EFFECT OF LENGTH OF TIME ON MEASURED DEMAND ELASTICITIES: THE PROBLEM REVISITED

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Abstract

This study centers attention on the effect of varying lengths of time (weekly, biweekly, monthly observations) on measured demand elasticities for disaggregate fresh beef products. Parameter estimates and elasticities based on monthly data differ from those based on biweekly or weekly data. Generally, inventory adjustment dominates with the latter time intervals. On the other hand, for three of the six disaggregate fresh beef products analyzed, habit formation is the dominating effect with monthly data.

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Introduction

To quote Manderscheid (p. 131), "the length of time period being considered is quite important when specifying elasticities." Elasticity estimates based on shorter time periods usually differ from those based on longer time periods (Manderscheid; Pasour and Schrimper; Sexauer). Shepherd, in considering the effect of time, suggests that two opposing forces exist which influence the elasticity of demand: (1) storage activities and (2) product substitution. Short-term elasticities (week, month) are likely to be greater than longer-term elasticities because of storage activities. Product substitution is likely to be positively related to the length of time period under consideration. Within short periods of time, Shepherd contends that the influence of product substitution on elasticity measures is likely to be more than offset by the opposite effect of storage activities.

The role of inventory demand and habits on consumer expenditure patterns also depends on the time dimension. The inventory adjustment/habit formation process also varies from commodity to commodity (Pasour and Schrimper). Generally though, inventory demand tends to dominate habits in short-term. Sexauer showed that short-run consumer behavior as opposed to longer-run consumer behavior is influenced more by consumer inventories than habits, particularly for food. Wohlgenant and Hahn reinforced this view by indicating that for pork, using monthly data, inventory behavior predominates and that demand is more elastic within a given month than over a longer period. Although not statistically significant, their structural parameter estimates for beef also indicated the predominance of inventory adjustments. For chicken, however, consumption habits were found to dominate inventory adjustment in the Wohlgenant and Hahn study.

This paper focuses on the effect of the length of time on demand for fresh beef products. But unlike the other studies mentioned above, this paper deals with more disaggregate fresh beef products grouped by carcass section (brisket, chuck, ground, loin, rib, and round). As well, this paper focuses attention on

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relatively short time periods (weekly, biweekly, and monthly) using scanner data from a retail food firm (43 supermarkets) in Houston.

Two related questions are addressed in this article. The first concerns the nature of dynamic adjustment in consumer demands for disaggregate food commodities other than traditionally analyzed aggregate food commodities. The second concerns the sensitivity of dynamic adjustments in demands to shorter time intervals. The use of scanner data permits the focus on shorter time intervals and also allows the analysis of more disaggregate food commodities.

Data and Procedures

Scanner data from all the stores in the firm are aggregated into weekly, biweekly, and monthly time series observations. The demand equations are estimated with weekly, biweekly, and monthly data over the period September 1986 to November 1988. This study is based on point-of-sale purchases. The number of individual fresh beef products (Universal Product Codes or UPCs) is 100. However, to conform to space restrictions, attention is centered on disaggregate fresh beef products grouped by carcass section (brisket(3), chuck(9), ground(9), loin(23), rib(11), round(14), and all other beef(31)). The numbers in parentheses correspond to the number of UPCs in the respective category. Pounds corresponding to the UPC as well as the price corresponding the UPC are reported by week for the time period in question.

The quantities of the various fresh beef products correspond to the sum of the respective quantities of the relevant UPCs. The implicit prices of the products in question are weighted averages of all individual UPC prices within the particular category. The weights correspond to the relative shares of the quantities of the UPCs to the total quantity within the relevant category. There are 113 weekly, 56 biweekly, and 25 monthly data points used in this analysis.

The analysis in this paper is centered on the use of the Houthakker-Taylor (HT) state adjustment model. The state variable in the model relates to either physical stocks or psychological stocks (habits) in consumption. The model contains two equations: a short-run demand function and a stock depreciation equation.

The specification of the HT model for the ith disaggregate beef product is

(1) $q_{it} = \alpha_i + B_i S_{it} + \gamma_{i1} P_{it} + \gamma_{i2} PAOB_t + \gamma_{i3} PPORK_t + \gamma_{i4}\, PPOULTRY_t + \gamma_{i5} Y_t$, and

(2) $\dot{S}_{it} = q_{it} - \delta_i S_{it}$

where i conforms to the ith fresh beef product (brisket, chuck, ground, loin, rib, round); q_{it} is purchases per 1000 customers (pounds/1000 customers) for the ith fresh beef product at time period t; S_{it} is the state variable of the ith product at time period t; P_{it} is the price (weighted average) of the ith product at time period t (¢/pound); $PAOB_t$ is the price of all the beef products other than the ith product at time period t (¢/pound); $PPORK_t$ is the price of pork at time period t (¢/pound); $PPOULTRY_t$ is the price of poultry at time period t (¢/pound); and Y_t is the total expenditure on meat products per 1000 customers at time period t (¢/1000 customers). Equation (2) relates that stocks depreciate at a geometric rate over time. $\dot{S}_{it}$ stands for the rate of change in the stock (physical or psychological) at t and $\delta_i S_{it}$ stands for the average depreciation of the stock at t. δ_i is the depreciation rate.

Due to data unavailability, total expenditures on meat products per 1000 customers is used in lieu of income or total expenditures. Also, since data are only from a single firm, some may argue that price elasticities are not estimable. The rationale for this proposition is as follows: (1) consumers can respond to price changes by shopping at different stores within a market, and (2) no information in this study is available on prices charged at other food stores. However, according to the Food Marketing Institute, only 27% shoppers compare prices from store to store (Cox and Foster). Additionally, multicollinearity between competitors' prices and in-store prices may be too strong to allow for measurement of the separate effects of the variables (Funk, Meilke, Huff). Therefore, in this study, the omission of competitors' prices may not necessarily be a limiting factor in estimating in-store price elasticities.

However, the structural specification given in equations (1) and (2) fails to account for in-store advertising and sales promotion activities as well as seasonal effects. Although the omission of these variables may result in bias of the parameter estimates, the emphasis in this paper is on the effect of the time interval on price and expenditure elasticities.

The sign of the coefficient associated with the state variable indicates the presence of an inventory-adjustment effect when negative and a habit-formation effect when positive. Consequently consumer demand at time t increases with a decrease in inventory (physical stocks) or a rise in stock of habits (psychological stocks). It is expected that inventory effects dominate habit formation for durable goods. For nondurable goods, the reverse is expected. This distinction between durables and nondurables is, however, ambiguous and depends on the time dimension (Sexauer). Any good, which provides a stream of services over time, can be conceived as a durable when the time dimension in question is short enough. The opportunity cost of consumer's shopping time becomes an increasingly important factor to consider as the time horizon decreases. As well, consumers might purchase more beef and store for later consumption when price decreases.

Following Houthakker and Taylor or Phlips, the reduced-form equation for each of the disaggregate beef products is as follows:

(3) $$q_{it} = A_{i0} + A_{i1}\Delta P_{it} + A_{i2}P_{it-1} + A_{i3}\Delta PAOB_t + A_{i4}PAOB_{t-1} + A_{i5}\Delta PPORK_t + A_{i6}PPORK_{t-1} + A_{i7}\Delta PPOULTRY_t + A_{i8}PPOULTRY_{t-1} + A_{i9}\Delta Y_t + A_{i10}Y_{t-1} + A_{i11}q_{it-1} + \epsilon_{it}$$

where:

$$A_{i0} = \frac{\alpha_i \delta_i}{1 - ½(B_i - \delta_i)} \qquad A_{i6} = \frac{\gamma_{i3}\delta_i}{1 - ½(B_i - \delta_i)}$$

$$A_{i1} = \frac{\gamma_{i1}(1 + ½\delta_i)}{1 - ½(B_i - \delta_i)} \qquad A_{i7} = \frac{\gamma_{i4}(1 + ½\delta_i)}{1 - ½(B_i - \delta_i)}$$

$$A_{i2} = \frac{\gamma_{i1}\delta_i}{1 - ½(B_i - \delta_i)} \qquad A_{i8} = \frac{\gamma_{i4}\delta_i}{1 - ½(B_i - \delta_i)}$$

$$A_{i3} = \frac{\gamma_{i2}(1 + ½\delta_i)}{1 - ½(B_i - \delta_i)} \qquad A_{i9} = \frac{\gamma_{i5}(1 + ½\delta_i)}{1 - ½(B_i - \delta_i)}$$

$$A_{i4} = \frac{\gamma_{i2}\delta_i}{1 - ½(B_i - \delta_i)} \qquad A_{i10} = \frac{\gamma_{i5}\delta_i}{1 - ½(B_i - \delta_i)}$$

$$A_{i5} = \frac{\gamma_{i3}(1 + ½\delta_i)}{1 - ½(B_i - \delta_i)} \qquad A_{i11} = \frac{1 + ½(B_i - \delta_i)}{1 - ½(B_i - \delta_i)}$$

Since the structural parameter, δ_i is overidentified, the reduced form coefficients in (3) are restricted to obtain a unique estimate of δ_i. These restrictions are as follows:

(4) $A_{i1} = A_{i2}\, A_{i9} / A_{i10}$

$A_{i3} = A_{i4}\, A_{i9} / A_{i10}$

$A_{i5} = A_{i6}\, A_{i9} / A_{i10}$

$A_{i7} = A_{i8}\, A_{i9} / A_{i10}$.

The unique solutions of δ_i and B_i using the reduced-form parameters are

(5) $\delta_i = 1/[(A_{i9}/A_{i10}) - ½]$ and

$B_i = \delta_i + [2(A_{i11} - 1)/(1 + A_{i11})]$

Solutions for δ_i, γ_{i1}, γ_{i3}, γ_{i4}, and γ_{i5} are then obtained by substituting δ_i and B_i from (5) into the expressions for the reduced-form coefficients. The γ_{ij}s are the short-run derivatives of purchases per 1000 customers with respect to prices and total expenditure on meat products. The long-run derivatives, on the other hand, are obtained by setting each $\dot{S}_{it}$ in (2) equal to zero and substituting the results into (1) to get

(6) $$q_{it} = \frac{\alpha_i\delta_i}{\delta_i - B_i} + \frac{\gamma_{i1}\delta_i}{\delta_i - B_i} P_{it} + \frac{\gamma_{i2}\delta_i}{\delta_i - B_i} PAOB_t + \frac{\gamma_{i3}\delta_i}{\delta_i - B_i} PPORK_t + \frac{\gamma_{i4}\delta_i}{\delta_i - B_i} PPOULTRY_t + \frac{\gamma_{i5}\delta_i}{\delta_i - B_i} Y_t$$

The demand equations are estimated with weekly, biweekly, and monthly data. Importantly, the respective equations are estimated using a nonlinear iterative seemingly unrelated regression algorithm (nonlinear estimation in the econometrics software package SHAZAM). SHAZAM uses a maximum likelihood estimation procedure in estimating nonlinear regressions.

A problem in the estimation of state adjustment models is serial correlation. The disturbance term in equation (3) will be autocorrelated if disturbance terms are included in structural equations (1) and (2) (Wohlgenant and Hahn). Due to the presence of the lagged dependent variable in equation (3), disturbance terms which are autocorrelated will give rise to inconsistent parameter estimates. Additionally, to detect the presence of serial correlation, the Durbin-Watson test is no longer appropriate. In this study, the Runs test is used in testing for serial correlation (Draper and Smith, pp. 157-159). The Runs test, a non-parametric procedure, relies on the examination of strings of positive and negative residuals (runs). If the arrangement of signs in the residuals is "extreme", serial correlation is said to exist. This test statistic is distributed asymptotically as a standard normal random variable. The Durbin-H statistic could have been used as well, but this test breaks down when the product of the sample size times the estimated variance associated with the lagged dependent variable exceeds 1. Serial correlation is found in the brisket, ground, and round equations using weekly data and in the chuck and round equations using the biweekly data. All the six equations in the monthly data series exhibit serial correlation. Serial correlation in these equations is corrected using the AUTO and DRHO options in SHAZAM.

Results

Descriptive statistics of the continuous variables in the analysis are exhibited in Table 1. For the weekly, biweekly, and monthly data, ground beef appears to be the most important item in terms of purchases per 1000 customers. On average, purchases per 1000 customers of ground beef is roughly 169 pounds. The least important is rib with only about 20 pounds per 1000 customers on average. In terms of prices, loin and rib are the most expensive items, while brisket and ground are the least expensive items.

The reduced form parameter estimates are reported in Table 2. Based on the Runs test statistics, after adjustments are made for first-order serial correlation, serial correlation problems are no longer evident in the models. Price effects, except for the lagged own price effect, are generally not statistically

Table 1. **Descriptive Statistics of the Continuous Variables**

I. WEEKLY DATA

	MEAN	S.D.	MEDIAN	MAX	MIN
Purchases/1000 Customers[a]					
BRISKET	25.84	37.60	12.37	214.83	4.71
CHUCK	25.70	24.97	17.31	127.47	8.25
GROUND BEEF	168.99	38.18	157.86	325.01	90.01
LOIN	38.58	13.94	34.79	91.93	15.99
RIB	19.56	6.51	18.71	57.86	9.58
ROUND	36.01	25.80	26.58	133.65	13.34
Price Variables[b]					
BRISKET	175.19	27.79	181.86	212.30	100.00
CHUCK	263.62	47.39	278.04	325.55	126.32
GROUND BEEF	190.42	23.11	197.26	223.86	134.37
LOIN	440.04	65.68	431.99	561.67	282.23
RIB	420.37	36.80	419.64	505.21	242.76
ROUND	309.44	45.12	323.06	370.34	182.12
PAOB1[1]	254.51	26.44	261.84	301.84	193.42
PAOB2[2]	247.44	24.62	253.90	297.91	191.25
PAOB3[3]	306.52	45.28	321.92	376.72	201.68
PAOB4[4]	224.53	24.95	230.58	262.60	173.51
PAOB5[5]	236.38	25.72	242.33	289.27	184.25
PAOB6[6]	242.53	26.74	251.13	295.43	186.35
PORK	299.74	35.01	297.75	378.84	204.09
POULTRY	173.06	27.55	177.92	220.43	91.68
Expenditure[c]	164810	31237	158682	282983	80612

II. BIWEEKLY DATA

	MEAN	S.D.	MEDIAN	MAX	MIN
Purchases/1000 Customers[a]					
BRISKET	26.12	26.13	13.60	112.47	6.75
CHUCK	25.73	16.16	18.24	68.26	10.03
GROUND BEEF	169.08	25.05	162.73	261.12	125.82
LOIN	38.17	10.07	38.10	62.49	21.76
RIB	19.46	4.78	19.06	37.55	11.52
ROUND	36.03	16.71	28.85	80.73	19.28
Price Variables[b]					
BRISKET	167.84	30.19	174.14	208.31	105.98
CHUCK	251.36	50.70	269.96	324.93	137.52
GROUND BEEF	188.53	19.66	192.70	220.36	140.12
LOIN	435.70	57.58	427.51	549.58	320.28
RIB	418.64	33.27	415.53	499.19	334.16

Table 1. (Continued)

ROUND	300.08	44.89	313.30	367.36	204.64
PAOB1	252.20	20.58	251.25	292.59	211.59
PAOB2	245.63	19.21	244.60	285.69	205.10
PAOB3	300.96	36.03	297.39	357.97	227.86
PAOB4	222.07	19.07	221.37	259.27	185.99
PAOB5	234.15	19.78	233.41	276.70	197.71
PAOB6	239.94	20.99	237.51	288.04	200.56
PORK	298.47	31.03	292.52	376.81	234.54
POULTRY	170.18	23.14	169.81	210.15	113.95
Expenditure[c]	164830	27777	156364	259491	122442
III. MONTHLY DATA					
	MEAN	S.D.	MEDIAN	MAX	MIN
Purchases/1000 Customers[a]					
BRISKET	26.29	19.03	16.82	91.69	10.43
CHUCK	26.02	8.68	25.54	39.84	13.61
GROUND BEEF	169.52	14.28	173.30	201.07	144.36
LOIN	38.39	8.37	37.33	55.94	25.51
RIB	19.70	4.30	19.05	35.56	13.92
ROUND	35.66	10.23	35.86	57.05	21.77
Price Variables[b]					
BRISKET	158.12	26.65	155.45	207.25	111.06
CHUCK	232.65	39.20	243.89	287.08	173.93
GROUND BEEF	187.47	14.56	189.69	211.19	157.54
LOIN	430.97	48.85	426.00	535.07	357.92
RIB	416.20	29.38	412.16	472.76	44.12
ROUND	292.07	37.37	287.14	353.12	231.86
PAOB1	251.33	14.26	252.41	279.40	229.30
PAOB2	245.02	13.99	247.50	272.28	215.43
PAOB3	298.51	27.99	302.46	352.02	229.86
PAOB4	221.50	14.98	225.49	245.00	191.50
PAOB5	233.49	14.93	237.15	260.79	202.57
PAOB6	239.10	15.61	243.24	265.00	208.23
PORK	296.41	28.52	287.26	361.99	252.62
POULTRY	167.47	17.80	161.65	197.90	133.94
Expenditure[c]	164602	26311	157017	236202	133425

1 Price of all the beef products except brisket
2 Price of all the beef products except chuck
3 Price of all the beef products except ground
4 Price of all the beef products except loin
5 Price of all the beef products except rib
6 Price of all the beef products except round

a Pounds
b Cents per pound
c Cents per 1000 Customers

Table 2. Estimates of the Reduced-Form Parameters of the State Adjustment Models

Variable	Model					
	Brisket	Chuck	Ground	Loin	Rib	Round
I. Weekly Data						
Intercept	52.987* (20.457)[a]	115.05* (32.419)	61.745* (12.930)	57.469* (13.154)	11.955* (4.726)	58.504* (16.316)
ΔP_{it}	-1.2182	-0.4932	-1.4030	-0.1702	-0.0956	-0.5543
P_{it-1}	-0.3449* (0.1164)	-0.4407* (0.1222)	-0.1578* (0.0567)	-0.1050* (0.0246)	-0.0217* (0.0105)	-0.1534* (0.0442)
$\Delta PAOB_t$	0.1077	0.0299	0.0921	0.0237	0.0019	0.0313
$PAOB_{t-1}$	0.0305 (0.0235)	0.0267 (0.0348)	0.0103* (0.0050)	0.0146 (0.0173)	0.0004 (0.0039)	0.0086 (0.0115)
$\Delta PPORK_t$	0.0042	0.0124	0.0558	0.0067	0.0096	0.0253
$PPORK_{t-1}$	0.0012 (0.0255)	0.0110 (0.0297)	0.0063 (0.0088)	0.0041 (0.0159)	0.0022 (0.0054)	0.0070 (0.0134)
$\Delta PPOULTRY_t$	0.0847	0.0217	0.0284	-0.0280	0.0179	-0.0701
$PPOULTRY_{t-1}$	0.0240 (0.0208)	0.0194 (0.0290)	0.0032 (0.0064)	-0.0173 (0.0162)	0.0041 (0.0044)	-0.0194 (0.0134)
ΔY_t	0.0001 (0.000078)	0.000085* (0.000035)	0.000866* (0.000070)	0.000184* (0.000024)	0.000106* (0.000020)	0.000068 (0.000042)
Y_{t-1}	0.000030 (0.000022)	0.000076* (0.000035)	0.000097* (0.000034)	0.000113* (0.000033)	0.000024* (0.000010)	0.000019 (0.000011)
q_{it-1}	0.6035* (0.1010)	0.0202 (0.2316)	0.6881* (0.0591)	0.1904 (0.1736)	0.5808* (0.1284)	0.5960* (0.0820)
RHO[b]	-0.2539* (0.1261)	0.2587 (0.2285)	-0.3672* (0.0974)	-0.1582 (0.1752)	-0.1728 (0.1402)	-0.6041* (0.0920)
R^2	0.7598	0.8720	0.8207	0.8029	0.4763	0.8512
DW[c]	2.1314	1.9780	2.1250	2.0125	1.9912	1.9883
Runs Test	-0.7088	-1.8956	1.7243	-0.6028	0.1688	-0.7562

Table 2. (Continued)

Variable	Model					
	Brisket	Chuck	Ground	Loin	Rib	Round
II. Biweekly Data						
Intercept	60.763 (34.531)	132.18* (20.492)	107.41* (25.377)	41.531* (13.349)	43.918 (28.447)	72.365* (23.889)
ΔP_{it}	-0.7346	-0.3207	-1.0756	-0.1261	-0.0711	-0.3649
P_{it-1}	-0.2567* (0.1224)	-0.4613* (0.0626)	-0.2082* (0.0856)	-0.1116* (0.0242)	-0.0639 (0.0398)	-0.1523* (0.0462)
$\Delta PAOB_t$	0.0967	0.0488	0.0624	0.0493	0.0017	-0.0146
$PAOB_{t-1}$	0.0338 (0.0315)	0.0702 (0.0602)	0.0121 (0.0086)	0.0436 (0.0289)	0.0015 (0.0216)	-0.0061 (0.0155)
$\Delta PPORK_t$	-0.1271	-0.0158	-0.1271	0.0493	-0.0257	-0.0208
$PPORK_{t-1}$	-0.0444 (0.0453)	-0.0228 (0.0428)	-0.0247 (0.0167)	0.0436 (0.0252)	-0.0231 (0.0284)	-0.0087 (0.0180)
$\Delta PPOULTRY_t$	-0.1104	-0.0152	-0.0697	0.0062	-0.0244	-0.0625
$PPOULTRY_{t-1}$	-0.0386 (0.0293)	-0.0218 (0.0423)	-0.0135 (0.0131)	0.0055 (0.0224)	-0.0219 (0.0208)	-0.0260 (0.0188)
ΔY_t	0.000064 (0.000086)	0.000051 (0.000036)	0.0007* (0.000085)	0.000144* (0.00003)	0.000064* (0.000027)	0.000081 (0.000048)
Y_{t-1}	0.000023 (0.000034)	0.000074 (0.000052)	0.000136* (0.000054)	0.000127* (0.000034)	0.000057 (0.000036)	0.000033 (0.000019)
q_{it-1}	0.6296* (0.1468)	-0.3680* (0.1774)	0.5064* (0.0986)	0.0187 (0.1994)	0.1598 (0.3843)	0.3461* (0.1356)
RHO	-0.3765 (0.1926)	0.4354* (0.1613)	-0.0269 (0.1554)	-0.1069 (0.2000)	0.2551 (0.3807)	-0.3723* (0.1436)
R^2	0.8471	0.9197	0.8184	0.8549	0.5865	0.8848
DW	1.8630	1.8270	1.8669	1.9858	1.9159	1.7922
Runs Test	-0.9333	-0.0749	0.4742	-0.6603	0.4319	-1.4475

Table 2. (Continued)

Variable	Model Brisket	Chuck	Ground	Loin	Rib	Round
III. Monthly Data						
Intercept	448.87*	74.461*	372.81*	98.222*	83.464*	95.743*
	(0.9814)	(0.9911)	(0.9836)	(1.0039)	(0.9940)	(1.0057)
ΔP_{it}	-0.5392	-0.2105	-1.2001	-0.0788	-0.1568	-0.2092
P_{it-1}	-0.8713*	-0.2408*	-1.0510*	-0.1384*	-0.1740*	-0.2252*
	(0.0465)	(0.0074)	(0.0385)	(0.0086)	(0.0086)	(0.0103)
$\Delta PAOB_t$	-0.4943	0.0053	-0.0029	-0.0745	0.0377	0.0263
$PAOB_{t-1}$	-0.7988*	0.0061	-0.0025	-0.1310*	0.0418*	0.0283
	(0.0472)	(0.0153)	(0.0186)	(0.0148)	(0.0213)	(0.0171)
$\Delta PPORK_t$	-0.3745	0.0054	-0.2139	0.0032	-0.0094	0.0194
$PPORK_{t-1}$	-0.6053*	0.0062	-0.1873*	0.0057	-0.0105	0.0209
	(0.0356)	(0.0161)	(0.0481)	(0.0132)	(0.0180)	(0.0181)
$\Delta PPOULTRY_t$	0.1748	-0.0420	-0.1263	0.0274	0.0153	-0.1043
$PPOULTRY_{t-1}$	0.2825*	-0.0481*	-0.1106*	0.0482*	0.0170	-0.1123*
	(0.0533)	(0.0230)	(0.0537)	(0.0237)	(0.0254)	(0.0275)
ΔYt	0.0002*	0.00092*	0.000639*	0.000093*	0.000041*	0.000064*
	(0.00002)	(0.000011)	(0.000036)	(0.000015)	(0.000006)	(0.000006)
Y_{t-1}	0.000323*	0.0001*	0.00059*	0.000163*	0.000045*	0.000068*
	(0.000038)	(0.000013)	(0.000035)	(0.00003)	(0.000007)	(0.000007)
q_{it-1}	-0.1608*	-0.1607*	-0.1088*	-0.2172*	-0.2722*	0.0143
	(0.0564)	(0.0240)	(0.0251)	(0.1020)	(0.0305)	(0.0475)
RHO	-0.387*	0.4732*	0.2988*	-0.7247*	0.9510*	0.2310*
	(0.0699)	(0.0604)	(0.0401)	(0.1276)	(0.0628)	(0.0554)
R^2	0.8097	0.8935	0.5902	0.9257	0.4225	0.8357
DW	1.3613	2.6539	2.6315	1.6527	3.0561	2.4000
Runs Test	-1.6469	1.7169	0.0350	-0.7165	1.2965	0.4555

[a] Estimated Standard Error
[b] Estimated coefficient associated with the first-order serial correlation process
[c] Not valid due to the presence of a lagged dependent variable
* Significantly different from zero at the 0.05 level

significant in the weekly and biweekly data series. However, some of the price effects, using the monthly data, are statistically significant. For the most part the coefficients associated with ΔY_t, Y_{t-1}, and q_{it-1} are statistically significant. The R^2 values range from 0.4763 (rib) to 0.8720 (chuck) using weekly data; from 0.5865 (rib) to 0.9197 (chuck) using biweekly data; and from 0.4225 (rib) to 0.9257 (loin) using monthly data.

The structural parameter estimates are exhibited in Table 3. The standard errors are not presented because they are only approximations and are only valid asymptotically (Houthakker and Taylor, pp. 51-52). Generally, the six products taken as a group reflect the importance of inventory adjustment relative to habit formation as the time period of analysis decreases. With monthly data, B_i, the coefficient associated with the state variable, is positive for three of the six fresh beef products. With biweekly data, B_i is positive for only two products. Finally with weekly data, B_i is negative for all six products. Thus, with biweekly data inventory adjustment dominates, and this influence is even stronger with weekly data. On the other hand, habit formation dominates in the demand for brisket, loin, and round in the monthly data series and for chuck and rib in the biweekly data series. This general idea of the importance of inventory adjustment relative to habit formation as the period of analysis decreases is consistent with the Sexauer study where various broadly aggregated goods are analyzed with annual, semi-annual, quarterly, and monthly data.

Short-run and long-run price and expenditure elasticities are presented in Table 4. In conformity with prior expectations, all the own-price elasticities are negative and all expenditure elasticities are positive. With weekly data, where inventory behavior predominates for all the six fresh beef products, the short-run price and expenditure elasticities are larger in absolute value than their long-run counterparts. The same situation holds with the biweekly data, except for chuck and rib where habit formation predominates. For ground beef, chuck and rib, the short-run price and expenditure elasticities, on the other hand, are smaller in absolute value than their long-run counterparts, with the monthly data.

Shepherd argues that own-price elasticity for any commodity first becomes smaller in absolute value as the adjustment period increases and then becomes larger or more elastic as the adjustment period is

Table 3. Structural Parameter Estimates of the State Adjustment Models

Fresh Beef Product	Structural Parameter Estimates							
	δ	B	α	γ_1	γ_2	γ_3	γ_4	γ_5
I. WEEKLY DATA								
BRISKET	0.3299	-0.1646	200.327	-1.3043	0.1153	0.0045	0.0907	0.000127
CHUCK	1.6170	-0.3038	139.481	-0.5346	0.0324	0.0134	0.0235	0.000092
GROUND	0.1192	-0.2504	613.841	-1.5688	0.1030	0.0624	0.0318	0.000968
LOIN	0.8931	-0.4671	108.113	-0.1977	0.0275	0.0078	-0.0325	0.000213
RIB	0.2574	-0.2730	58.771	-0.1072	0.0021	0.0108	0.0201	0.000119
ROUND	0.3212	-0.1849	228.223	-0.5984	0.0338	0.0273	-0.0756	0.000073
II. BIWEEKLY DATA								
BRISKET	0.4234	-0.0311	176.112	-0.7440	0.0979	-0.1287	-0.1119	0.000065
CHUCK	5.1219	0.7928	81.666	-0.2850	0.0434	-0.0141	-0.0135	0.000046
GROUND	0.2143	-0.4410	665.388	-1.2898	0.0748	-0.1524	-0.0836	0.000843
LOIN	1.5874	-0.3392	51.365	-0.1380	0.0539	0.0539	0.0068	0.000158
RIB	1.6312	0.1824	46.428	-0.0676	0.0016	-0.0244	-0.0231	0.0000609
ROUND	0.5274	-0.4442	203.876	-0.4291	-0.0172	-0.0245	-0.0735	0.000095
III. MONTHLY DATA								
BRISKET	8.4167	5.6502	127.100	-0.2467	-0.2262	-0.1714	0.0800	0.000092
CHUCK	2.6734	-0.0931	66.380	-0.2147	0.0054	0.0055	-0.0429	0.000094
GROUND	1.5579	-0.9304	537.033	-1.5140	-0.0036	-0.2698	-0.1593	0.000806
LOIN	14.4602	11.3503	17.355	-0.0245	-0.0231	0.0010	0.0085	0.000288
RIB	2.4932	-1.0029	91.996	-0.1918	0.0461	-0.0115	0.0187	0.000501
ROUND	2.3316	0.3881	80.966	-0.1904	0.0240	0.0176	-0.0949	0.000058

Table 4. Short-Run and Long-Run Price and Expenditure Elasticities of the Dynamic Models of Demand for Disaggregate Fresh Beef Products

	Elasticity with Respect to				
	OWN-PRICE	Price of ALL OTHER BEEF	Price of PORK	Price of POULTRY	EXPENDITURE
WEEKLY DATA					
BRISKET	-8.8429[a]	1.1356	0.0522	0.6077	0.8126
	(-5.8991)[b]	(0.7574)	(0.0348)	(0.4054)	(0.5421)
CHUCK	-5.4837	0.3119	0.1564	0.1585	0.5908
	(-4.6169)	(0.2628)	(0.1317)	(0.1335)	(0.4974)
GROUND BEEF	-1.7677	0.1868	0.1107	0.0326	0.9443
	(-0.5701)	(0.0602)	(0.0357)	(0.0105)	(0.3046)
LOIN	-2.2549	0.1600	0.0609	-0.1460	0.9129
	(-1.4805)	(0.1052)	(0.0400)	(-0.0959)	(0.5981)
RIB	-2.309	0.0259	0.1658	0.1779	1.0010
	(-1.1175)	(0.0126)	(0.0805)	(0.0864)	(0.4858)
ROUND	-5.1422	0.2274	0.2277	-0.3637	0.3359
	(-3.2637)	(0.1444)	(0.1445)	(-0.2308)	(0.2132)
BIWEEKLY DATA					
BRISKET	-4.7807	0.9459	-1.4706	-0.7289	0.4102
	(-4.4532)	(0.8812)	(-1.3697)	(-0.6790)	(0.3849)
CHUCK	-2.7842	0.4143	-0.1636	-0.0895	0.2940
	(-3.2942)	(0.4902)	(-0.1934)	(-0.1059)	(0.3482)
GROUND BEEF	-1.4382	0.1332	-0.2690	-0.0842	0.8218
	(-0.4703)	(0.0436)	(-0.0880)	(-0.0275)	(0.2690)
LOIN	-1.5752	0.3138	0.4219	0.0303	0.6823
	(-1.2979)	(0.2585)	(0.3477)	(0.0250)	(0.5631)
RIB	-1.4543	0.0195	-0.3742	-0.2024	0.5167
	(-1.6361)	(0.0219)	(-0.4216)	(-0.2280)	(0.5815)
ROUND	-3.5738	-0.1145	-0.2030	-0.3473	0.4346
	(-1.9398)	(-0.0623)	(-0.1102)	(-0.1885)	(0.2359)
MONTHLY DATA					
BRISKET	-1.4838	-2.1625	-1.9324	0.5097	0.5729
	(-4.5144)	(-6.5787)	(-5.8792)	(1.5506)	(1.7405)
CHUCK	-1.9197	0.0514	0.0632	-0.2760	0.5997
	(1.8544)	(0.0497)	(0.0612)	(-0.2667)	(0.5820)
GROUND BEEF	-1.6743	-0.0064	-0.4718	-0.1574	0.7827
	(-1.0482)	(-0.0040)	(-0.2954)	(-0.0985)	(0.4894)
LOIN	-0.2750	-0.1336	0.0078	0.0371	0.1235
	(-1.2764)	(-0.6212)	(0.0364)	(0.1726)	(0.5745)
RIB	-4.0521	0.5465	-0.1741	0.1595	0.4190
	(-2.8895)	(0.3897)	(-0.1241)	(0.1137)	(0.2983)
ROUND	-1.5595	0.1608	0.1470	-0.4460	0.2689
	(-1.8713)	(0.1929)	(0.1763)	(-0.5351)	(0.3226)

[a] Short-run
[b] Long-run

lengthened. Hence, own-price elasticities probably have a U shape when plotted against length of adjustment period. Pasour and Schrimper show that in order for the elasticity of demand to have a U shape with respect to the length of adjustment effect (p. 788), "it would be necessary that the storage effect be decreasing at a more rapid rate than the rate of increase in the adjustment of the demand for use for shorter lengths of run." However, except for the short-run own-price elasticities for ground and rib as well as the long-run own-price elasticities for brisket and ground, the results fail to substantiate the claim by Shepherd. Importantly too, the magnitudes and the signs of cross-cut elasticities (all other beef), cross-product elasticities (pork and poultry), and expenditure elasticities are functions of the time dimension.

Summary

This analysis emphasizes the role of time on price and expenditure elasticity estimates for disaggregate fresh beef products. The analysis also documents the utility of scanner data in research and the role of inventory adjustment and habit formation effects on consumer behavior. The results indicate the importance of inventory adjustment over habit formation as the time interval is shortened. Marketing decisions by business managers are often influenced not only by the expected month to month changes in prices and expenditures but also by intra-month changes. This study provides the kind of analysis about the dynamics of consumer behavior in the very short run with more disaggregate beef commodities.

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