Documenting Food Safety Claims and Their Influence on Product Prices

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In response to increasing customer attention to food attributes, agribusinesses are employing novel product differentiation strategies. As an example, we investigate the use of food safety claims on new packaged food products from the food manufacturers' perspective. First, using two product innovation databases, we investigate claim use on labels in seven English-speaking countries over the period from 1980 to 2008. Then, based on manufacturer recommended selling prices and using U.S. data (from 2002 to 2008), we apply parametric and nonparametric hedonic methods to identify supply-side (agribusiness) valuations of chemical and microbiological claims in two food categories. We identify a significant 5 cent premium per ounce for a "preservative free" claim in spoonable yogurts. We do not find a statistically significant impact for "*E. coli* free" messages on meat and poultry products but find a significant price premium (19.3 cents and 25.7 cents per ounce in the two models) for "antibiotic free" claims in this category.

Key Words: food safety claims, parametric and nonparametric hedonic models, price premium

Label messages are playing rich and multiple roles in food marketing, particularly in light of consumers' increasing efforts to enhance their health and well-being through product choices. Traditionally, food labels provide information required by government agencies such as the U.S. Food and Drug Administration (FDA). This information is intended to provide consumers with product selection cues such as nutritional content, serving size, and ingredients. Recently, certain food safety claims have emerged on food labels. When effective, such label claims transfer salient information from farmers, ranchers, manufacturers, retailers, and food service operations to consumers about risk reductions derived from production and processing techniques employed through the supply chain. An effective message is defined as one that provides information sufficient to change consumer behavior. Frequently voluntary, such labeling initiatives may precede government regulation or standardization of claim messages, audits, or certification procedures. For example, food labels containing claims such as "antibiotic, *E. coli* and pesticide free," and "HACCP" (Hazard Analysis & Critical Control Points) are emerging in the United States and elsewhere. These labels reflect firms' efforts to capture, or to be perceived as possessing, a high degree of food safety awareness. Such messages also exhibit a firm's innovative behavior and product/process standard requirements. As part of a broader analysis of the communication of food attributes through supply chains, this paper explores food manufacturer pricing strategies for new packaged foods in an attempt to determine if "safety sells" in the final consumer market.

While there is an evolving literature exploring consumer-stated preferences for food quality (see Melton et al. 1996, McCluskey 2000, Banterle, Baldi, and Stranieri 2008) and safety (see Baker 1999, Onyango, Nayga and Govindasamy 2006) attributes, there is limited quantitative analysis of safety messages actually applied on labels.[1] In this study we investigate the use of food safety claims on new food and beverage products in seven major English-speaking countries. The claims include "antibiotic, *E. coli*, pesticide, *Salmonella*, *Listeria,*

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[1] Kimberlin and Winterstein (2008) is an exception, where the use of pharmaceutical safety messages is explored. The authors found great variability in the quality of medication information provided.

and preservative free"; "food safety"; and "HACCP." A comparison is made across two product innovation databases: Datamonitor's Product Launch Analytics (PLA, formerly Product Scan) and Mintel's Global New Products Database (GNPD), two global databases that track innovations in consumer packaged goods.

This paper examines food manufacturer pricing strategies from a supply side, focusing on the introductory price of novel packaged foods. Using hedonic price models applied to U.S. spoonable yogurt products newly launched from January 1, 2005 to September 30, 2008, we investigate *perceived* price premiums for "preservative and pesticide free" claims to evaluate chemical risks. To examine the potential for differentiation based on perceptions of reduced microbiological risks, we explore the price premium of *"E. coli* and antibiotic free" claims on U.S. meat and poultry products newly launched from January 1, 2002 to December 31, 2004. This study explores the pricing behavior of food firms using the manufacturer's suggested retail price (MSRP) at the time of launch. Launch MSRP may not be the price offered in all stores at all stages of a product life cycle. Firms may follow price skimming or penetration pricing strategies that create a dynamic price as the level of diffusion/adoption changes. Our hedonic pricing models are supply-side models and do not analyze consumer response to these pricing strategies. Finally, in order to verify the results estimated by parametric hedonic price models, nonparametric models are applied. Following a background discussion of labeling that spans the seven countries, we introduce the data and present the models and results, leading to our conclusions and the implications of our findings.

A Background on Food Labels in Different Countries

Informational labeling is designed to assist consumers in their product selections. Nutrition information and food safety information as two major types of labeling have divergent policy histories in different countries. Here we compare the experiences of seven English-speaking countries: the United States, the United Kingdom, the Republic of Ireland, Canada, New Zealand, Australia, and South Africa.

In the United States, there are currently two main federal laws governing food products under the FDA's jurisdiction: the Federal Food, Drug, and Cosmetic Act (FD&C Act) and the Fair Packaging and Labeling Act. The Nutrition Labeling and Education Act (NLEA) is an amendment of the FD&C Act. The FDA is responsible for ensuring that foods sold in the United States are safe, wholesome, and properly labeled. They guide the use of terms such as "low fat," "light," "reduced cholesterol," "low sodium," "low calorie," and "fresh." The Nutrition Labeling and Education Act of 1990 mandated detailed nutritional information on most food packages and defined standards for health claims. In September 1994, the Center for Food Safety and Applied Nutrition issued *A Food Labeling Guide* with revisions in June 1999. The latest version, issued in April 2008, detailed claims permitted for food labels. Current FDA Food Labeling Guidance & Regulations cover detailed ingredient lists, nutrition labeling, and claim use, but do not directly cover issues such as microbial food safety, pesticide residues, and the use of preservatives. Nutrient content claims, health claims, qualified health claims, and structure/function claims are four types of claims with binding and nonbinding recommendations about appropriate usage [see Hooker and Teratanavat (2008) for a review of the differences across such nutrition marketing claims].

In the United Kingdom (UK), The Food Labelling Regulations 1996 require food to be marked or labeled with certain requirements such as name, ingredients and their amounts, the process used in manufacture, and nutrition labeling. Additional labeling requirements were set up for certain categories of food such as pre-packed alcoholic drinks and raw milk (The Food Labelling Regulations 1996). The UK's Food Standards Agency (FSA) regularly issues *Labelling Guidance* notes for food businesses, recently clarifying issues such as place of origin, Quantitative Ingredient Declarations on food labeling, what food should carry a "use by" date, and nutrition labeling (FSA 2008).

In Ireland the main legislation of food labeling is EU Council Directive 2000/13/EC (referred to as the General Labelling Directive); European Communities (Labelling, Presentation and Advertising of Foodstuffs) Regulations 2002 (SI 483/2002); and EU Directive 2003/89/EC. The legislation covers labels on pre-packaged food, labels on nonpackaged food, nutritional labeling, food additives, and food supplements, etc. All food labeling legislation is enforced through the Food Safety Authority of Ireland (FSAI). In April 2008, they published a new guidance leaflet for the food industry to provide clarity on the general and compulsory legal requirements for the labeling of food (FSAI 2008).

In Canada, the 2003 *Guide to Food Labelling and Advertising* provides information on food labeling and advertising requirements, as well as policies that apply to statements and claims made about foods and alcoholic beverages. Food claims adhering to the guidelines set out in this document are considered to comply with the provisions of the Food and Drug Act, the Food and Drug Regulations, the Consumer Packaging and Labelling Act and Regulations, and other relevant legislation. Requirements include basic food labeling provisions; food claims, whether in advertisements, on food labels, or other displays; nutrition labeling; nutrition content claims; diet-related health claims; etc. (Canadian Food Inspection Agency 2008).

In South Africa, the main food laws are the Foodstuffs, Cosmetics and Disinfectants Act, 1972 and its regulations. The Department of Health, Department of Agriculture, and South African Bureau of Standards (SABS) are the key stakeholders in food control. The information required to appear on any label is name and address, product name, list of ingredients, the net mass declaration, storage instructions, grading of the product, and nutrition labeling, etc. New draft Food Labelling Regulations were published in 2007. The regulations made provisions for an extensive list of new and amended definitions and mandatory date markings, as well as specific conditions for nutritional information on food labels (South Africa Department of Health 2008).

Australia and New Zealand jointly committed to the development and implementation of a single set of food standards through signing a Joint Food Standards Setting Treaty (the "Food Standards Treaty") in 1995, which led to the joint Australia New Zealand Food Standards Code. There is currently a prohibition on health and related claims under the Australia New Zealand Food Standards Code (The Food Code) with the exception of the "folate/neural tube defect" health claim. The Food Code applies to packaged food produced in and imported into Australia and New Zealand (Australia New Zealand Food Authority 1995).

Overall Use of Food Safety Claims

Given the variety of labeling regulations seen across these nations, and the relatively small number of rules specifically addressing food safety (as opposed to nutrition), a comparison of the nature of the claims seen appears to be justified. This section explores the use of food safety claims on products launched in the United States, the United Kingdom, the Republic of Ireland, Canada, New Zealand, Australia, and South Africa. Using information from PLA and GNPD, we focus on the food and beverage industries, with searches covering the periods from January 1, 1980 to September 30, 2008 for PLA, and June 1, 1996 to September 30, 2008 for GNPD. The following food safety-related claims are investigated: "antibiotic, *E. coli*, pesticide, *Salmonella*, *Listeria*, and preservative free"; "food safety"; and "HACCP." Newly marketed food and beverage products are examined to determine if labels contain the above messages.

The eight food safety messages are selected due to their public health significance and appearance on existing product labels. An antibiotic is an antimicrobial drug widely used in medicine, agriculture, and industrial fermentations for treating infections caused by bacteria. Misuse and overuse of these drugs, however, have contributed to public health concerns over antibiotic resistance in certain animal-based products. This resistance develops when potentially harmful bacteria change in a way that reduces or eliminates the effectiveness of human antibiotics. Food-producing animals are given antibiotics for therapeutic, disease prevention, or production reasons. However, these drugs can cause microbes to become resistant to drugs used to treat human illness, ultimately making some human diseases harder to treat. Increasing problems with resistant strains call for restrained use and alternative strategies. Evidence that drugs used in food-producing animals can cause antibiotic-resistant infections in consumers spurred the FDA's Center for Veterinary Medicine to take action: for example, the banning of the antibacterial Baytril for disease treatment in chickens and turkeys (Bren 2001). There have been similar concerns that certain pesticides used on food crops may be dangerous to consumers or to the environment.

The increasing number of emerging pathogens is one of the most critical challenges for food safety; since the 1970s, bacteria that were not previously regarded as important causes of food-borne illness became more widespread, such as *Escherichia (E.) coli* O157:H7 and *Salmonella enteritidis* (FDA 2005). Recent outbreaks of *E. coli* have produced significant public health impacts. In 2006, an outbreak associated with *E. coli* O157:H7-contaminated spinach spread across 26 states. As of January 2007, 205 persons were infected, resulting in 3 deaths; of the 103 people hospitalized, 31 developed a type of kidney failure called hemolytic-uremic syndrome (CDHS-FDA, 2007). Raw meats, poultry, eggs, milk and dairy products, fish, sauces, and salad dressing are often associated with *Salmonella* and *E. coli,* making these products candidates for related food safety claims.

The term "food safety" is a frequently used, inclusive descriptor appearing in all kinds of media communications (Fleming, Thorson, and Zhang 2006), often as a catchall for public concern about food hygiene. It is included as the most general of our search terms. Preservatives are food additives used to inhibit the growth of microorganisms in processed foods and improve the foods' keeping quality or stability. Although preservatives (in the United States) are "generally recognized as safe" (or GRAS) food ingredients, consumer risk perceptions and concerns over allergies motivate their inclusion as a search term.

Hazard Analysis and Critical Control Point (HACCP) is a state-of-the-art approach to food safety management spanning seven key principles. A number of U.S. food companies already use the system in their manufacturing processes. The FDA mandated HACCP for the seafood industry on December 18, 1995 and for the juice industry on January 19, 2001. HACCP is in use in other countries, including Canada and the UK. The Food Safety Enhancement Program is the Canadian Food Inspection Agency's approach to encourage and support the development, implementation, and maintenance of HACCP systems in all federally registered establishments. Plant-specific HACCP plans are facilitated through the development of various generic models to cover as many processes and products as possible (Canadian Food Inspection Agency 2008). In the UK, from January 1, 2006, Regulation 853/2004 of the European Parliament on the Hygiene of Foodstuffs requires that food business operators shall put into place, implement, and maintain a permanent procedure based on the principles of HACCP. The regulation applies to any size of the food business (Food Standards Agency 2008).

We searched the two new-product databases using inclusive queries (see Table 1 for results of PLA and GNPD searches). All food and beverage products are included in the search process. Few products include a food safety claim. However, there are some interesting similarities and differences in the results across the databases. First, "HACCP" and *"E. coli*, *Salmonella,* and *Listeria* free" messages are infrequently used on product labels. This finding is consistent across the seven countries, although the appearance of such claims on food and beverage innovations is relatively higher in the United States. Regardless, the prevalence of such claims remains very rare. Based on the PLA data, the total number of new food and beverage items launched was: UK 19,500; Canada 7,210; Ireland 965; South Africa 4,098; New Zealand 3,603; Australia 9,807; and USA 115,430. Of these only 0-0.08 percent contained a food safety claim.

For the following six countries, the UK, Ireland, Canada, New Zealand, Australia, and South Africa, new products rarely included any of the first seven claims (antibiotic, *E coli*, pesticide, *Salmonella* or *Listeria* free; food safety; or HACCP). These signals include supply-chain-wide messages that require information to be shared by the producers and manufacturers before it can be sent to the consumer. In comparison, U.S. innovations appear to more frequently use these terms. This may be contrary to expectations, given U.S. product liability laws. Such laws describe the circumstances under which an individual can recover damages for a defective food item, along with the nature and extent of compensation that may be awarded for injuries or deaths due to contaminated food products (Buzby, Frenzen, and Rasco 2002). When the manufacturer fails to exercise "reasonable care" in producing, marketing, or selling the implicated food, and because of this failure someone becomes ill, the manufacturer then may be held liable for any resulting court-awarded compensation (Buzby,

Table 1. Summary of Food Safety Claims

	PLA (January 1, 1980 to September 30, 2008)							
	Antibiotic free	*E. coli* free	Food safety	HACCP	Pesticide free	*Salmonella* free	*Listeria* free	Preservative free
UK	0	1	2	0	4	7	1	49
CANADA	5	1	10	2	7	1	0	35
Ireland	0	0	0	0	0	0	0	2
South Africa	0	0	1	0	0	1	0	56
New Zealand	0	0	1	0	0	0	0	19
Australia	0	0	2	0	0	2	0	45
US	94	14	70	18	83	28	5	938
	GNPD (June 1, 1996 to September 30, 2008)							
	Antibiotic free	*E. coli* free	Food safety	HACCP	Pesticide free	*Salmonella* free	*Listeria* free	Preservative free
UK	12	0	6	0	38	5	0	4112
CANADA	37	0	14	0	70	0	0	1520
Ireland	1	0	1	0	1	0	0	432
South Africa	7	0	1	3	18	0	0	831
New Zealand	1	0	25	0	15	0	0	1034
Australia	9	0	10	9	65	0	0	2384
US	587	9	137	11	424	11	1	8585

Frenzen, and Rasco 2001). If a firm claims a higher level of safety on the food label, but then has a recall, they may be more likely to be held responsible for the personal injuries attributed to the contaminated food.[2] The balance of economic incentives for (risk averse) firms may align with caution for food label claims, explaining the relatively low adoption rate for such messages. An alternative strategy has firms engaging in (supply-chain-wide) efforts to elevate product quality, but not exhibiting them on the food label. If this is the case, firms may be missing a valuable opportunity to attract health-conscious consumers and command a price premium. Certain firms do currently present food safety information on their labels to help consumers make product choices and to educate consumers about food safety.

"Antibiotic and pesticide free" and "food safety" messages are more frequently seen. In GNPD, the number of products carrying these messages reached several hundred in the United States and dozens in other countries, especially the UK, Canada, and Australia. The more frequent presence of these messages on food labels is in line with the increasing public attention and preference for natural and organic foods in these markets. For example, according to FDA policy, "natural" means the product does not contain synthetic or artificial ingredients (FDA 2008). A "preservative free" claim is the mostly frequently seen food safety message. In PLA, there are nearly one thousand new food and beverage products with "preservative free" messages; in GNPD, more than eight thousand.

Food safety claims span several food categories (see Table 2). "*Salmonella* free" claims mostly appear on dairy foods, but also are used for meat, poultry, meals, and entrees. Similarly, "*E. coli* and *Listeria* free" claims are mainly used on meat, certain poultry, and dairy products. "HACCP" claims generally appear on beverages and seldom on food products.

[2] Alternatively, the notion of average quality (Rasco 1997) may suggest that once one firm makes such a claim, it is incumbent upon the entire industry to follow similar practices, else they may be found to be supplying a dangerous product that breaks implicit warranty provisions.

Table 2. Distribution of Food Safety Claims Across Product Categories

Category	*Salmonella* free	*E. coli* free	*Listeria* free	HACCP	Food Safety	Antibiotic free	Pesticide free	Preservative free
Dairy Food	Yes	Yes	Yes		Yes			
Meat	Yes	Yes	Yes		Yes	Yes	Yes	
Poultry	Yes	Yes	Yes		Yes	Yes	Yes	
Meals & Entrees	Yes				Yes	Yes		
Beverages				Yes		Yes	Yes	Yes
Bread Products								Yes
Cereals							Yes	Yes
Chips								Yes
Cookies								Yes
Sandwiches								Yes
Pastry & Baked Products								Yes
Sauces & Gravies								Yes
Spices, Extracts & Seasonings								Yes
Sauces, Pizza & Pasta					Yes			
Oil, Shortening & Cooking Sprays					Yes		Yes	
Fruits & Fruit Side Dishes					Yes		Yes	
Snacks						Yes		
Spices, Extracts & Seasonings							Yes	
Staples							Yes	
Vegetables & Vegetable Side Dishes							Yes	

Note: "Yes" implies that the number of new food product innovations is at least 2.

The Hedonic Price Model

Turning to the perspective of food manufacturers, it is interesting to determine whether they have attempted to incorporate a premium into their pricing strategies for products bearing a claim of some type. Hedonic price models are used to explore pricing strategies. The hedonic model, developed by Rosen (1974), constructs implicit prices of attributes by generating an equilibrium between consumers' and producers' actions. As stated above, we don't include market prices in this analysis, focusing on the supply-side prices $p(z)$ that we assess for values based on the presence or absence of product characteristics. Rosen argued that the hedonic pricing function is completely determined by the supply side in the long run. This long-term equilibrium indicated that the marginal price of a particular attribute should be equal across firms, keeping other attributes constant, and should be the same as the lowest marginal cost of producing that attribute (Nimon and Beghin 1999). In practice, hedonic pricing models have been widely used to value food attributes, employing either demand- or supply-side data (See Loureiro and McCluskey 2000, Nimon and Beghin 1999).

Employing the standard hedonic price model setup, the price of a food product P is assumed to be defined by a function, $P = P(z)$, relating prices and characteristics, where z is a vector of attributes. This z accounts for the possibility that some firms pay better attention to producing a particular bundle of attributes than others. The implicit price of an additional unit of a particular attribute is estimated as the partial derivative of the hedonic price function in terms of that specific characteristic. Each producer chooses an optimal bundle of attributes to produce in order to maximize profit, subject to a cost constraint. The coefficient of the attribute suggests the marginal willingness to accept a price for a specific product attribute (Rosen 1974). A general hedonic model can be written as $P(z) = p(z_1, z_2, z_3, \ldots, z_n)$, where $z = (z_1, z_2, z_3, \ldots, z_n)$ is a vector including a bundle of product attributes. P_{z_i} is the implicit price of the attribute z_i from the food manufacturers' perspective.

Feenstra's theoretical framework (1995) suggests that, when considering imperfectly competitive markets, price markup above marginal cost should be added as an explanatory variable in the model. However, in empirical work based on Rosen's hedonic pricing model, perfect competition is widely assumed (yet the approach attempts to value product differentiation strategies). Indeed, the literature applying hedonic pricing methods can be categorized into two sets. One set simply does not mention market structure. For example, Loureiro and McCluskey (2000) use a hedonic approach to estimate the price premium of the Protected Geographical Identification label in fresh meat products. Lecocq and Visser (2006) analyzed Bordeaux wine, investigating the objective characteristics presented on the label, and found that market price is influenced by those features. Nimon and Beghin (1999) used apparel catalog data to evaluate price premiums for environmental attributes such as organic-cotton apparel, environmentally friendly dyes, and no-dyes. Lacking production cost, they selected Rosen's perfectly competitive model rather than Feenstra's imperfect competition framework and argued the virtue of the approach.

The other set of articles do have cost information. Osborne and Smith (1997) evaluated the price markup of site-specific environmental amenities for coastal beaches. They explored private firms' rental price, using time series data for a six-year period. Firm-specific wage indexes and a wage index for the real estate sector were measured cost variables.

It seems that in practice most researchers applied the hedonic model without consideration of market structure, as few have cost information. In order to consider market structure, we incorporate a product innovation level variable. This variable describes whether the product is highly innovative or is similar to existing products. This proxy is an indicator of how many "similar" products there may be in the category and thus is a measure of market structure.

Data

This study estimates the implicit initial offer prices of food characteristics. MSRP aims to standardize prices across locations at the time of launch. These price data are generally available in GNPD and PLA. The U.S. spoonable yogurt market is first considered. The entire set of newly marketed yogurts available in the GNPD database, launched between January 1, 2005 and September 30, 2008, are explored.

Two possible model specifications can be used [equations (1) and (2)].

$$(1)\quad PPO = \alpha_0 + \beta_1 PFREE + \beta_2 KOSHER + \beta_3 BRAND + \beta_4 NEW + \beta_5 CHILD + \beta_6 ORGA + \beta_7 PEST + \varepsilon$$

$$(2)\quad \text{Ln}PPO = \alpha_0 + \beta_1 PFREE + \beta_2 KOSHER + \beta_3 BRAND + \beta_4 NEW + \beta_5 CHILD + \beta_6 ORGA + \beta_7 PEST + \varepsilon$$

Previous applications have used either linear (see Wilson 1984, Bolan and Schroeder 2002, Maguire, Owens, and Simon 2004, Taylor and Brester 2005) or semi-log functional forms (see Estes and Smith 1996, Steiner 2004) to examine price-quality characteristics. The more flexible, functional form of a Box-Cox transformation model has also been used (See Palmquist 1984, Jordan et al. 1985, Loureiro and McCluskey 2000) and is applied here. The power parameter $\lambda = 0$ is found in the estimated confidence interval [-0.5, 0.1], suggesting that a semi-log functional form of the hedonic price model is appropriate. Therefore equation (2) is estimated.

Empirical Estimation and Results

Inherent in such hedonic approaches are concerns about endogeneity. A Hausman test confirmed such between "preservative free" claims and product price. Thus we employed a Two-Stage Least Squares model with an instrumental variable (the new fitted value of the endogenous variable *PFREE*) to derive consistent parameter estimates.

The price per ounce (*PPO*) is computed from the MSRP. Variable definitions and summary statistics are presented in Table 3. All products that use an "antibiotic free" message also have a "pesticide free" claim. In order to avoid multicollinearity, only one of the messages can be included in the model. Variable *PEST* is selected. If variable *BIO* is used, the results are not significantly different.

Table 3. Descriptive Statistics of the GNPD Data (Spoonable Yogurt)

Variable	Description	N	Mean	Std Dev	Min	Max
PPO	Price per ounce ($)	181	0.12 45	0.0965	0.0309	1.165
PFREE	Preservative free claim (yes = 1, no = 0)	181	0.0663	0.2495	0	1
KOSHER	Kosher certified (yes = 1, no = 0)	181	0.5028	0.5014	0	1
BRAND	= 1 if the product is a national brand, = 0 if a private brand	181	0.7182	0.4511	0	1
NEW	= 1 if the product is a new formulation or new variety, = 0 otherwise	181	0.4972	0.5014	0	1
PEST	Pesticide free claim (yes = 1, no = 0)	181	0.0055	0.0743	0	1
CHILD	= 1 if the product is positioned toward children, = 0 otherwise	181	0.0884	0.2847	0	1
ORGA	Organic claim (yes = 1, no = 0)	181	0.0773	0.2679	0	1

Spoonable yogurt has an average price per ounce of 12.45 cents, with a wide range between 3.09 cents and $1.165. Table 4 reports the results of the hedonic price model and the estimated coefficients for each included label message. Given the semi-log specification, coefficients can be interpreted as a percent change of the average price. A price premium for each message is calculated using equation (3) and reported in Table 4.

(3) Price Premium of Parameter β
= Average (PPO)*Parameter β Estimate.

PFREE is positive as expected and significant at the 95 percent level. The parameter estimate implies that a "preservative free" claim has an average premium of 40.90 percent (a 5.09 cents markup). A *KOSHER* claim, however, has a small negative but statistically insignificant effect on yogurt price. Though the claim has no direct impact on price, it may still have other marketing advantages (promotion, product differentiation, etc.). Compared to a private label, national brands generate an average premium of 27.81 percent, a 3.46 cents markup, significant at the 95 percent level. *NEW* is statistically insignificant, which implies that innovative products have a price advantage over those entering a category with similar existing products. Based on this crude proxy, the effect of market structure is not obvious in spoonable yogurt products.

Yogurts with an "organic" claim have a statistically significant (95 percent level) price premium: 39.09 percent (4.87 cents). Factors influencing the adoption of an "organic" claim include the requirements that ingredients are grown without using most conventional pesticides; that fertilizers are not made with synthetic ingredients, bioengineering, or sewage sludge; and that ionizing radiation is not used (Gold 2007). Producers have realized the value of organic claims on product labels and have an increasing interest in marketing organic yogurt. In comparison, "antibiotic and pesticide free" claims (*PEST*) are not significant. Notice that the number of yogurts carrying such messages is small.

Table 4. Parametric Hedonic Price Model: GNPD Data

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|	Estimated Premium
Intercept	-2.4138	0.0779	-31	<.0001	--
PFREE	0.4090	0.1377	2.97	0.0034	0.0509
KOSHER	-0.0297	0.0665	-0.45	0.6559	-0.0037
BRAND	0.2781	0.0741	3.76	0.0002	0.0346
NEW	-0.0025	0.0675	-0.04	0.9706	-0.0003
CHILD	-0.1474	0.1188	-1.24	0.2163	-0.0183
ORGA	0.3909	0.1288	3.04	0.0028	0.0487
PEST	-0.2849	0.4585	-0.62	0.5353	-0.0355
	F value = 4.52	Pr > F = 0.0001			

n = 181

A Hedonic Price Model for "*E. coli* Free"

Food-borne illness caused by microorganisms is an important and growing public health problem, and most countries have documented significant increases over recent decades in the incidence of disease caused by microorganisms in food, including pathogens (World Health Organization 2002). Among all microbiological risks, *E. coli* is chosen

Table 5. Descriptive Statistics of PLA Data (Meat and Poultry Products)

Variable	Description	N	Mean	Std Dev	Minimum	Maximum
PPO	Price Per Ounce ($)	172	0.3557	0.2332	0.0790	1.7475
EFREE	*E. coli* free claim (yes = 1, no = 0)	181	0.0331	0.1795	0	1
NATU	Natural claim (yes = 1, no = 0)	181	0.0994	0.3001	0	1
ANTIFREE	Antibiotic free claim (yes = 1, no = 0)	181	0.0829	0.2765	0	1
MEAT	= 1 if the product is meat, = 0 if poultry	181	0.5856	0.4940	0	1
NEW	= 1 if the product is innovative, = 0 otherwise	181	0.0523	0.2233	0	1
FAMILY	= 1 if family package size, = 0 if regular size	181	0.0939	0.2925	0	1
COOKED	= 1 if cooked or fully cooked, = 0 if raw	181	0.5249	0.5008	0	1
FREGR	= 1 if ground meat products, = 0 otherwise	181	0.0276	0.1643	0	1

as an example in our hedonic analysis due to recent outbreaks. Among the products claiming to be "*E. coli* free," meat and poultry account for eight, the other six include dairy and baby food products. Thus meat and poultry products are our focus for the "*E. coli* free" claim. The data span January 1, 2002 to December 31, 2004 and were collected from the PLA database. The sample size is 172. Variable *PPO* is price per ounce calculated as above. Variable definitions and summary statistics are presented in Table 5. An average meat and poultry product had a price per ounce of 35.57 cents, with a wide range between 7.9 cents and $1.7475. Among the variables explored, product package size may affect price if firms charge lower per-unit prices for bulk or family packages (see *FAMILY*).

Applying a Box-Cox maximum likelihood method again, the optimal λ is found to be zero. Therefore, a semi-log functional form of the hedonic price model is appropriate [equation (4)].

$$\text{(4)}\quad \text{Ln}\,PPO = \alpha_0 + \beta_1 EFREE + \beta_2 NATU + \beta_3 ANTIFREE + \beta_4 MEAT + \beta_5 NEW + \beta_6 FAMILY + \beta_7 COOKED + \beta_8 FREGR + \varepsilon$$

Possible endogeneity between "antibiotic free" and price was again confirmed with a Hausman test. A Two-Stage Least Squares model is used to correct for the endogeneity; Table 6 presents the estimated coefficients for label claims. The percent change of the average price and implicit price premiums are also estimated. The sign on *EFREE* is positive as expected, implying that products with an "*E. coli* free" message command a higher price than those without, with an average 14.75 percent premium (5.25 cents). However, the variable is not significant. The total number of products with an "*E. coli* free" message is much smaller than for the other claims explored above. This may suggest that producers and manufacturers have paid less attention to differentiating products based on *E. coli* claims, or that concern over liability is more pressing in these products.

A "natural" claim has a positive impact (64.20 percent premium, 22.84 cents markup), which is significant at the 95 percent confidence level. Factors influencing the use of "natural" claims include the requirements that the product does not

Table 6. Parametric Hedonic Price Model: PLA Data

Variable	Estimate	Error	t Value	Pr > |t|	Estimated Premium
Intercept	-1.1836	0.0707	-16.74	<.0001	--
EFREE	0.1475	0.4584	0.32	0.7481	0.0525
NATU	0.6420	0.1192	5.38	<.0001	0.2284
ANTIFREE	0.5432	0.1613	3.37	0.0009	0.1932
MEAT	-0.1220	0.0717	-1.7	0.0909	-0.0434
NEW	0.3271	0.1556	2.1	0.0371	0.1163
FAMILY	-0.2556	0.1161	-2.2	0.029	-0.0909
COOKED	0.0663	0.0705	0.94	0.3482	0.0236
FREGR	-0.6312	0.3253	-1.94	0.054	-0.2245
	F value = 7.19	Pr > F = 0.0001			

n = 172

contain artificial flavors, coloring ingredients, chemical preservatives, or any other artificial or synthetic ingredients, and that the product and its ingredients are not more than minimally processed (Food Safety and Inspection Service 2006). Positive marginal prices for the use of an "antibiotic free" claim by meat and poultry manufacturers are statistically significant at a 95 percent level of confidence (54.89 cents per ounce with an average 54.32 percent premium).

Nonparametric Models

Rosen's theory of hedonic prices (1974) has also been tested econometrically using recently developed nonparametric techniques to examine the effects of qualitative factors on product price. Rosen recommended that the functional form restrictions should be relaxed. Nonparametric methods that place no restrictions on it may provide more reliable information about implicit prices. To verify the estimation results of the parametric hedonic price models in previous sections, we employ generalized nonparametric regression, fitting an additive regression model to GNPD and PLA data for spoonable yogurt and meat and poultry products, respectively.

The generalized additive nonparametric regression model specifies that the average value of y is a sum of separate terms for each predictor, but these terms are merely assumed to be smooth functions of the x's:

$$E(y|x_1, x_2, \cdots x_k) = \alpha + f_1(x_1) + f_2(x_2) + \cdots + f_k(x_k) \quad (5)$$

As Fox (2000) stated, an advantage of the additive regression model is that it reduces to a series of two-dimensional partial regression problems, which means each $f_i\,(x_i)$, $i = 1, \ldots, k$. This is beneficial both in computation and, even more importantly, with regard to interpretation. Concerns over dimensionality are avoided through a univariate smoother, and estimates of the individual terms explain how the independent variables affect the dependent variable. The generalized additive nonparametric models for yogurt data and meat and poultry product data are presented in equations (6) and (7).

$$PPO_i = \alpha + f_1(PFREE_i) + f_2(KOSHER_i) + f_3(BRAND_i) + f_4(NEW_i) + f_5(CHILD_i) + f_6(ORGA_i) + f_7(PEST_i) \quad (6)$$

$$PPO_i = \alpha_1 + g_1(EFREE_i) + g_2(NATU_i) + g_3(ANTIFREE_i) + g_4(MEAT_i) + g_5(NEW_i) + g_6(FAMILY_i) + g_7(COOKED_i) + g_8(FREGR_i) \quad (7)$$

where $f_i(X)$, $i = 1, 2, \ldots, 7$, and $g_i(X)$, $i = 1, 2, \ldots, 8$ are smooth functions.

The yogurt results (see Table 7) imply that a "preservative free" message on average has an implicit price premium of 4.54 cents. In the parametric model, the implicit price premium was 5.09 cents. Thus, we are confident that the "preservative free" claim has a positive premium of 5 cents per ounce. It is significant at an 85 percent confidence level. If the yogurt claims to be "organic," it has an average 5.6 cents premium compared to the 4.87 cents premium in the parametric model (significant at the 95 percent level). As with the parametric model, "pesticide and antibiotic free" claims are insignificant.

The estimation results of a nonparametric model applied to meat and poultry products (see Table 8) suggest that those products with an "*E. coli* free" message on average have an implicit price premium of 18.47 cents compared to products without

Table 7. Nonparametric Hedonic Model: GNPD Data

Variable	Coefficient Estimate	Standard Error	t Value	Pr (>|t|)
Intercept	0.0852	0.0168	5.082	9.63E-07
PFREE	0.0454	0.0296	1.533	0.127
KOSHER	0.0062	0.0143	0.433	0.6653
ORGA	0.056	0.0277	2.021	0.0448
BRAND	0.037	0.016	2.309	0.0221
NEW	0.0103	0.0145	0.71	0.4789
CHILD	-0.0251	0.0255	-0.982	0.3277
PEST	-0.1129	0.1022	-1.105	0.2707

n = 181

Table 8. Nonparametric Hedonic Model: PLA Data

Variable	Coefficient Estimate	Standard Error	T Value	Pr (>|t|)
Intercept	0.3098	0.0322	9.629	< 2e-16
EFREE	0.1847	0.2091	0.883	0.378392
NATU	0.2237	0.0611	3.661	0.000339
ANTIFREE	0.2567	0.0732	3.506	0.000587
COOKED	0.0455	0.032	1.425	0.156172
MEAT	-0.015	0.0326	-0.459	0.646634
NEW	0.027	0.0743	0.362	0.71746
FAMILY	-0.0619	0.0528	-1.171	0.243238
FREGR	-0.3114	0.1491	-2.089	0.038273

n = 172

such a claim. As with the parametric model, the variable *EFREE* is insignificant. The number of products using an "*E. coli* free" message is so small; firms may also have a limited ability to monitor such a claim through the supply chain (Hooker and Roe 2002). A "natural" claim has an average 22.37 cents premium, which is statistically significant at the 95 percent confidence level. The nonparametric model verifies the significance level of an "antibiotic free" claim and indicates an average 25.67 cents premium similar to the 19.32 cents premium in the parametric model.

Conclusions

This study investigates the use of safety messages on food and beverage product labels. By examining recent innovations reported in two tracking databases, we find the United States is leading in the still-uncommon use of food safety messages among other English-speaking countries. "Preservative free" claims are most frequent among the set of claims explored, followed by "antibiotic and pesticide free" and "food safety" claims. "*E. coli*, *Salmonella,* and *Listeria* free" and "HACCP" information appear on labels to a lesser extent.

We develop parametric and nonparametric hedonic price models to investigate potential price premiums from chemical and microbiological risk reductions in two food categories in the United States. Nonparametric model results verify the direction of the parameter estimations. We find evidence that a "preservative free" message adds extra value to yogurts, on average about 5 cents per ounce. We also found an average premium for an "*E. coli* free" attribute (5.25 cents in the parametric model and 18.47 cents in the nonparametric model). The limited number of products with "*E. coli* free" messages may impose restrictions on its significance. "Antibiotic free" appears to be valued in price setting for meat and poultry products. Thus, we find limited support that safety sells and that it influences the pricing of yogurt and meat and poultry products. In addition, firms have realized the value-adding benefits of claims such as "preservative and antibiotic free." The value of "microbiological free" claims awaits further recognition and practical labeling, supply chain, and liability strategies.

The infrequent use of "food safety" claims may be due to unclear assurances regarding food from suppliers. While certain claims may be under the direct control of activities conducted within the food manufacturers' plants (e.g., pathogen risk reduction through an intervention or "kill step"), other claims (e.g., "hormone free") may rely on information being shared through the supply chain.

The price premium findings for "food safety" claims are specific to spoonable yogurt and meat and poultry products in the United States, and they will be enriched from investigation of such claims applied in other food categories and nations. This investigation examines the firms' launch (MRSP) pricing behavior, and the analysis of food safety claims could be furthered by incorporating consumer behavior throughout the product life cycle. Sales (e.g., scanner) data combined with this product label information can also contribute to a richer comparison of stated and revealed preferences for "food safety" claims when linked to consumer estimates of willingness to pay.

Claims on food labels provide a (leading) indicator of consumer demand. Their use can provide a strategic advantage for producers and retailers. Full utilization of the value of "food safety" claims informs researchers about a firm's pricing strategy and provides a better understanding of private incentives to deliver food safety. Food safety risks may be real or perceived, with the perception of risk influenced by uncertainty (Wahlqvist and Ball 2002). This study does not explore this issue in sufficient depth. Further analysis of this dimension is justified.

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