	2.2975**	0.4982
Organic dummy *Jan_2008	1.8182**	0.5199
Organic dummy *Feb_2008	2.3686**	0.4253
Organic dummy *Mar_2008	2.1724**	0.4377
Organic dummy *Apr_2008	2.3264**	0.4985
Organic dummy *May_2008	2.1459**	0.4753
Organic dummy *Jun_2008	2.2953**	0.4851
Organic dummy *Jul_2008	2.0224**	0.4940
Organic dummy *Aug_2008	2.2807**	0.5590
Organic dummy *Sep_2008	2.3058**	0.4328
Organic dummy *Oct_2008	2.4356**	0.5077
Organic dummy *Nov_2008	2.6149**	0.5170
Organic dummy *Dec_2008	2.2510**	0.4468

Notes: **indicates statistical significance at the 5% level

Table A1 continued

Variables	Coefficient	Standard Error
Organic dummy *Jan_2009	3.1783**	0.6024
Organic dummy *Feb_2009	2.8075**	0.8336
Organic dummy *Mar_2009	3.1066**	0.5850
Organic dummy *Apr_2009	3.1889**	0.6577
Organic dummy *May_2009	2.9632**	0.6241
Organic dummy *Jun_2009	2.5777**	0.4446
Organic dummy *Jul_2009	2.2844**	0.4431
Organic dummy *Aug_2009	2.5176**	0.4721
Organic dummy *Sep_2009	2.3197**	0.4665
Organic dummy *Oct_2009	2.5775**	0.6115
Organic dummy *Nov_2009	2.7070**	0.5460
Organic dummy *Dec_2009	2.4132**	0.6443
Organic dummy *Jan_2010	2.6745**	0.6171
Organic dummy *Feb_2010	2.4016**	0.7307
Organic dummy *Mar_2010	2.5494**	0.4973
Organic dummy *Apr_2010	2.0660**	0.4087
Organic dummy *May_2010	2.4549**	0.4712
Organic dummy *Jun_2010	2.1913**	0.5093
Organic dummy *Jul_2010	2.1685**	0.4875
Organic dummy *Aug_2010	2.0850**	0.4152
Organic dummy *Sep_2010	1.9797**	0.4829
Organic dummy *Oct_2010	2.4724**	0.6012
Organic dummy *Nov_2010	2.1614**	0.5227
Organic dummy *Dec_2010	1.9779**	0.5137
Organic dummy *Jan_2011	1.4163**	0.4635
Organic dummy *Feb_2011	1.5228**	0.6176
Organic dummy *Mar_2011	1.7367**	0.4026
Organic dummy *Apr_2011	2.0418**	0.4238
Organic dummy *May_2011	2.1231**	0.4433
Organic dummy *Jun_2011	2.2151**	0.5060
Organic dummy *Jul_2011	2.3844**	0.5017
Organic dummy *Aug_2011	2.1959**	0.5779
Organic dummy *Sep_2011	2.2430**	0.5584
Organic dummy *Oct_2011	2.2454**	0.4557
Organic dummy *Nov_2011	2.2241**	0.5024
Organic dummy *Dec_2011	2.3380**	0.4647
Organic dummy *Jan_2012	3.8409**	0.5740
Organic dummy *Feb_2012	3.6778**	0.6017
Organic dummy *Mar_2012	3.8803**	0.6321
Organic dummy *Apr_2012	3.5953**	0.5965
Organic dummy *May_2012	3.3769**	0.8319
Organic dummy *Jun_2012	3.7893**	0.5758
Organic dummy *Jul_2012	3.1733**	0.5726
Organic dummy *Aug_2012	2.9499**	0.5333
Organic dummy *Sep_2012	2.9568**	0.5973
Organic dummy *Oct_2012	2.8530**	0.5823
Organic dummy *Nov_2012	2.8246**	0.5026
Organic dummy *Dec_2012	2.7968**	0.4938

Notes: **indicates statistical significance at the 5% level

Appendix B: Description of Survey

We keyword search articles related to organic dairy from all national and local newspapers on LexisNexis Academic database. The organic dairy news articles used in the survey were published during the January, 2009 to December, 2012 time span, yielding 48 monthly periods.

The survey respondents are undergraduate students at Kansas State University, who enrolled in Principles of Microeconomics (ECON 120, Section B) in the spring semester of 2019. This survey exercise was given as an extra credit assignment, available to all students enrolled in the class. The bonus points associated with the survey exercise accounts for 8.33% of the final grade. Each survey respondent is required to read all news articles in their assigned group, and record their opinion of each article after reading. The respondents were instructed to choose one of the three options provided that best expressed their opinion of the article. The three opinion options are: (*i*) the contents of the article increase the likelihood I would purchase organic milk instead of non-organic milk; (*ii*) the contents of the article decrease the likelihood I would purchase organic milk instead of non-organic milk; or (*iii*) the contents of the article has no impact on my choice between organic and non-organic milk.

A total of 153 students were enrolled in the course, and 144 of these students chose to participate in the survey exercise, yielding a participation rate of 94.74%. Since there are 48 monthly periods of news articles, we organize the 144 survey participants into 48 groups, each group having three participants. Each group is assigned the set of newspaper articles that were published in a given month. Each respondent in a group independently reads and evaluates the set of articles assigned to the group.

Table B1 provides summary data describing select characteristics of the survey respondents. 41.67% of the survey respondents are female and 58.33% are male. 67.36% of the survey participants are from the College of Business, majoring in either Accounting, Business Administration, Finance, or Marketing and Management. 20.14% of the survey respondents are from the College of Arts and Science, majoring in either Biology, Economics, History, Sociology, Social Science, Physics, Microbiology, English, or Political Science. 4.86% of the survey respondents are from the College of Engineering, majoring in Computer Science or Mechanical Engineering. 3.5% of the survey respondents are from the College of Agricultural, majoring in Animal Science and Industry, Food Science and Industry, or Horticulture. And the remainder of

the survey participants are from the College of Education and College of Human Ecology, majoring in Hospitality Management, Psychology, or Human Ecology.

Table B1: Summary Statistics of Survey Respondents

Description	Number of Respondents by Category	Percentage of Respondents by Category
How many days per week do you drink dairy milk?		
0 days / week	37	25.69%
1 days / week	20	13.89%
2 days / week	27	18.75%
3 days / week	21	14.58%
4 days / week	10	6.94%
5 days / week	15	10.42%
6 days / week	6	4.17%
7 days / week	8	5.56%
Total	144	100%
How many days per week do you drink non-dairy milk?		
0 days / week	106	73.61%
1 days / week	7	4.86%
2 days / week	9	6.25%
3 days / week	7	4.86%
4 days / week	8	5.56%
5 days / week	2	1.39%
6 days / week	2	1.39%
7 days / week	3	2.08%
Total	144	100%
Do you believe health benefits are greater from consuming organic food compared to their non-organic counterpart?		
Yes	66	45.83%
No	34	23.61%
Uncertain	44	30.56%
Total	144	100%

Table B1: Summary Statistics of Survey Respondents (Continued)

Description	Number of Respondents by Category	Percentage of Respondents by Category
Do you believe health benefits are greater from consuming organic dairy milk compared to non-organic dairy milk?		
Yes	51	35.42%
No	46	31.94%
Uncertain	47	32.64%
Total	144	100%
How many days per week do you drink organic dairy milk?		
0 days / week	115	79.86%
1 days / week	10	6.94%
2 days / week	7	4.86%
3 days / week	5	3.47%
4 days / week	2	1.39%
5 days / week	3	2.09%
6 days / week	0	0.00%
7 days / week	2	1.39%
Total	144	100%
Which of the following age groups do you belong to?		
18-20	121	84.03%
21-23	14	9.72%
24-26	4	2.78%
27-29	3	2.09%
30-32	0	0.00%
33-35	1	0.69%
Over 35	1	0.69%
Total	144	100%

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