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

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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

(1) $\qquad \mathbf{y} = \mathbf{X}\beta + \mathbf{W}\lambda + \varepsilon$

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; $\beta$ is a $k \times 1$ vector of unknown parameters;

$\mathbf{W}$ is a $n \times q$ matrix of covariates for the random effects; $\lambda$ is a $q \times 1$ vector of random effects;

and $\varepsilon$ 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.

**References**

Abelson, P.W. and A. Markandya. "The Interpretation of Capitalized Hedonic Prices in a Dynamic Environment." *Journal of Environmental Economics and Management*. 12(1985):195-206.

Bajari, P. and C.L. Benkard. "Demand Estimation with Heterogeneous Consumers and Unobserved Product Characteristics: A Hedonic Approach." *Journal of Political Economy*. 113(2005): 1239-1276.

Baltagi, B.H., Song, S.H. and B.C. Jung. "The Unbalanced Nested Error Component Regression Model." *Journal of Econometrics*. 101(2001):357-381.

Baltagi, B.H. *Econometric Analysis of Panel Data*. 3rd Edition. Hoboken, NJ: John Wiley & Sons, 2005.

Bartik, T.J. "The Estimation of Demand Parameters in Hedonic Price Models." *Journal of Political Economy*. 95(1987):81-88.

Becker, G.S. "A Theory of the Allocation of Time." *The Economic Journal*. 75(1965):493-517.

Bender, B., Gronberg, T.J., and H.S. Hwang. "Choice of Functional Form and the Demand for Air Quality." *Review of Economics and Statistics*. 62(1980):638-643.

Berry, S. "Estimating Discrete-Choice Models of Product Differentiation." *Rand Journal of Economics*. 25(1994):242-262.

Berry, S., Levinsohn, J., and A. Pakes. "Automobile Prices in Market Equilibrium." *Econometrica*. 63(1995):841-890.

Berry, S. and A. Pakes. "The Pure Characteristics Demand Model." *International Economic Review*. 48(2007):1193-1225.

Breusch, T.S. and A.R. Pagan. "The Lagrange Multiplier Test and Its Applications to Model Specification in Econometrics." *Review of Economic Studies*. 47(1980):239-253.

Brown, J.N. and H.S. Rosen. "On the Estimation of Structural Hedonic Price Models." *Econometrica*. 50(1982):765-768.

Cameron, A.C. and P.K.Trivedi. *Microeconometrics Using Stata*. College Station, TX: Stata Press, 2009.

Capps, O., Tedford, J.R., and J. Havlicek. "Household Demand for Convenience and Nonconvenience Foods." *American Journal of Agricultural Economics*. 67(1985):863-869.

Carpio, C.E., Wohlgenant, M.K., and C.D. Safley. "A Structural Econometric Model of Joint Consumption of Goods and Recreational Time: An Application to Pick-Your-Own Fruit." *American Journal of Agricultural Economics*. 90(2008):644-657.

Caswell, J.A. "How Labeling of Safety and Process Attributes Affects Markets for Food." *Agricultural and Resource Economics Review*. 27(1998):151-158.

Chang, J.B., Lusk, J.L., and F.B. Norwood. "The Price of Happy Hens: A Hedonic Analysis of Retail Egg Prices." *Journal of Agricultural and Resource Economics*. 35(2010):406-423.

Chavas, J.P. and K. Kim. "Cointegration Relationships and Hedonic Pricing of Differentiated Commodities: An Application to Price Dynamics in the US Dairy Sector." *Applied Economics*. 37(2005):1813-1827.

Cherlow, J.R. "Accessibility and the Value of Time in Commuting: Comment." *Southern Economic Journal*. 44(1978):293-297.

Chiswick, B.R. "The Economic Value of Time and the Wage Rate: Comment." *Western Economic Journal*. 5(1967):294-295.

Crafton, S.M. "Convenience Store Pricing and the Value of Time: A Note on the Becker-Devany Full Price Model." *Southern Economic Journal*. 45(1979):1254-1260.

DeSerpa, A.C. "A Theory of the Economics of Time." *The Economic Journal*. 81(1971):828-846.

Diamond, D.B. and B.A. Smith. "Simultaneity in the Market for Housing Characteristics." *Journal of Urban Economics*. 17(1985):280-292.

Duan, N. "Smearing Estimate: A Nonparametric Retransformation Method." *Journal of the American Statistical Association*. 78(1983):605-610.

Eales, J.S. and L. Unnevehr. "Demand for Beef and Chicken Products: Separability and Structural Change." *American Journal of Agricultural Economics*. 70(1988):521-532.

Ekeland, I., Heckman, J.J., and L. Nesheim. "Identification and Estimation of Hedonic Models." *Journal of Political Economy*. 112(2004):S60-S109.

_____. "Identifying Hedonic Models." *The American Economic Review*. 92(2002):304-309.

Epple, D. "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products." *Journal of Political Economy*. 95(1987):59-80.

Gronau, R. "Home Production - A Forgotten Industry." *The Review of Economics and Statistics*. 62(1980):408-416.

Greene, W.A. *Econometric Analysis*. 5th Edition. Upper Saddle River, NJ: Prentice Hall, 2003.

Halvorsen, R. and R. Palmquist. "The Interpretation of Dummy Variables in Semilogarithmic Equations." *The American Economic Review*. 70(1980):474-475.

Halvorsen, R. and H.O. Pollakowski. "Choice of Functional Form for Hedonic Price Equations." *Journal of Urban Economics*. 10(1981):37-49.

Hamermesh, D. "Time to Eat: Household Production under Increasing Income Inequality." *American Journal of Agricultural Economics*. 89(2007):852-863.

Hausman, J.A. "Specification Tests in Econometrics." *Econometrica*. 46(1978):1251-1271.

Heckman, J.J., Matzkin, R.L., and L. Nesheim. "Nonparametric Identification and Estimation of Nonadditive Hedonic Models." *Econometrica*. 78(2010):1569-1591.

Huffman, W.W. "Household Production and the Demand for Food and Other Inputs: U.S. Evidence." *Journal of Agricultural and Resource Economics*. 36(2011):465-487.

Jekanowski, M.D., Binkley, J.K., and J.S. Eales. "Convenience, Accessibility, and the Demand for Fast Food." *Journal of Agricultural and Resource Economics*." 26(2001):58-74.

Johnson, M.B. "Travel Time and the Price of Leisure." *Western Economic Journal*. 4(1966): 135-145.

_____. "Reply." *Western Economic Journal*. 5(1967):296.


_____. "On the Economics of Road Congestion." *Econometrica*. 32(1964):137-150.

Kahn, S. and K. Lang. "Efficient Estimation of Structural Hedonic Systems." *International Economic Review*. 29(1988):157-166.

Kahneman, D., Krueger, A.B., Schkade, D.A., Schwartz, N., and A.A. Stone. "A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method." *Science*. 306(2004): 1776-1780.

Kennedy, P.E. "Estimation with Correctly Interpreted Dummy Variables in Semilogarithmic Equations." *The American Economic Review*. 71(1981):801.

Kinsey, J. "Working Wives and the Marginal Propensity to Consume Food Away from Home." *American Journal of Agricultural Economics*. 65(1983):10-19.

Lancaster, K.J. "A New Approach to Consumer Theory." *Journal of Political Economy*. 74(1966): 132-157.

Larson, D.M. and S.L. Shaikh. "Empirical Specification Requirements for Two-Constraint Models of Recreation Choice." *American Journal of Agricultural Economics*. 83(2001):428-440.

Matzkin, R.L. "Nonparametric Estimation of Nonadditive Random Functions." *Econometrica*. 71(2003):1339-1375.

McConnell, K.E. "Double Counting in Hedonic and Travel Cost Models." *Land Economics*. 66(1990):121-127.

McCracken, V.A. and J.A. Brandt. "Household Consumption of Food-Away-From-Home: Total Expenditure and by Type of Food Facility." *American Journal of Agricultural Economics*. 69(1987): 274-284.

Mendelsohn, R. "Estimating the Structural Equations of Implicit Markets and Household Production Functions." *The Review of Economics and Statistics*. 66(1984):673-677.

_____. "Identifying Structural Equations with Single Market Data." *The Review of Economics and Statistics*. 67(1985):525-529.

Mills, F.C. *The Behavior of Prices*. New York, NY: National Bureau of Economic Research, 1927.

Miller, D.M. "Reducing Transformation Bias in Curve Fitting." *The American Statistician*. 38(1984):124-126.

Mohring, H. "Land Values and the Measurement of Highway Benefits." *Journal of Political Economy*. 69(1961):236-249.

Moses, L.N. "Income, Leisure, and Wage Pressure." *The Economic Journal*. 72(1962):320-334.

Moses, L.N. and H.F. Williamson. "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation." *Journal of Political Economy*. 71(1963):247-264.

Muellbauer, J. "Household Production Theory, Quality, and the Hedonic Technique." *The American Economic Review*. 64(1974):977-994.

Nelson, J.P. "Accessibility and the Value of Time in Commuting." *Southern Economic Journal*. 43(1977):1321-1329.

_____. "Accessibility and the Value of Time in Commuting: Reply." *Southern Economic Journal*. 44(1978):298-300.

Nevo, A. "Measuring Market Power in the Ready-to-Eat Cereal Industry." *Econometrica*. 69(2001): 307-342.

Oort, C.J. "The Evaluation of Travelling Time." *Journal of Transport Economics and Policy.*" 3(1969):279-286.

Owen, J.D. "The Value of Commuter Speed." *Western Economic Journal.* 7(1969):164-172.

Parcell, J.L. and T.C. Schroeder. "Hedonic Retail Beef and Pork Product Prices." *Journal of Agricultural and Applied Economics.* 39(2007):29-46.

Park, J.L. and O. Capps. "Demand for Prepared Meals by U.S. Households." *American Journal of Agricultural Economics.* 79(1997):814-824.

Petrin, A. "Quantifying the Benefits of New Products: The Case of the Minivan." *Journal of Political Economy.* 110(2002):705-729.

Prochaska, F.J. and R.A. Schrimper. "Opportunity Cost of Time and Other Socioeconomic Effects on Away-From-Home Food Consumption." *American Journal of Agricultural Economics.* 55(1973): 595-603.

Rabe-Hesketh, S. and A. Skrondal. "Multilevel Modeling of Complex Survey Data." *Journal of the Royal Statistical Society, Series A.* 169(2006):805-827.

_____. *Multilevel and Longitudinal Modeling Using Stata.* 2nd Edition. College Station, TX: Stata Press, 2008.

Rabe-Hesketh, S., Skrondal, A. and A. Pickles. "Maximum Likelihood Estimation of Limited and Discrete Dependent Variable Models with Nested Random Effects." *Journal of Econometrics.* 128(2005):301-323.

Redman, B.J. "The Impact of Women's Time Allocation on Expenditure for Meals Away from Home and Prepared Foods." *American Journal of Agricultural Economics.* 62(1980):234-237.

Robbins, L. "On the Elasticity of Demand for Income in Terms of Effort." *Economica.* 29(1930): 123-129.

Roe, B. and I. Sheldon. "Credence Good Labeling: The Efficiency and Distributional Implications of Several Policy Approaches." *American Journal of Agricultural Economics.* 89(2007):1020-1033.

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy.* 82(1974):34-55.

Self, S.G. and K.Y. Liang. "Asymptotic Properties of Maximum Likelihood Estimators and Likelihood Ratio Tests under Nonstandard Conditions." *Journal of the American Statistical Association.* 82(1987):605-610.

Siegel, J. "Intrametropolitan Migration: A Simultaneous Model of Employment and Residential Location of White and Black Households." *Journal of Urban Economics*. 2(1975):29-47.

Skrondal, A. and S. Rabe-Hesketh. *Generalized Latent Variable Modeling: Multilevel, Longitudinal, and Structural Equation Models*. Boca Raton, FL: Chapman & Hall/CRC, 2004.

Small, K.A. "The Scheduling of Consumer Activities: Work Trips." *The American Economic Review*. 72(1982):467-479.

Smith, V.K. "Time and the Valuation of Environmental Resources." Discussion paper 98-07, Washington, DC: Resources for the Future, November 1997.

Song, M. "Measuring Consumer Welfare in the CPU Market: An Application of the Pure-Characteristics Demand Model." *Rand Journal of Economics*. 38(2007):429-446.

Stock, J.H. and M.W. Watson. "Heteroskedasticity-robust Standard Errors for Fixed Effects Panel Data Regression." *Econometrica*. 76(2008):155-174.

Stram, D.O. and J.W. Lee. "Variance Components Testing in the Longitudinal Mixed Effects Model." *Biometrics*. 50(1994):1171-1177.

Trajtenberg, M. "The Welfare Analysis of Product Innovations, with an Application to Computed Tomography Scanners." *Journal of Political Economy*. 97(1989):444-479.

U.S. Department of Agriculture. Food Safety and Inspection Service. http://www.fsis.usda.gov/ (accessed January 3, 2012).

U.S. Department of Labor. Bureau of Labor Statistics. American Time Use Survey (ATUS). http://www.bls.gov/tus/ (accessed January 3, 2012).

Ward, C.E., Lusk, J.L., and J.M. Dutton. "Implicit Value of Retail Beef Product Attributes." *Journal of Agricultural and Resource Economics*. 33(2008):364-381.

Waugh, F.V. "Quality Factors Influencing Vegetable Prices." *Journal of Farm Economics*. 10(1928): 185-196.

White, H. "A Heteroskedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrica*. 48(1980):817-838.

Wooldridge. J.M. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: The MIT Press, 2002.

Wright, C. "Residential Location in a Three-dimensional City." *Journal of Political Economy*. 79(1971):1378-1387.

**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.