## **Modeling Frankfurter Purchases**

Beef in various forms is used in many aspects of food processing, making it theoretically possible that consumers might make very far-reaching adjustments in response to the BSE announcements. For example, consumers could have been fearful of gelatin in processed foods. The most processed food we focus on in this report is frankfurters. We focus on purchases of frankfurters and the subset of frankfurters that are made without beef as the latter offers an obvious substitution possibility for consumers trying to avoid beef.

Figure 5 suggests (and statistics confirm) that there is no long-term trend in weekly purchases, but seasonality is obviously present. The first model we explore is a purely seasonal model. Seasonality is accounted for by regressing weekly quantities purchased on 52 seasonal 0/1 (dummy) variables. The dummy variables represent the 52 weeks of the year. The purely seasonal dummy model is

$$y_t = \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t$$

where  $y_t$  represents pounds of frankfurters purchased weekly. The left-most numerical column in table 7 shows the results from estimating this model. Although the variation in weekly quantities purchased is large, the purely seasonal dummy model explains nearly 78 percent of the total variation. That is, habit and tradition appear to dominate any possible explanation for the purchase pattern. For our purposes, this result suggests that we may have explained enough of the variation so that additional variables representing BSE announcement impacts could separate out the impacts of the announcements from purchases conditioned by habit and tradition.

Our second model augments the seasonal dummy model by allowing for impacts of the BSE announcements. We add five new dummy variables to indicate the weeks immediately following the Canadian announcement and five dummy variables to indicate weeks immediately following the Washington State announcement.

The model accounting for seasonality and the BSE announcements is

$$y_{t} = \sum_{i=1}^{52} \gamma_{i} D_{it} + \sum_{j=1}^{5} \delta_{j} CAN_{jt} + \sum_{k=1}^{5} \delta_{k} WASH_{kt} + \varepsilon_{t} \quad t = 1, 2, ..., 364$$

Results of estimating the model appear in the column next to the seasonal dummy model results. The estimated coefficients on all of the variables representing the weeks following BSE announcements are indistinguishable from zero, that is, there is no evidence to reject the zero hypothesis.

Most frankfurters are made with beef, but there are some that are made with turkey, chicken, and/or pork and contain no beef. Federal regulations require labels to indicate which meats are in each package. Generally, frankfurters that do not contain beef say so prominently on labels. Thus, all

Table 7
Regression results from purely seasonal and BSE announcement models

		Dependent variable					
		Quantity of					
		ntity of		no-beef			
		frankfurters		frankfurters			
Independent	purc	purchased		purchased			
variables		Seasonal and	Seasonal and BSE				
in addition to		BSE					
52 seasonal	Seasonal	announcement	Seasonal	announcement			
variables	model	model	model	model			
		Estimated coefficient (p value)					
OANIA		000000					
CAN1		3480717		992063.9			
OANIO		(0.2396)		(0.2925)			
CAN2		-4449059		-1279880			
CAN3		(0.1331) 86345.90		(0.1747) 1140848			
CANS							
CAN4		(0.9767) -2114794		(0.2262) -1117900			
CAN4		(0.4746)		(0.2357)			
CAN5		-2410430		411009.9			
CANS				(0.6625)			
WASH1		(0.4151) -2865906		-229410.7			
WAGITI		(0.3327)		(0.8075)			
WASH2		-2386278		-1319814			
WATOTIE		(0.4198)		(0.1617)			
WASH3		1171005		389307.5			
***************************************		(0.6921)		(0.6793)			
WASH4		-858607.6		223711.2			
		(0.7715)		(0.8122)			
WASH5		121594.7		1504326			
		(0.9672)		(0.1109)			
Summary statist	tics	(,		(,			
$R^2$	0.779342	0.784112	0.587438	0.601742			
Adjusted R <sup>2</sup>	0.743273	0.740506	0.520000	0.521299			
Durbin-Watson	2.256271	2.271388	1.740221	1.711250			

Source: Economic Research Service/USDA.

others can be assumed to be wholly or partially beef (usually in a mixture with pork). Consumers are easily alerted to the choice they face when selecting frankfurters: made with beef or made without beef. Thus, there are two possible reasons for failing to find an impact of the BSE announcements. There might not have been an impact, or the impact could have been masked as consumers switched from frankfurters made with beef to no-beef frankfurters.

We constructed weekly quantities purchased of no-beef frankfurters by excluding all products that included beef. Averaging across all weeks, 22.4 percent of frankfurters purchased did not contain beef. Expenditures on no-beef frankfurters averaged 19.7 percent of all frankfurters. If consumer switching masked the BSE impact, then the switching should be easily observable in the no-beef frankfurter market. That is, a small percentage decrease in all frankfurters would show up as a much larger change in no-beef frankfurters.

The third and fourth columns in table 7 repeat the previous exercise for the subset of no-beef frankfurters. Again, the purely seasonal model explains the majority of variation in purchases (59 percent). Introducing variables to represent the 5 weeks after each BSE announcement adds nothing to the explanatory power of the regression. None of the weekly dummy BSE announcement variables are significantly different from zero. This regression offers no evidence that consumers substituted no-beef frankfurters for frankfurters made with beef. Here, there is no indication of any BSE impact.

Lower prices could have muted consumers' resistance to purchasing frankfurters. But, we know from the seasonal dummy model that habit and tradition already explain a large majority of the variation in purchases. So, the influence of price here is necessarily limited. Even so, we want to explain that part of the pattern of purchases to reveal the existence, duration, and magnitude of BSE impacts.

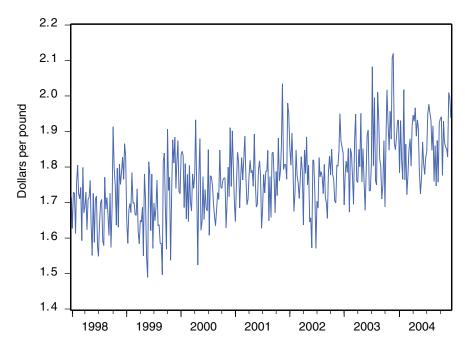
Figure 10 shows that the retail price of frankfurters has not been stationary, but trended upward over 7 years at an annual rate of 1.7 percent per year, estimated from a linear trend. To account for inflation, we use the weekly price of bread as a price index, dividing the price of frankfurters by the price of bread. The result is indicated by P<sub>t</sub>. The model accounting for seasonality, price, and the BSE announcements is

$$y_t = \beta P_t + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Figure 10

Weekly U.S. retail price of frankfurters, 1998-2004

Retail prices for frankfurters trended upward at 1.7 percent annually between 1998 and 2004



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

The left-most column in table 8 shows the results of adding contemporaneous inflation-adjusted price to the regression. The price coefficient is clearly significant and the regression's explanatory power is higher than those reported in table 7. Adding the price variable does help reveal potential BSE impacts. In the second week following the Canadian announcement, purchases appear to have been reduced. The coefficient on CAN2 is negative and, at a 10-percent level of significance, differs from zero. Thus, there is some evidence for a short-lived (1 week) reduction in purchases. The negative coefficient suggests that purchases were reduced by 4.8 million pounds, or 21 percent of the purchases forecast without the announcement impact. However, the evidence for an announcement impact is not very strong. The 95-percent confidence interval on the impact ranges

Table 8
Regression results from seasonal models, accounting for price effects and BSE announcements

		Depender	nt variable				
	Dependent variable Quantity of						
	Quant	tity of	no-beef				
	frankfu		frankfu	rters			
Independent	purch	ased	purchased				
variables		Seasonal and	Seasonal and				
in addition to S	easonal, price,	price-BSE	Seasonal, price	price-BSE			
52 seasonal	and BSE	announcement		announcement			
dummy a	announcement	interaction	announcement	interaction			
variables	model	model	model	model			
			value)				
Frankfurter price/	-9091536	-9068182	-1426983	-1441923			
bread price	(0.0000)	(0.0000)	(0.0000)	(0.0000)			
(Frankfurter price/							
bread price)		-860321.8		-223054.3			
xCAN		(0.5281)		(0.6636)			
(Frankfurter price/							
bread price)		-1755188		-705898.1			
xWASH		(0.1564)		(0.1400)			
CAN1	2531014		880442.1				
0.4110	(0.3742)		(0.3359)				
CAN2	-4774498		-1533646				
OANIO	(0.0936)		(0.0947)				
CAN3	989196.8		1155088				
OANIA	(0.7281)		(0.2068) -1063855				
CAN4		-1400834					
CANE	,	(0.6223)					
CAN5		-3028335					
WASH1	(0.2872) -3219624		(0.8199) -300076.1				
MASHI	(0.2576)		(0.7427)				
WASH2	(0.2576) -2458096		(0.7427) -1579544				
WASHZ	(0.3871)		(0.0853)				
WASH3	-114497		130542.6				
VVAOLIO	(0.9680)		(0.8866)				
WASH4	-1250314		71666.43				
WAGIT	(0.6599)		(0.9375)				
WASH5	-630260.8		1220017				
VVAOLIO	(0.8246)		(0.1836)				
Summary statistics (0.1030)							
$B^2$	0.801425	0.798116	0.626183	0.614650			
Adjusted R <sup>2</sup>	0.760522	0.762836	0.549184	0.547308			
Durbin-Watson	2.274128	2.259880	1.812526	1.852497			

Source: Economic Research Service/USDA.

from an increase of 0.8 million pounds to a decrease of 10.3 million pounds. That is, a conclusion of no impact is within the confidence interval.

The second column allows for the possibility that consumers changed the way they responded to retail prices just after the BSE announcements. Again, we include one variable to distinguish the 2-week period immediately following each announcement.

CAN = 1 for the weeks beginning May 21 and May 28, 2003, 0 otherwise.

WASH = 1 for the weeks beginning December 24 and December 31, 2003, 0 otherwise.

The model accounting for seasonality, price, and price-BSE announcement interactions is

$$y_{t} = \beta P_{t} + \sum_{i=1}^{52} \gamma_{i} D_{it} + \delta_{CAN} CAN_{t} P_{t} + \delta_{WASH} WASH_{t} P_{t} + \varepsilon_{t} \quad t = 1, 2, ..., 364$$

Results show that the contemporaneous inflation-adjusted retail price is significant. However, here the interaction of the Canadian announcement and price fails a significance test at all reasonable confidence levels. Similarly, the interaction of the Washington State announcement and price is not significant. There is no compelling evidence to suggest that consumers reacted differently to prices after the announcements. The insignificance of the cross of price and the Canadian announcement suggests that the 2-week period was too long, mixing possible impacts in 1 week with no impacts in another. Thus, the previous model with separate variables for each post-announcement week is likely sufficient. That is, the duration of any impact was limited to 1 week.

The third and fourth columns in table 2 report results of estimating announcement impacts on purchases of no-beef frankfurters. Regressing the quantity of no-beef frankfurters on the contemporaneous inflation-adjusted retail price of no-beef frankfurters, 10 announcement-effect dummy variables, and the 52 seasonal dummy variables shows two significant announcement effects. Both second-week dummy variables (Canada and Washington State) indicate reduced purchases for those weeks. In both cases, impacts are limited to the second week after the announcement. Like the results reported for all frankfurters (column one), the regression does not precisely estimate impacts. The mean estimates of impact are a decrease of 1.5 million pounds from the Canadian announcement and a decrease of 1.6 million pounds from the Washington State announcement. However, the 95percent confidence interval for both announcements extends into positive numbers, indicating increases in purchases. The mean impacts suggest that consumers reacted to the announcements by temporarily reducing purchases of all frankfurters, beef or no-beef. There is no evidence that consumers substituted no-beef frankfurters for frankfurters made with beef.

Table 9 shows that it is unlikely that grocers lowered retail prices to reduce consumers' adjustments to the BSE announcements. Observed prices are either above the range of forecasts (trend, or trend plus seasonal models) or

Table 9
Comparing frankfurter price forecasts with observed prices after the BSE announcements

	Observed price		Forecast price				
Week beginning	Unadjusted	Inflation adjusted	Linear trend	Trend and seasonal model	Linear trend, inflation adjusted	Trend and seasonal model, inflation adjusted	
	Dollars per pound						
All frankfur	ters:						
12/24/03 12/31/03 5/21/03 5/28/03	1.93 1.93 1.67 1.77	1.61 1.62 1.41 1.53	1.84 1.84 1.81 1.81	1.89 1.81 1.71 1.76	1.58 1.58 1.57 1.57	1.60 1.57 1.46 1.53	
No-beef frankfurters:							
12/24/03 12/31/03 5/21/03 5/28/03	1.58 1.56 1.56 1.41	1.32 1.40 1.31 1.22	1.56 1.56 1.56 1.56	1.49 1.67 1.51 1.52	1.34 1.34 1.36 1.36	1.25 1.46 1.29 1.33	

Source: Economic Research Service/USDA.

within the range. In either case, there is no suggestion that retail prices were especially low in the 2 weeks following announcements. Only the nobeef frankfurter prices in the second week following the Canadian announcement are below the forecast range. There, the prices are 7-10 percent lower than reasonably anticipated, and not large enough to substantially offset calculated coefficients.

The findings for no-beef frankfurters were opposite to expectations that BSE announcements would lead consumers to substitute away from beef frankfurters. A possible explanation is that many consumers were simply confused about the ingredients in no-beef frankfurters and fled no-beef frankfurters more than frankfurters containing beef. This scenario sounds unlikely. A better explanation is that some events unrelated to BSE announcements led consumers to reduce no-beef frankfurter purchases. That is, there is little evidence to indicate BSE announcements influenced consumers' frankfurter purchases.