Measuring the Value of Convenience: A Hedonic Pricing Model Approach in the Market for Breakfast Sausages

Steven S. Vickner, M.B.A., Ph.D.
Assistant Professor
Department of Agricultural, Environmental, and Development Economics
The Ohio State University
Room 224, Agricultural Administration Building
2120 Fyffe Road
Columbus, OH 43210

Phone: 614-292-6229
Email: vickner.3@osu.edu

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Abstract

In this paper, we estimated a hedonic pricing model for the U.S. refrigerated breakfast sausage market using The Nielsen Company's weekly scanner data for the grocery store distribution channel from May 22, 2010 through May 14, 2011. While the attributes used to measure the marginal, implicit price or value of convenience included indicator variables for both pre-cooked and microwavable products, the model also controlled for other observable product attributes such as product shape (roll, link, patty), fat content, size, size squared, organic, kosher, sodium content, flavor, meat type (pork, beef, chicken, turkey, chicken-turkey blend, and other blends based on pork), private label, and merchandising. A unique structure to this database was a gradient of convenience for raw, pre-cooked, and microwavable. Additionally, we ascertain if the product shape such as roll, link, or patty could affect the marginal value of convenience. Finally, given that cooking breakfast sausage can splatter and create a greasy mess, we ascertain if fat content could affect the marginal value of convenience as well. All of the parameter estimates on the product attributes were consistent with a priori expectations and statistically significant ($p<0.01$); the only exception was the parameter estimate on the fat content attribute which was not statistically significant ($p>0.10$).

The marginal value for pre-cooked products was estimated to be $0.56 per pound. If the pre-cooked product was also sold in a microwavable container, the marginal value was estimated to be $0.47 per pound. Consumers in this market appear to be willing to pay more for the convenience or time savings of a pre-cooked or microwavable product. Regarding product shape, parameter estimates of marginal values for rolls and links (relative to the base of patty) were estimated to be, respectively, -$0.76 per pound and -$0.05 per pound. This finding too may be interpreted as a higher willingness to pay for convenience and time savings.

The larger the product package, hence the heavier its weight, the lower was the price per pound as expected a priori. However, the smallest and largest package sizes increased slightly in price. Both organic and kosher products exhibited positive marginal values, respectively, of $1.84 and $2.45 per pound. Lower sodium products maintained a marginal value of -$0.44 per pound, while products without a specialized flavor, such as spicy cajun, sweet maple or applewood smoked, maintained a premium of $0.09 per pound. The marginal value for pork-only sausage was $1.25 per pound. The marginal value for beef-only sausage was $0.99 per pound. The marginal value for chicken-only sausage was $4.48 per pound. The marginal value for turkey-only sausage was $0.76 per pound. The marginal value for chicken-turkey blended sausage was $5.96 per pound. The base case for the meat type attribute was a blend of pork and another meat. Finally, a private label or store brand sausage product maintained a marginal value of -$0.54 per pound. The merchandising variable was designed to account for the effect of in-store feature advertisements and product displays on price. The estimated parameter on this factor was negative and statistically significant ($p<0.01$) indicating a marginal value of -$1.00.

Market conditions, such as the seven major holidays and monthly seasonality terms, were also included in the model. None of the seven calendar holiday effects was statistically significant ($p>0.10$), and only three of the eleven monthly seasonality effects were statistically significant ($p<0.10$). The linear regression model was estimated using White's heteroskedasticity-consistent standard errors. It is noted, in the analysis period, no relevant product recalls occurred for sausage or related products (USDA-FSIS, 2012).

Keywords: agribusiness, beef, chicken, convenience, hedonic pricing, implicit prices, meat industry, pork, scanner data, turkey, value-added

Introduction

The notion of time and convenience has been long discussed and debated the academic literature. Consumers typically have a higher willingness-to-pay for a product that saves time in the kitchen ceteris paribus. The American Time Use Survey (ATUS) of the U.S. Department of Labor, Bureau of Labor Statistics (2012), has been referenced extensively to document patterns of time use for American consumers. For example, in 2010, the average daily hours expended for food preparation and cleanup for participating individuals was 1.02 hours in total. In comparison, individuals on average spent 8.68 hours sleeping, 7.48 hours working, 3.44 hours watching TV, 1.17 hours eating and drinking, and 0.75 hours grocery shopping. Time saved in the kitchen can be allocated elsewhere to other competing activities in a 24-hour day (Kahneman et al., 2004).

In this paper, we estimated a hedonic pricing model for the U.S. refrigerated breakfast sausage market using The Nielsen Company's weekly scanner data for the grocery store distribution channel from May 22, 2010 through May 14, 2011. While the attributes to measure the marginal value of convenience included indicator variables for both pre-cooked and microwavable products, the model also controlled for other observable product attributes such as product shape (roll, link, patty), fat content, size, size squared, organic, kosher, sodium content, flavor, meat type (pork, beef, chicken, turkey, chicken-turkey blend, and other blends based on pork), private label, and merchandising. A unique structure to this database was a gradient of convenience for raw, pre-cooked, and microwavable. Additionally, we ascertain if the product shape such as roll, link, or patty could affect the marginal value of convenience. Finally, given that cooking breakfast sausage can splatter and create a greasy mess, we ascertain if fat content could affect the marginal value of convenience as well. The hedonic pricing model also controls for holidays and seasonality effects.

Literature Review

The economics of time allocation, given time is a scarce resource, is as old as economics itself. An early attempt to address the leisure-labor tradeoff is given by Robbins (1930), yet many of the historical papers addresses travel cost in transportation (Mohring, 1961; Moses, 1962; Moses and Williamson, 1963; Johnson, 1964, 1966, 1967; Chiswick, 1967; Owen, 1969; Oort, 1969; Wright, 1971; Siegel, 1975; Nelson, 1977, 1978; Cherlow, 1978; Small, 1982) and recreation (Smith, 1997; Larson and Shaikh, 2001). Clearly, Becker (1965) and DeSerpa (1971) have formalized a theory of time allocation that is now well-known and routinely cited. In the applied economics literature, several studies addressed convenience, the food-away-from-home distribution channel, and household production (Prochaska and Schrimper, 1973; Crafton, 1979; Gronau, 1980; Redman, 1980; Kinsey, 1983; Capps, Tedford, and Havlicek, 1985; McCracken and Brandt, 1987; Park and Capps, 1997; Jekanowski, Binkley, and Eales, 2001; Hamermesh, 2007; Carpio, Whohlgenant, and Safley, 2008; Huffman, 2011). The purpose of this study is to address convenience, and hence time, in a hedonic pricing model. Muellbauer's (1974) critiques of hedonic pricing in the context of household production are noted, as are the nuances associated with measuring the welfare of new products and innovations (Trajtenberg, 1989; Petrin, 2002).

Perhaps the earliest application of hedonic pricing in agricultural economics is credited to Waugh (1928), and not surprisingly other economists of his time were also exploring these ideas with application to both agricultural and non-agricultural commodities (Mills, 1927). Now well-known, a formal framework of hedonic pricing based on "implicit prices" of product characteristics or attributes was first presented by Rosen (1974). This research built upon earlier theory of Lancaster (1966) where consumers receive utility from the characteristics or attributes that make up a product, not directly from quantities of the product being consumed. Hedonic pricing models have

been used quite extensively in the valuation of the attributes of food, beverages, automobiles, land, housing, and livestock including both beef cattle and horses.

The theory of labeling of credence goods, such as food, beverage, and bio-based products, is well-summarized and advanced Roe and Sheldon (2007) and others historically (Caswell, 1998). The attribute of interest in this study is a "convenient" breakfast sausage, although we control for many other observable product attributes. Empirically and historically, Rosen's (1974) hedonic pricing methodology has been extensively applied in agricultural and resource economics, urban economics, environmental economics, labor economics, and beyond. Typically just the first stage of his modeling framework has been applied, although some authors have attempted to apply a "corrected" or properly identified second stage as well with the ultimate goal to make welfare estimates; see Brown and Rosen (1982), Diamond and Smith (1985), Mendelsohn (1984, 1985), Bartik (1987), Epple (1987), and Kahn and Lang (1988). More recently, Ekeland, Heckman, and Nesheim (2002, 2004), Bajari and Benkard (2005), Heckman, Matzkin, and Nesheim (2010) have revived interest in Rosen's methods and provide approaches to overcome identification issues, assumptions of separability, and assumptions of additivity of the hedonic price function (Matzkin, 2003).

Many of the methodologies and concepts have been extensively applied in the literature on the livestock and meat industries. Eales and Unnevehr (1988) addressed structural change and the demand for convenience in the U.S. meat industry using a demand systems approach for the 1965-1985 time frame. Chavas and Kim (2005) used a cointegration model to analyze prices of U.S. dairy products for the 1970-1999 time frame. Parcell and Schroeder (2007) used a hedonic pricing model on the Meat Panel Diary data for the 1992-2000 time frame. Ward, Lusk, and Dutton (2008) used a hedonic pricing framework to analyze fresh beef products from Oklahoma City, Oklahoma,

Tulsa, Oklahoma, and Denver, Colorado for the July-August 2006 time frame. Chang, Lusk, and Norwood (2010) applied a hedonic pricing model to shell eggs using both quarterly scanner data for the U.S. for the 2004-2008 time frame and weekly scanner data for Dallas/Fort Worth, Texas and San Francisco/Oakland, California for the January 2007-January 2009 time frame.

Data Description

Data were collected by The Nielsen Company for the U.S. grocery store distribution channel. These data span the 52-week time frame from the Saturday ending May 22, 2010 through May 14, 2011. In this database are 791 separate products. Of these, 164 products, or 20.7% of the total, are pre-cooked. The descriptive statistics are presented in Table 1. The price of sausage is measured in U.S. dollars per pound. Size is measured in pounds. All other variables, except for merchandising, are indicator variables. The merchandising variable is a continuous variable bound between zero and one measuring the fraction sales in a given week for a given product marketed using some form of in-store feature advertisement or display. There 41,239 observations in the database.

Model Development and Empirical Results

A stylized hedonic pricing model using mixed effects linear regression notation is given by

$$\mathbf{y} = \mathbf{X}\beta + \mathbf{W}\lambda + \varepsilon \tag{1}$$

where $\mathbf{y}$ is a $n \times 1$ vector of prices transformed; $\mathbf{X}$ is a $n \times k$ matrix of covariates describing physical attributes of the breakfast sausage products; β is a $k \times 1$ vector of unknown parameters; $\mathbf{W}$ is a $n \times q$ matrix of covariates for the random effects; λ is a $q \times 1$ vector of random effects; and ε is a $n \times 1$ vector of disturbance terms. The term $\mathbf{W}\lambda + \varepsilon$ represents the random components

of (1) and it follows distributional assumptions well-known in the literature (Baltagi, 2005; Baltagi, Song, and Jung, 2001; Rabe-Hesketh and Skrondal, 2006; Rabe-Hesketh, Skrondal, and Pickles, 2005; Skrondal and Rabe-Hesketh, 2004). Estimation of (1) is performed using the Stata/SE 12.1 software (Cameron and Trivedi, 2009; Rabe-Hesketh and Skrondal, 2008). For the purposes of this initial paper, it is assumed $\mathbf{W} = \mathbf{0}$ to simplify the modeling. Hence, any clustering in the data, say for products within a brand or repeated observations within a product, is assumed to be negligible yet will explored in future research. It is conjectured that $\mathbf{X}$ adequately captures this clustering behavior. Ordinary least squares with White's (1980) heteroskedasticity-consistent standard errors is used to estimate the hedonic pricing model. Choice of and implications for functional forms in hedonic pricing are well documented by Bender, Gronberg, and Hwang (1980), Halvorsen and Palmquist (1980), Halvorsen and Pollakowski (1981), Kennedy (1981), Duan (1983), and Miller (1984). A lin-lin functional form proved to be adequate for the purposes of this paper. Issues related to capitalized prices (Abelson and Markandya, 1985) and double-counting (McConnell) have also been noted.

Tables 2a-2c catalog the parameter estimates and robust standard errors for the total U.S. breakfast sausage hedonic pricing model. The base case is given by the following product attribute and market condition values: raw, non-microwavable, patty, regular fat content, non-organic, non-kosher, regular sodium content, flavored, pork blend, non-private label, non-holiday week, and the month of December. Table 2a presents the full hedonic pricing model. Table 2b represents a hedonic pricing model in which the indicator variable for the link shape is excluded. Finally, Table 2c further excludes the indicator variable for fat content. The intent of excluding those two variables, which may also provide convenience benefits, is to ascertain any kind of specification bias in the full model. The parameter estimates are quite stable across all three tables.

The marginal value for pre-cooked products was estimated to be $0.56 per pound. If the pre-cooked product was also sold in a microwavable container, the marginal value was estimated to be $0.47 per pound. Consumers in this market appear to be willing to pay more for the convenience or time savings of a pre-cooked or microwavable product. Regarding product shape, parameter estimates of marginal values for rolls and links (relative to the base of patty) were estimated to be, respectively, -$0.76 per pound and -$0.05 per pound. This finding too may be interpreted as a higher willingness to pay for convenience and time savings.

The larger the product package, hence the heavier its weight, the lower was the price per pound as expected a priori. However, the smallest and largest package sizes increased slightly in price. Both organic and kosher products exhibited positive marginal values, respectively, of $1.84 and $2.45 per pound. Lower sodium products maintained a marginal value of -$0.44 per pound, while products without a specialized flavor, such as spicy cajun, sweet maple or applewood smoked, maintained a premium of $0.09 per pound. The marginal value for pork-only sausage was $1.25 per pound. The marginal value for beef-only sausage was $0.99 per pound. The marginal value for chicken-only sausage was $4.48 per pound. The marginal value for turkey-only sausage was $0.76 per pound. The marginal value for chicken-turkey blended sausage was $5.96 per pound. The base case for the meat type attribute was a blend of pork and another meat. Finally, a private label or store brand sausage product maintained a marginal value of -$0.54 per pound. The merchandising variable was designed to account for the effect of in-store feature advertisements and product displays on price. The estimated parameter on this factor was negative and statistically significant ($p<0.01$) indicating a marginal value of -$1.00.

Market conditions, such as the seven major holidays and monthly seasonality terms, were also included in the model. None of the seven calendar holiday effects was statistically significant

($p>0.10$), and only three of the eleven monthly seasonality effects were statistically significant ($p<0.10$). The linear regression model was estimated using White's heteroskedasticity-consistent standard errors. It is noted, in the analysis period, no relevant product recalls occurred for sausage or related products (USDA-FSIS, 2012).

Summary, Conclusions, and Directions for Future Research

In this paper, we estimated a hedonic pricing model for the U.S. refrigerated breakfast sausage market using The Nielsen Company's weekly scanner data for the grocery store distribution channel from May 22, 2010 through May 14, 2011. While the attributes used to measure the marginal, implicit price or value of convenience included indicator variables for both pre-cooked and microwavable products, the model also controlled for other observable product attributes such as product shape (roll, link, patty), fat content, size, size squared, organic, kosher, sodium content, flavor, meat type (pork, beef, chicken, turkey, chicken-turkey blend, and other blends based on pork), private label, and merchandising. A unique structure to this database was a gradient of convenience for raw, pre-cooked, and microwavable. Additionally, we ascertain if the product shape such as roll, link, or patty could affect the marginal value of convenience. Finally, given that cooking breakfast sausage can splatter and create a greasy mess, we ascertain if fat content could affect the marginal value of convenience as well. All of the parameter estimates on the product attributes were consistent with a priori expectations and statistically significant ($p<0.01$); the only exception was the parameter estimate on the fat content attribute which was not statistically significant ($p>0.10$).

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The linear regression model was estimated using White's heteroskedasticity-consistent standard errors. It is noted, in the analysis period, no relevant product recalls occurred for sausage or related products (USDA-FSIS, 2012). Given the advent of new approaches to the identification and estimation of hedonic pricing models, the present research provides a set of estimates for future comparison purposes.

As previously mentioned, Rosen's (JPE, 1974) hedonic pricing methodology has been extensively applied in many disciplines of social science. Standard practice is to estimate the first stage of his modeling approach. Several authors have attempted to apply a "corrected" or properly identified second stage as well with the ultimate goal to make welfare estimates; see Brown and Rosen (1982), Diamond and Smith (1985), Mendelsohn (1984, 1985), Bartik (1987), Epple (1987), and Kahn and Lang (1988). More recently, Ekeland, Heckman, and Nesheim (2002, 2004), Bajari and Benkard (2005), Heckman, Matzkin, and Nesheim (2010) have revived interest in Rosen's methods and provide approaches to overcome identification issues, assumptions of separability, and assumptions of additivity of the hedonic price function (Matzkin, 2003). While beyond the scope of the present study, we will adopt and apply these nascent methodologies to identify and estimate similar hedonic pricing functions in future research. Other related approaches to this general problem do exist and are noted; advances in industrial organization and marketing research on demand systems for differentiated products have been made recently by Nevo (2001), Berry and Pakes (2007) and Song (2007), which build upon the seminal and now standard works of Berry (1994) and Berry, Levinsohn, and Pakes (1995). These approaches could also provide additional insights to this study and other related projects.

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Table 1. Descriptive Statistics for Variables in Hedonic Pricing Models[a]

Variable	Mean	Standard Deviation
PRICE	3.638	1.596
COOKED	0.203	0.402
MICROWAVE	0.003	0.051
ROLL	0.394	0.489
LINK	0.377	0.485
LOWFAT	0.081	0.273
SIZE	1.067	0.681
SIZESQ	1.602	2.913
ORGANIC	0.008	0.091
KOSHER	0.0005	0.021
LOWSALT	0.006	0.079
REGFLAVOR	0.367	0.482
PORK	0.839	0.367
BEEF	0.027	0.162
CHICKEN	0.022	0.147
TURKEY	0.066	0.248
CHKTRKBLEND	0.002	0.042
PRIVLABEL	0.136	0.342
ANYMERCH	0.105	0.203

[a] Based on a sample of 41,239 observations. Descriptive statistics for holiday and seasonality indicator variables are available upon request from the author.

Table 2a. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
COOKED	0.557	***	0.022
MICROWAVE	0.467	***	0.090
ROLL	-0.758	***	0.014
LINK	-0.048	***	0.015
LOWFAT	0.037		0.026
SIZE	-1.309	***	0.029
SIZESQ	0.187	***	0.006
ORGANIC	1.841	***	0.165
KOSHER	2.454	***	0.109
LOWSALT	-0.438	***	0.068
REGFLAVOR	0.094	***	0.014
PORK	1.250	***	0.028
BEEF	0.990	***	0.043
CHICKEN	4.482	***	0.096
TURKEY	0.759	***	0.038
CHKTRKBLEND	5.962	***	0.061
PRIVLABEL	-0.543	***	0.014
ANYMERCH	-0.997	***	0.023

(continued)

Table 2a. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
HOLIDAY1	-0.008		0.050
HOLIDAY2	-0.014		0.052
HOLIDAY3	-0.030		0.047
HOLIDAY4	-0.024		0.050
HOLIDAY5	0.002		0.048
HOLIDAY6	-0.005		0.051
HOLIDAY7	0.001		0.050
MONTH1	0.038		0.033
MONTH2	0.031		0.033
MONTH3	0.055	*	0.031
MONTH4	0.095	***	0.035
MONTH5	0.015		0.033
MONTH6	-0.075	**	0.033
MONTH7	-0.039		0.036
MONTH8	-0.012		0.033
MONTH9	0.005		0.033
MONTH10	0.006		0.033
MONTH11	0.015		0.035
CONSTANT	3.821	***	0.052
R-squared	0.412		

[a] Based on a sample of 41,239 observations. Dependent variable is price ($/pound). All models estimated with White's heteroskedasticity-consistent standard errors. Note: *** 1%, ** 5%, * 10% significance levels.

Table 2b. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
COOKED	0.556	***	0.022
MICROWAVE	0.458	***	0.090
ROLL	-0.758	***	0.014
LINK	-0.048	***	0.015
LOWFAT	---		---
SIZE	-1.311	***	0.029
SIZESQ	0.188	***	0.006
ORGANIC	1.838	***	0.165
KOSHER	2.454	***	0.109
LOWSALT	-0.436	***	0.068
REGFLAVOR	0.095	***	0.014
PORK	1.245	***	0.028
BEEF	0.983	***	0.043
CHICKEN	4.489	***	0.095
TURKEY	0.770	***	0.037
CHKTRKBLEND	5.956	***	0.061
PRIVLABEL	-0.544	***	0.013
ANYMERCH	-0.997	***	0.023

(continued)

Table 2b. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
HOLIDAY1	-0.008		0.050
HOLIDAY2	-0.014		0.052
HOLIDAY3	-0.030		0.047
HOLIDAY4	-0.024		0.050
HOLIDAY5	0.002		0.048
HOLIDAY6	-0.005		0.051
HOLIDAY7	0.001		0.050
MONTH1	0.038		0.033
MONTH2	0.031		0.033
MONTH3	0.055	*	0.031
MONTH4	0.095	***	0.035
MONTH5	0.015		0.033
MONTH6	-0.075	**	0.033
MONTH7	-0.039		0.036
MONTH8	-0.012		0.033
MONTH9	0.005		0.033
MONTH10	0.006		0.033
MONTH11	0.015		0.035
CONSTANT	3.828	***	0.051
R-squared	0.412		

[a] Based on a sample of 41,239 observations. Dependent variable is price ($/pound). All models estimated with White's heteroskedasticity-consistent standard errors. Note: *** 1%, ** 5%, * 10% significance levels.

Table 2c. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
COOKED	0.562	***	0.021
MICROWAVE	0.451	***	0.089
ROLL	-0.729	***	0.014
LINK	---		---
LOWFAT	---		---
SIZE	-1.296	***	0.028
SIZESQ	0.186	***	0.005
ORGANIC	1.831	***	0.165
KOSHER	2.452	***	0.109
LOWSALT	-0.451	***	0.068
REGFLAVOR	0.093	***	0.014
PORK	1.256	***	0.027
BEEF	0.991	***	0.042
CHICKEN	4.485	***	0.095
TURKEY	0.781	***	0.036
CHKTRKBLEND	5.947	***	0.061
PRIVLABEL	-0.543	***	0.013
ANYMERCH	-0.996	***	0.023

(continued)

Table 2c. Hedonic Pricing Model of Breakfast Sausage[a]

Variable	Coefficient		S.E.
HOLIDAY1	-0.008		0.050
HOLIDAY2	-0.014		0.052
HOLIDAY3	-0.030		0.047
HOLIDAY4	-0.024		0.050
HOLIDAY5	0.002		0.048
HOLIDAY6	-0.004		0.051
HOLIDAY7	0.001		0.050
MONTH1	0.038		0.033
MONTH2	0.031		0.033
MONTH3	0.055	*	0.031
MONTH4	0.095	***	0.035
MONTH5	0.015		0.033
MONTH6	-0.075	**	0.033
MONTH7	-0.039		0.036
MONTH8	-0.012		0.033
MONTH9	0.005		0.033
MONTH10	0.006		0.033
MONTH11	0.015		0.035
CONSTANT	3.776	***	0.047
R-squared	0.412		

[a] Based on a sample of 41,239 observations. Dependent variable is price ($/pound). All models estimated with White's heteroskedasticity-consistent standard errors. Note: *** 1%, ** 5%, * 10% significance levels.