A Farm to Retail Sectoral Analysis of the Northeast Food Industry

C. M. Gempesaw II, G. C. Reisner, and P. J. Wobus

Previous studies analyzing the U.S. food industry have used national data and/or have focused on a particular sector of the industry. However, regional differences in resource endowments, income opportunities and population distribution imply that the impact of changing economic environment will not be the same for all regions. A farm to retail multiproduct sectoral model for the Northeast food industry is developed and estimated. This regional approach is used to analyze the effects of changes in exogenous variables on the Northeast region's food production and consumption. Empirical results are presented in terms of intrasectoral flexibilities and elasticities. Selected results from other regions are also presented and compared with the Northeast results.

Introduction

In view of the vital role played by the food industry in the provision of income, employment and, more importantly, food supply, there is a need to continually study the structure of the food industry. The changing structure of farming, fluctuating input and output prices, changing government policy on farm subsidies, increasing nonfood retail prices, and changes in the regional structure of food manufacturing firms are some of the factors that affect the industry. However, regional differences in factor endowments, income and population distribution imply that the impact of these and other factors will not be the same for all regions. Blakely points out the importance of conducting research in regional markets for agricultural and food products. A regional approach is used in this study to analyze the effects of exogenous variables on food production and consumption in the Northeast.[1]

The Northeast food industry is denned in this study to include the farm production sector, the marketing sector, which includes processing and distribution activities, and the retail (consumer) sector, which demands the food products produced and processed by the farm and marketing sector. Over the years, the Northeast food industry has lost its competitive edge over other regions. As shown , in Table 1, the Northeast farm sector has experienced a decline in its relative percentage share of J the U.S. farm value of production in all farm products except for dairy products. The same is true in the marketing sector where the Northeast's value of shipment percentage shares have all declined except for the poultry and egg product group. The Northeast region's demand for food products as measured by regional income percentage shares has also decreased over the years.

The purpose of this paper is to examine the structure of the Northeast food industry using a farm to retail multiproduct sectoral approach. The specific objectives are:

1. To develop a theoretically consistent methodological approach in estimating the sectoral relationships among the farm, marketing and retail sectors of the food industry.
2. To use this approach to empirically estimate a farm to retail multiproduct model to analyze the impacts of changes in exogenous variables on farm prices, demand for farm prod-

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[1] Following the Bureau of Labor Statistics' regional classification, the Northeast region is defined to include Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont.

[2] Lee and Stanton and Madden provide comprehensive analyses of trends and possible causes of these trends affecting the competitiveness of Northeast food and agricultural system.

Table 1. Northeast Farm Value of Production, Value of Shipments, and Income Percentage Shares to Total U.S. (%).

	1950			1970			1983		
Products	Farm[1]	Marketing[2]	Retail[3]	Farm	Marketing	Retail	Farm	Marketing	Retail
Meat Animals	3.08	13.17	30.10	1.86	11.09	27.12	2.16	7.70	23.32
Dairy Products	18.77	23.15	30.10	21.06	19.85	27.12	19.52	16.09	23.32
poultry and Eggs	20.51	7.67	30.10	11.26	9.53	27.12	8.31	10.03	23.32
Feed Grains	6.18	—	—	5.80	—	—	5.99	—	—
Fruits and Vegetables	11.65	42.08	30.10	10.66	20.78	27.12	7.52	17.61	23.32
Food Grains	2.02	27,64	30.10	.50	16.45	27.12	.45	18.80	23.32
Other Products	1.57	9.77	30.10	1.94	5.25	27.12	.78	2.02	23.32

[1] Source: **Agriculture** Statistics.
[2] **Annual** Survey of Manufacturers. **Census of Manufacturers.**
[3] **Statistical Abstract; (Percentage Income Shares).**

ucts, retail prices, and retail demand in the Northeast.

The discussion in this paper shall proceed as follows. The second section provides a brief review of related previous studies on the food industry. The third section discusses the conceptual framework and empirical specification. The fourth section covers the data construction. The fifth section presents and analyzes the results and the last section discusses conclusions from the study.

Related Studies

Much has been written concerning the effects of changes in economic factors on the production, processing and demand for food products. In his seminal article, Gardner developed a theoretical model for the food industry that permits the evaluation of simultaneous equilibrium in three related sectors: farm output supply, retail demand, and supply of marketing services. Each sector was represented by a pair of demand and supply equations and assumed elasticities were utilized to illustrate how the farm-retail price spread changes when exogenous variables in any of the three markets shift. Heien improved on Gardner's study by adding dynamic considerations in a static equilibrium model, that is, assuming supply and demand are not always in equilibrium and that this disequilibrium is a primary reason for causing price changes. Dunn and Heien developed a framework for the interrelationships of various food products and sectors. They specified the demand for farm output as part of an interrelated factor demand system for the marketing sector. Both structural and reduced form elasticities for the demand for farm output were then estimated.

However, these and other studies (e.g., Lamm and Westcott, Gempesaw and Dunn, 1987) on the food industry were based on aggregate national data. A regional approach recognizes that different characteristics may be associated with each region, making national results misleading for a particular region. Schertz et al. have noted that because of the extreme heterogeneity among production regions, producers' response to changes in product and factor prices is expected to differ substantially among regions.[3] Furthermore, none of these studies have explicitly specified and estimated simultaneously the supply and demand equations associated with each sector and each product.

A common approach is discernible among studies dealing with the food industry. These studies have analyzed how supply and demand for one or more commodities react as certain specified variables change. However, there are fundamental differences in the approach taken by researchers to meet this objective. Many studies (e.g., Ball and Chambers, Dunn) have dealt with only a single commodity, ignoring potential interaction among other products. Models used in the past typically lacked a sound theoretical and conceptual framework. Restrictive functional forms were commonly used before being replaced by the currently more popular flexible functional forms. Even those studies (e.g., Saez and Shumway, Gempesaw and Dunn, 1986) that avoided these problems invariably focused only on a single sector of the food economy. As a result, activities occurring in the excluded sectors of the food industry are disregarded.

Conceptual Framework

The relationships among the different sectors comprising the food industry can be modeled using the

[3] **See, for example, the comprehensive** study done **by** Saez **and** Shumway in **analyzing the output supply and input** demand responses of the ten farm **production** regions in the U.S.

neoclassical theories of cost minimization and indirect utility maximization. Based on these theories, a simple framework showing how the different sectors interact is presented. Consider the food industry to be comprised of the farm sector, marketing sector and retail demand sector. The farm sector is assumed to pursue cost minimizing behavior.

(1) $$C_{FR} - C_{FR}(Q_{FR},R,Z)$$

Cost of production (C_{FR}) is a function of a vector of farm outputs (Q_{FR})* [a] vector of variable farm input prices (R), and a vector of fixed factors and other exogenous variables (Z). Output pricing behavior based on competitive market theory is assumed such that the marginal cost of supplying a farm output is equal to its price (P_{FR}), where P_{FR} is a vector of farm output prices.

(2) $$P_{FR} = P_{FR}(Q_{FR},R,Z)$$

In the same manner, the marketing sector is depicted as minimizing the cost of processing and distributing food products (C_{MR}) subject to a vector of output levels (Q_{MR})> [a] vector of farm output prices (P_{FR}) that are considered input prices in this sector, and a vector of variable nonfarm marketing input prices (P_w).

(3) $$C_{MR} — C_{MR}(Q_{MR},P_{FR}>P_W)$$

The derived demand for farm output by the marketing sector can be obtained using Shephard's lemma:

(4) $$Q_{FM} = Q_{FM}(Q_{MR}.P_{FR},P_W)$$

where Q_{FM} is a vector of farm output demand by the marketing sector. By assuming marginal cost pricing, the vector of marketing output prices (P_R) is a function of the same arguments in (3).

(5) $$P_R = P_R(Q_{MR},P_{FR},P_W)$$

The retail demand sector assumes a behavioral structure of consumers whose objective function is to maximize their utility function (U_R) subject to a given level of income constraint (I), a vector of food prices (P_R), and a vector of nonfood prices (P_{NF}).

(6) $$U_R = U_R(P_R,P_{NF},I)$$

By maximizing U_R given its income constraint, a set of retail food demand equations is derived expressing the quantity demand for food (Q_{RD}) as a function of the same arguments in (6).

(7) $$Q_{RD} = Q_{RD}(P_R,P_{NF},I)$$

The system of equations to be estimated are comprised of equations (2), (4), (5) and (7). With these conceptual framework, the farm, marketing and consumer sectoral responses to changes in exogenous variables can be estimated simultaneously.

Empirical Specification

This study modeled the farm to retail sectoral interaction by using the normalized quadratic/Marshallian (NQM) functional form. The NQM functional form specifies a normalized quadratic cost function for the farm and marketing sectors and following Huang, a Marshallian demand equation was specified in the retail sector. The farm sector equation (2) was specified as:

$$(8)\quad P^*_{FR_i} = a_i + \sum_{l=1}^{6} B_{il}\, Q_{FR_l} + \sum_{k=1}^{5} Y_{ik}\, R^*_k + \sum_{m=1}^{3} U_{im}\, Z_m + e_i \qquad i = 1\ldots6,$$

where:

$P^*_{FR_i}$ = normalized output prices of meat animals, dairy products, poultry and eggs, fruits and vegetables, feed grains, and other food products;

Q_{FR_l} = farm output supply of the same products defined above;

R^{*k} = normalized variable input prices of hired labor, agricultural chemicals, feed, seed and livestock, farm capital and miscellaneous inputs;

Z_m = fixed input quantities of land and number of family labor, and an exogenous variable—government subsidies.

The derived demand for farm output equation (3) by the marketing sector was specified as:

where:

$Q_{FM}J$ = farm output demand for meat animals, dairy products, poultry and eggs, fruits and vegetables, and other food products;

P^*_{FR} = normalized output prices of meat animals, dairy products, poultry and eggs, fruits and vegetables, and other food products;

$P^*_{w_h}$ = normalized nonfarm variable input prices of container, sup-

plies, fuel, hired labor, and materials;

QMR_n = marketing sector output levels of meat animals, dairy products, poultry and eggs, fruits and vegetables, and other food products.

The marginal cost pricing equation (5) was specified as:

$$(10)\quad P^*_{R_g} = e_g + \sum_{i=1}^{5} E_{gi} P^*_{FR_i} + \sum_{h=i}^{5} H_{gh} P^*_{W_h} + \sum_{n=1}^{5} K_{gn} Q_{MR_n} + e_g \quad g = 1\ldots5,$$

where:

$P^*_{R_g}$ = normalized retail rood prices of meat animals, dairy products, poultry and eggs, fruits and veg etables, and other food products;

$P^*_{FR_i}$, $P^*_{W_h}$, and Q_{MR_n} are defined above.

The retail food demand equation (7) was specified as:

$$(11)\quad Q_{RD_r} = f_r + \sum_{g=1}^{5} S_{rg} P^*_{R_g} + \sum_{y=1}^{5} V_{ry} P^*_{NF_y} + W_r I^* + e_r \quad r = 1\ldots5,$$

where:

QRD_r = retail food demand for meat animals, dairy products, poultry and eggs, fruits and vegetables, and other food products;

$P^*_{R_g}$ = as defined above;

P^*_{NF} = normalized nonfood prices of medical care, and other goods and services;

I^* = real per capita income.

Equations (8), (9), (10) and (11) were estimated simultaneously using three stage least squares. The system of equations consisted of 21 equations with over 300 parameters estimated.

Data Construction

Farm Sector:

In this study, the production structure of the Northeast farm sector was assumed to be separable in six food commodity groups: meat animals, dairy products, poultry and eggs, feed grains, fruits and production and price data for individual commodities in each group were collected. For example, the meat animal group is a composite of cattle and calves, hogs, and sheep and lambs. Actual quantity and price levels for each commodity in the nine Northeast states were gathered for the period 1949-83. The units of measurement in each commodity group were then standardized.

Two types of aggregation were conducted: aggregation among individual commodities and aggregation across states. For quantity levels, the standardized units of measure were added to form regional aggregates for each commodity. The regional aggregates of the individual commodities in each group were then combined to form the regional commodity group quantity aggregate. The aggregation of farm prices was a more complicated task since simple addition of prices would lead to an erroneous measure. Price levels for each individual commodity were aggregated across states using annual state level production percentage shares as weights. The regional price level for each commodity group were then aggregated utilizing annual regional production percentage shares within the commodity group as weights.

Farm output and price data as reported in various government publications were in the form of either crop marketing year or calendar year data. Aggregating crop and calendar year data produces inconsistent results. Thus, crop year output and price data were adjusted to calendar year data using unpublished USDA crop marketing distribution data. In order to separate the effects of inventories, net farm output calendar year data were estimated by gathering inventory data and deducting it from farm output data.

National level price data for the variable farm inputs were gathered from the *Agricultural Statistics* (AS). The variable farm input price data collected from AS were agricultural chemicals, feed, seed and livestock, and miscellaneous inputs. The farm capital service price data were provided by Ball. The hired labor wage rate was estimated by dividing hired labor expenditures of the nine Northeast states by the corresponding number of hired labor from *Farm Labor* and *Farm Employment.* Fixed factors included were land and family labor. Government payments were collected from the *Economic Indicators of the Farm Sector.* An aggregate production price index paid by farmers from the AS was used as the normalizing variable for the farm sector. Various published and unpublished data from the U.S. Department of Agriculture were used as the major sources of data in constructing the farm sector data set.

Marketing Sector;

Two problems were encountered in collecting data for the marketing sector regional output which was proxied by the real value of shipments in this study. First, there were no regional time-series data available for value of shipments that covered the 1949-83 period. Second, regional data were only provided during the census years while the *Annual Survey of Manufacturers* (ASM) only provided complete time-series data at the national level. To solve these problems, information from both *Census of Manufacturers* (CM) and ASM were used in constructing the Northeast marketing sector output by commodity group. Value of shipment data were collected by region and commodity group from CM. The non-census years' data were exponentially interpolated. The percentage value of shipments to total national value of shipments of each region by commodity group were then computed. National level data by commodity group were also collected from the ASM. Using the regional percentage shares from the CM data, the regional value of shipments were derived by multiplying the regional percentage shares with the national level value of shipment data from the ASM. Since the value of shipments were in current dollars, it was adjusted by producer price index for each respective commodity to express the current dollar output in real terms.[4]

Marketing sector farm inputs were defined as farm sector outputs. The feed grain commodity group was excluded because it was considered an intermediate farm input. The Northeast farm output is not necessarily equal to the region's marketing sector demand for farm output. Thus, a methodology was devised to establish an indicator for the Northeast region's demand for farm products. The Northeast region's value of shipment percentage shares from the CM were multiplied by the U.S. farm production per commodity group net of exports to derive an indicator for the regional demand for farm output.

Nonfarm inputs to the marketing sector considered here were intermediate materials, containers, supplies, fuel and hired labor. Except for the hourly earnings of hired labor, all nonfarm input prices at the national level were collected from the *Producer Price Index.* Hourly earnings data were obtained from the *Statistical Abstract* (SA). Data for the marketing sector also covered the 1949—83 period. An aggregate producer price index for processed food from the SA was used as the normally variable in this sector.

Retail Sector:

Retail prices in the Northeast for dairy, ft-^ and vegetables, and bakery products were indicated by the New York City consumer price index f_{0r} these products and obtained from the Bureau $_{O}$f Labor Statistics. Meat product and poultry and ee_{g} price indices were not available at the regional level The national price index for meat products $\backslash v_{as}$ used instead. The national price index for poultry was combined with the national price index f_{0r} eggs using annual poultry expenditures and egg expenditures, respectively, as weights.

Nonfood price indices in the Northeast (New York City price index) for housing, clothing, transportation, medical care, and other goods and services were obtained from the Bureau of Labor Statistics. National level consumption expenditure data for the various commodity groups were gathered from *Food Consumption, Prices, and Expenditures.* These included expenditure data for meat, dairy, poultry and eggs, fruits and vegetables, and other food products. The other food product category was mainly comprised of grain mill and bakery product consumer expenditures.

State-level personal income data was collected from the SA and percentage income shares of the Northeast to total national income was estimated. Northeast food consumption expenditure per commodity group was estimated by multiplying national expenditures with the Northeast percentage income shares. The region's retail demand for food products was then derived by deflating the region's food product expenditures by the corresponding food product retail price series. It should be noted that this procedure does not actually represent the unique regional demand for food in terms of tastes and preferences. Regional differences in food demand were based only on regional price and income differences. Population data per state were also collected from the SA so that the regional income per capita variable could be derived.

The data set for all three sectors were transformed to index numbers (1983 = 100) to standardize the different units of measurement and facilitate the comparability of parameter estimates. A more detailed explanation of data construction and variable measurement is found in Gempesaw et al.

Model Results

The parameter estimates and standard errors for equations (8), (9), (10) and (11) are given in Tables

[4] The regional value of shipment data should also be adjusted for inventories to measure output in terms of actual production rather than shipments. However, inventory data were not available at the regional

3 4, 5 and 6, respectively. Approximately forty-five percent of the coefficients were significant at the 90 percent confidence level and thirty-four percent of the estimates were significant at the 95 percent confidence level. The Durbin-Watson test statistic and the coefficients of multiple determination (R^2) for each of the individual equations are also presented in the same tables. Except for the poultry farm output demand equation, the Durbin-Watson test statistic for each equation was either in the inconclusive or no auto-correlation range. Eleven of the twenty-one R^2 estimates were above 0.90 while the lowest R^2 estimated was 0.75.

A model may have very good statistical fit, that is, high R^2 and small standard errors, but may have very poor simulation fit. To evaluate how closely the estimated equations simulate over the range of observations, several standard measures of ex-post explanatory power are presented in Table 2. The mean percent errors (MPEs) and the root-mean-square percent errors (RMSEs) were estimated for the individual equations. The smaller the errors, the better the fit. All the MPEs were close to zero while the RMSEs were also low. The RMSEs ranged from a low of 1.05 percent to a high of 8.08 percent. The dairy marginal cost pricing equation had the best fit while the fruit and vegetable demand for farm output equation had the worst fit.

Low MPEs and RMSEs are not the only desirable measures of simulation fit. Another useful simulation statistic is Their s inequality coefficient (U). If U = 0, there is a perfect fit and if U - 1, the predictive performance of the model is as bad as it possibly could be (Pindyck and Rubinfeld). The Theil inequality coefficients are also presented in Table 2 and were all very close to zero. The inequality coefficient can also be decomposed into three proportions: DM (BIAS), US (VAR) and DC (COV), respectively. The UM (BIAS) proportion is a measure of the extent to which the simulated and actual average values deviate from each other. The US (VAR) proportion measures the ability of the model to replicate the variance of the actual values. The UC (COV) proportion represents the unsystematic error. The ideal values for UM (BIAS) and US (VAR) are close to zero while UC (COV) should approach 1. These ideal values are closely approximated by the estimated proportions as shown in Table 2.

Analysis of Results

Inasmuch as the data used in the model estimation were all indexed (1983 = 100), the parameter slope estimates can also be interpreted as elasticities/flexibilities based on their 1983 values. Table 3 shows the flexibilities for the Northeast farm sector. A flexibility gives the percentage change in price associated with a percentage change in quantity.[5] Price dependency implies that the quantity of production is selected and the corresponding output price is obtained using marginal cost pricing. Inasmuch as the rational producer must operate in the increasing portion of the marginal cost curve, the relationship between quantity and price must be positive. However, the estimated values of the own-price flexibilities except for poultry were all negative. These negative estimates capture the shifts in the marginal cost curve along a given demand schedule instead of the movement along a fixed marginal cost curve. The downward shifts in the marginal cost curve can be caused by several factors such as technology advancements, lower factor prices, among others.

Dairy had the largest own-price flexibility while meat product was least affected by quantity changes. The Northeast is a major supplier of dairy and a very small producer of meat products. Thus, meat product prices in the Northeast are not substantially affected by increases in the region's meat production. Since dairy prices are set by public policy, quantity changes were not expected to have a significant impact on price. However, it could also be argued that quantity increases are taken into account by policymakers in setting price levels. A closer analysis of the data showed that during the last decade, Northeast dairy production increased at annual rate of 2.3 percent. On the other hand, the current market price of dairy increased by almost 6 percent annually but the real market price of dairy actually decreased. The inflation-adjusted market price of dairy was higher in 1970 than it was in 1983. Therefore, continued increases in dairy production in the Northeast were accompanied by decreases in the dairy real market price.

Higher farm variable input prices were expected to contribute positively to higher production cost and ultimately, higher output prices. Seventy percent of the estimates associated with the variable input prices had positive signs. The number of family labor contributed to higher product prices of meat, dairy, poultry and other food. An increase in the land variable was positively related with the output prices of feed grains, fruits and vegetables, and other food while it was negatively related with

[5] **Flexibilities are often more appropriate in agriculture. Due to the seasonality of most** farm **output, the quantities produced** determine the **supply and price available for consumption.** Furthermore, the **perishable nature of most agricultural products dictates that the** total **amount produced must be consumed** within **a certain period thus causing** price **to adjust in clearing the** market.

Table 2. Northeast Farm to Retail Sectoral Model Within Sample Validation Statistics

	Mean Percent Error MPE (%)	Root Mean Square Error RMSE (%)	Their s Inequality Statistic THEIL U	Proportions UM(BIAS)	US (VAR)	UC (COV)
Farm Sector Output						
Pricing Equations						
Meat	0.33	6.48	0.0309	0.000	0.020	0.980
Dairy	0.02	1.51	0.0074		0.005	0.995
Poultry	0.41	7.18	0.0294	0.000	0.006	0.994
Fruits & Veg.	0.51	7.68	0.0367	0.000	0.025	0.975
Feed Grains	0.09	3.81	0.0190	0.000	0.005	0.995
Other Food	0.15	4.21	0.0204	0.000	0.028	0.972
Demand For Farm						
Output Equations:						
Meat	0.01	1.73	0.0082	0.000	0.000	1.000
Dairy	0.38	6.56	0.0327	0.000	0.015	0.985
Poultry	0.53	7.91	0.0336	0.000	0.039	0.961
Fruits & Veg.	0.14	8.08	0.0313	0.000	0.001	0.999
Other Food	0.11	3.78	0.0203	0.000	0.004	0.996
Marginal Cost						
Pricing Equations:						
Meat	0.14	4.72	0.0226	0.000	0.006	0.994
Dairy	0.01	1.05	0.0053	0.000	0.003	0.997
Poultry	0.03	3.53	0.0158	0.000	0.000	1.000
Fruits & Veg.	0.04	2.61	0.0130	0.000	0.006	0.994
Other Food	0.02	1.94	0.0097	0.000	0.005	0.995
Retail Food						
Demand Equations:						
Meat	0.09	3.44	0.0182	0.000	0.009	0.991
Dairy	0.06	3.05	0.0152	0.000	0.011	0.989
Poultry	0.07	4.48	0.0181	0.000	0.001	0.999
Fruits & Veg.	0.11	3.36	0.0169	0.000	0.011	0.989
Other Food	0.11	4.29	0.0209	0.000	0.004	0.996

Table 3. Matrix of Parameter Estimates: Northeast Farm Sector, 1949-83**

		Farm Output					
Farm Prices	Intercept	Meat	Dairy	Poultry	Feed Grains	Fruits & Veg.	Other Food
Meat	401.03	-0.04	1.09	-0.71	0.28	0.09	0.26
	(258.10)	(0.34)	(1.18)	(0.29)	(0.34)	(0.15)	(0.14)
Dairy	136.32	0.05	- 1.11	0.18	0.21	-0,06	-0.03
	(52.08)	(0.06)	(0.23)	(0.06)	(0.06)	(0.02)	(0.02)
Poultry	108.88	0.68	1.45	0.03	0.46	-0.13	0.04
	(391.81)	(0.51)	(1.81)	(0.45)	(0.52)	(0.23)	(0.22)
Feed Grains	-274.66	-0.41	0.15	-0.12	-0.77	0.04	-0.02
	(128.64)	(0.16)	(0.57)	(0.14)	(0.16)	(0.07)	(0.06)
Fruits & Veg.	-394.78	-0.07	-0.63	0.69	-0.27	-0.55	-0.24
	(260.79)	(0.35)	(1.20)	(0.30)	(0.35)	(0.15)	(0.14)
Other Food	-77.38	-0.15	0.96	0.05	-0.03	-0.03	-0.54
	(217.54)	(0.29)	(1-01)	(0.25)	(0.30)	(0.12)	(0.12)

Table 3. (Continued)

Variable Input Prices					Other Emogenous Variables				
Farm Capital	Agri. Chem.	Feed, Seed & Lvstck	Msc. Inputs	Hired Labor	Family Labor	Land	Govt. Payments	R- Square	D.W.
-0.51	-1.21	0.03	1.29	0.13	0.27	-3.95	0.02	0.7754	1.75
(0-28)	(0.29)	(0.41)	(0.75)	(0.15)	(0.19)	(2.91)	(0.07)		
0.02	0.12	0.21	0.97	0.11	0.04	-1.12	0.04	0.9747	2.37
(0-05)	(0.05)	(0.08)	(0.14)	(0.03)	(0.03)	(0.59)	(0.01)		
0-05	0.31	-0.92	-0.85	0.59	0.85	-2.84	0.14	0.9461	2.56
(0.43)	(0.44)	(0.64)	(1-13)	(0.29)	(0.29)	(4.42)	(0.11)		
0.18	0.47	-0.18	0.52	0.03	-0.17	4.14	-0.16	0.8567	2.08
(0.13)	(0.14)	(0.20)	(0.36)	(0.07)	(0.09)	(1.45)	(0.03)		
0.36	0.61	0.51	-0.84	-0.13	-0.46	5.92	0.08	0.8607	1.92
(0.28)	(0.29)	(0.42)	(0.76)	(0.15)	(0.19)	(2.95)	(0.07)		
-0.34	0.72	0.46	-0.87	0.16	0.11	1.27	-0.11	0.8118	2.17
(0.24)	(0.24)	(0.35)	(0.64)	(0.13)	(0.16)	(2.47)	(0.06)		

Flexibilities **are estimated at their 1983 value; Numbers in parenthesis are standard errors.

the livestock product groups. It should be noted that government payments had a positive effect on all livestock product prices and fruits and vegetable price and a negative effect on feed grain and other food product prices. Other than dairy products, these two product groups are the main beneficiaries of government subsidies that encourage more production and consequently depress output prices.

The 1983 elasticity estimates for the Northeast farm output demand are given in Table 4. Theoretically, an increase in the farm price of a certain product should have a negative effect on farm output demand for that product. This was found to be true for poultry and eggs, fruits and vegetables, and other food products but not for meat and dairy products. The effect of non-farm input prices on farm level demand was mixed. Hired labor wages, material and supply prices generally had negative impacts while container and fuel prices had positive effects. An increase in marketing sector output had positive effects on the respective demand for farm output for all products. Poultry marketing output generated the highest demand for poultry farm output while other food marketing output generated the lowest demand for other food farm output. This was an expected result considering that a large share of the processed poultry product comes from the farm while a small share of processed other food product (e.g., cereals) is derived from the farm. For example, the 1986 farm value share of broiler chickens was 55 percent while farmers only received about 7.5 percent of the final cost of cereal and baked goods (Dunham).

Table 5 presents the estimates for the Northeast marketing sector marginal cost pricing equations. It is hypothesized that the impact of farm prices on the corresponding retail prices should be positive. Furthermore, those products that have a large farm value percentage share of the retail price, such as meat, dairy and poultry, should affect retail food prices the most. The results in Table 5 show that meat, poultry and dairy farm prices had the largest impact on their respective retail food prices. Except for the other food group, all farm product prices had positive effects on their respective retail prices. These findings are generally consistent with Lamm and Westcott's and Helen's results. The effect of nonfarm input prices on retail prices was generally mixed although one would expect that higher non-farm input prices should have a positive effect on retail food prices. The impact of higher marketing output on retail prices was negative for dairy products and positive for the rest.

The estimates for the Northeast retail food demand equations are given in Table 6. The own-price estimates were expected to be negative while the impact of the income variable should be positive, assuming the retail food commodity groups are not inferior products. The own-price estimates for meat, poultry, and fruits and vegetables followed theoretical expectations while the dairy and other food own-price estimates had wrong signs. The income variable had positive effects on all food groups with poultry having the largest income impact and meat animals having the lowest income effect. Theoretically, an increase in nonfood retail prices could bring about a decrease in retail food demand, that is, the income effect dominates. But it is also conceivable that an increase in nonfood retail prices will not have a negative effect on food demand. This implies that higher prices will result in lower consumption of nonfood items rather than

Table 4. Matrix of Parameter Estimates for Farm Output Demand: Northeast Marketing Sector. 1949-83**

		Farm Prices					Nonfarm Input Prices				
Quantitites	Intercept	Meat	Dairy	Poultry	& Veg.	Food	Con-tainer	Supplies	Fuel	Hired Labor	Materials
Meat	70.94	0.09	-0.24	0.16	-0.01	0.07	0.17	1.03	-0.04	-0.87	-0.13
	(51.18)	(0.08)	(0.17)	(0.04)	(0.05)	(0.05)	(0.29)	(0.39)	(0.12)	(0.21)	(0.19)
Dairy	563.85	0.04	0.21	0.05	-0.28	-0.63	0.56	-1.47	0.36	-2.84	-1.15
	(224.24)	(0.35)	(0.77)	(0.19)	(0.26)	(0.26)	(1.28)	(1-71)	(0.56)	(0.95)	(0.87)
Poultry	384.59	-0.31	-0.39	-0.06	-0.19	-0.07	1.01	-1.55	0.36	-1.64	-1.21
	(170.78)	(0.27)	(0.59)	(0.14)	(0.20)	(0.19)	(0.97)	(1.30)	(0.42)	(0.72)	(0.67)
Fruits & Veg.	594.38	-0.04	-0.13	0.31	-0.14	0.11	2.33	-0.91	0.82	-5.18	-2.47
	(231.79)	(0.36)	(0.79)	(0.19)	(0.26)	(0.26)	(1-29)	(1.74)	(0.57)	(0.98)	(0.90)
Other Food	266.31	-0.03	-0.42	0.15	-0.08	-0.09	0.78	-0.06	0.38	-1.67	-0.99
	(109.44)	(0.17)	(0.38)	(0.09)	(0.13)	(0.12)	(0.63)	(0.83)	(0.27)	(0.46)	(0.42)

Marketing Output						
Meat	Dairy	Poultry	Fruits & Veg.	Other Food	R-Square	D.W.
0.37	0.11	-0.26	0.33	-0.49	0.9936	1.67
(0.15)	(0.04)	(0.13)	(0.07)	(0.09)		
0.51	0.63	1.03	-0.91	-0.79	0.8851	1.39
(0.69)	(0.19)	(0.60)	(0.30)	(0.41)		
0.53	0.18	0.97	-0.05	-0.39	0.7651	0.96
(0.51)	(0.14)	(0.46)	(0.23)	(0.31)		
0.14	0.29	0.93	0.45	-1.54	0.9765	1.56
(0.68)	(0.20)	(0.63)	(0.31)	(0-42)		
0.17	0.14	0.22	-0.49	0.29	0.9611	1.25
(0.33)	(0.09)	(0.29)	(0.15)	(0.20)		

****Elasticities are estimated at their 1983 value; Numbers in parenthesis are standard errors.**

Table 5. Matrix of Parameter Estimates for Marginal Cost Pricing: Northeast Marketing Sector, 1949-83**

		Farm Prices					Nonfarm Input Prices				
Retail Prices	Intercept	Meat	Dairy	Poultry	Fruits & Veg.	Other Food	Con-tainer	Supplies	Fuel	Hired Labor	Materials
Meat	168.96	0.83	-0.52	-0.05	-0.19	-0.15	-0.99	-0.08	0.32	-0.94	0.32
	(66.85)	(0.10)	(0.23)	(0.05)	(0.07)	(0.07)	(0.37)	(0.51)	(0.16)	(0.28)	(0.26)
Dairy	149.55	-0,04	0.41	-0.03	-0.01	0.04	0.11	-0.33	-0.06	-0.91	-0.21
	(29.06)	(0.04)	(0.11)	(0.02)	(0.03)	(0.05)	(0.16)	(0.22)	(0.07)	(0-12)	(0.11)
Poultry	808.36	0.23	-1.19	0.48	-0.01	-0.32	0.01	-1.49	0.26	-3.92	-2.18
	(87.97)	(0.13)	(0.29)	(0.07)	(0.09)	(0-10)	(0.49)	(0.66)	(0.21)	(0.37)	(0.54)
Fruits &	126.04	-0,08	0.11	-0.07	0.18	0,02	-0.13	-0.52	-0.04	-0.12	0.05
Veg.	(63.48)	(0.09)	(0.21)	(0.05)	(0.07)	(0.07)	(0.36)	(0.48)	(0.15)	(0.26)	(0.24)
Other Food	47.61	-0.32	0.04	-0.09	0.02	-0.01	0.31	-0.07	-0.23	0.13	0.54
	(49.67)	(0,07)	(0.17)	(0.04)	(0.05)	(0.05)	(0.28)	(0.37)	(0.12)	(0.21)	(0.19)

Marketing Output						
Meat	Dairy	Poultry	Fruits &Veg.	Other Food	R-Square	D.W.
0.51	0,02	0.52	0.04	-0.29	0.9259	1.91
(0.19)	(0.05)	(0.18)	(0.09)	(0.12)		
0.21	-0.12	0.13	0.19	0.11	0.9703	2.75
(0.09)	(0.02)	(0.07)	(0.03)	(0.05)		
0.71	-0.28	1.56	-0.42	0.51	0.9952	2.30
(0.25)	(0.07)	(0.24)	(0.12)	(0.15)		
0.03	-0.11	0.01	0.08	0.34	0.8673	2.13
(0.19)	(0.05)	(0.17)	(0.08)	(0.11)		
-0.04	-0.05	-0.18	0.13	0.34	0.8883	2.14
(0.15)	(0.04)	(0.13)	(0.06)	(0.09)		

**Elasticities are based on their 1983 value; Numbers in parenthesis are standard errors.

a reduction in retail food demand. The estimated impacts of nonfood prices on retail food demand were generally mixed. Housing, transport, and medical prices were generally found to have negative effects on livestock products.

Regional Comparisons

This section presents selected results from the South, North Central and West regions for comparison with the Northeast results. A similar data set was gathered for these three regions[6] and the same model specification was estimated. A complete discussion of data collection procedures is also found in Gempesaw et al. Table 7 presents the own-price flexibilities and elasticities by region and sectoral equations. In terms of the farm sector output price dependent equations, the Northeast meat flexibility was relatively small in magnitude compared to the other regions. Note that the North Central region, which is the major supplier of meat products, had the largest own-price flexibility for meat.

The dairy own-price flexibility of the Northeast was the largest, followed by the West and North Central regions. The South, which has the smallest dairy production relative to the other regions, also had the smallest own-price flexibility. The poultry own-price flexibility for the Northeast had a positive sign while the other regions had large negative flexibilities. The Northeast own-price flexibility for fruits was greater than the other regional results. The North Central region, which does not produce as much fruits and vegetables as the other regions, had the lowest own-price flexibility. The results for the feed grain flexibilities surprisingly showed that the North Central region, which is the major feed grain supplier, had the lowest own-price flexibility. On the other hand, the South and West regions, which are deficient regions in feed grains, had the highest own-price flexibilities. For the other food own-price flexibility, only the Northeast and West regions had negative signs, with the West flexibility being greater than the Northeast estimate.

The signs of the regional own-price elasticities for the farm output demand equations were mostly contrary to *a priori* expectations. Both the Northeast and South regions had two incorrect signs while the North Central and West regions only had one correct sign. A possible reason for these results is that most if not all regions are either deficit or surplus producers of one or more commodity. For the deficit regions, the processors demanding the farm output were expected to be affected by the farm prices of the regions from where they purchase their farm output requirements and not only by their own regional farm price. For example, the Northeast demands meat animal products from the North Central region or the South buys dairy products from the Northeast. This implies that in terms of model specification, the Northeast demand for farm output, for example, should not only depend on the Northeast region's own-farm prices but also on the farm prices of other regions that supply the Northeast's farm output requirements. Conceptually, regional farm output demand may depend largely on the own-regional farm price only if that region is a surplus producer. Another reason might be the existence of little or no substitution relationships among farm outputs. Dunn and Heien noted that meat cannot be substituted for milk in the production of cheese for example. They tested and found no substitution relationships among the use of farm output. Thus, incorrect model specification might have caused the wrong signs of the estimated own-price elasticities for farm output demand.

The marginal cost pricing equation results represent the own-price elasticity effect of farm prices on retail food prices. For example, a one percent increase in meat farm prices will cause a .83 percent increase in meat retail price in the Northeast. Based on the meat product category, the Northeast and South farm prices had the largest impact on its regional retail meat prices. Except for the South, the effect of regional farm prices of dairy on regional retail prices were very similar in the Northeast, North Central and West regions. The four regions also had similar results for the poultry and egg and fruits and vegetable product groups. The other food product results were mixed with the North Central, which is the major production center for this product category, having the only correct positive result.

The own-price elasticities for the regional retail food demand are also given in Table 7. The meat own-price elasticities were found to be very similar among regions. The Northeast dairy own-price elasticity had the wrong sign. Among the other regions, the North Central dairy elasticity was the largest in magnitude. It should be noted that the regional poultry own-price elasticities were generally lower than most of the other product groups' elasticities. This may reflect the increasing demand for poultry products compared to meat products for example. The Northeast had the largest own-price elasticity for fruits and vegetables while the regional results for the other food products were all incorrect. Income elasticities were also estimated

[6] **The regions were** defined based **on** Bureau of **Labor** Statistics regional classification.

Table 6. Matrix of Parameter Estimates for Retail Food Demand: Northeast Retail Sector, 1949-83**

	Retail Prices						Nonfood Prices					Emogenous Variable		
Retail Quantities	Intercept	Meat	Dairy	Poultry	Fruits & Veg.	Other Food	Housing	Clothing	Transport	Medical	Other Goods	Per Cap. Income	R- Square	D.W.
Meat	20.63	-0.45	0.22	-0.04	0.21	-0.22	-0.21	0.14	-0.01	0.69	0.08	0.38	0.9872	1.71
	(27.27)	(0.05)	(0.18)	(0.02)	(0.11)	(0.12)	(0.09)	(0.04)	(0.22)	(0.18)	(0.12)	(0.16)		
Dairy	221.83	-0.27	0.32	-0.03	-0.22	-0.36	-0.02	0.07	-0.93	-0.14	-0.43	0.79	0.8721	2.77
	(32.24)	(0.06)	(0.24)	(0.02)	(0.13)	(0.15)	(0.12)	(0.06)	(0.26)	(0.21)	(0.15)	(0.19)		
Poultry	4.27	0.17	-0.02	-0.14	-0.05	-0.51	-0.21	-0.12	0.46	-0.29	0.68	0.95	0.9883	2.13
	(34.81)	(0.06)	(0.24)	(0.02)	(0.14)	(0.16)	(0.12)	(0.06)	(0.28)	(0.22)	(0.16)	(0.21)		
Fruits & Veg.	126.68	-0.03	0.58	-0.15	-0.93	0.02	0.21	0.08	-0.85	0.08	0.13	0.62	0.9662	2.49
	(25.92)	(0.05)	(0-19)	(0.03)	(0.10)	(0.12)	(0.10)	(0.04)	(0.21)	(0.16)	(0.11)	(0.15)		
Other Food	-16.77	0.22	-0.67	-0.08	0.19	0.81	-0.26	0.21	0.51	0.11	-0.32	0.47 (0.25)	0.9708	1.81
	(42.13)	(0.08)	(0.30)	(0.03)	(0.17)	(0.20)	(0.16)	(0.07)	(0.34)	(0.27)	(0.19)			

****Elasticities are estimated at** their **1983 value;** Numbers **in parenthesis are standard errors.**

for the five food products by regions. Except for the North Central region, poultry products had the largest income effect among the livestock products. All income elasticities estimated were positive, indicating that none of the food products are inferior. These results are different from those estimated by Dunn and Heien who found meat products to have the largest income effect and poultry and dairy having negative income effects.

Conclusion

The Northeast region is characterized by greater industrial development, higher population density, and an above-average income per capita compared to other regions in the U.S. These differences suggest that the Northeast food industry's response to changes in economic conditions may also be unique. The objective of this study was to develop a method to estimate and measure the effects of changes in exogenous variables on food production and consumption in the Northeast. A multiproduct, multisector model was specified and estimated simultaneously. The empirical results were presented in terms of elasticities and flexibilities estimated at their 1983 values. Estimation and simulation statistical measures were also presented. The same model specification was also estimated for three other regions and regional comparisons of own-price flexibilities, own-price elasticities, and income elasticities were also conducted.

Several implications can be derived from these estimated results. First, the Northeast response to

Table 7. 1983 Values of Own-Price Elexibilities and Elasticities, by Region and Sector

	Northeast	South	North Central	West
Farm Sector Output Pricing Equations:				
Meat	-0.04	-0.42	-0.63	-0.32
Dairy	-1.11	-0.01	-0.27	-0.72
Poultry	0.03	-1.13	-0.82	-2.45
Fruits & Veg.	-0.77	-0.31	-0.02	-0.22
Feed Grains	-0.55	- 1.25	-0.43	- 1.03
Other Food	-0.54	1.95	0.43	-1.17
Demand for Farm Output Equations:				
Meat	0.09	-0.03	0.10	0.31
Dairy	0.21	0.13	-0.08	0.21
Poultry	-0.06	-0.03	0.18	0.11
Fruits & Veg.	-0.14	0.08	0.01	-0.01
Other Food	-0.09	-0.02	0.05	0.33
Marginal Cost Pricing Equations:				
Meat	0.83	0.78	0.41	0.33
Dairy	0.41	0.07	0.50	0.53
Poultry	0.48	0.36	0.49	0.32
Fruits & Veg.	0.18	0.11	0.18	0.17
Other Food	-0.01	-0.01	0.07	-0.03
Retail Food Demand Equations:				
Meat	-0.45	-0.48	-0.54	-0.39
Dairy	0.32	-0.22	-0.46	-0.16
Poultry	-0.14	-0.02	-0.05	-0.20
Fruits & Veg.	-0.93	-0.62	-0.37	-0.29
Other Food	0.81	0.65	0.83	0.53
Income Elasticities:				
Meat	0.38	0.73	0.87	0.40
Dairy	0.79	0.58	0.34	0.48
Poultry	0.95	1.00	0.63	0.86
Fruits & Veg.	0.62	0.85	0.55	0.50
Other Food	0.47	1.12	0.81	1.35

changes in the exogenous variables were generally different from other regions. Second, the regional specialization of agricultural production and differences in factor endowments seemed to have an influence in the regional food production and consumption responses. Third, production oriented government subsidies such as those provided to producers of feed grains and other food products contributed to lower Northeast farm prices of these products. However, price oriented government subsidies (e.g., dairy price support) contributed to higher Northeast dairy farm price. Fourth, increases in the Northeast marketing sector output generated an increase in the demand for all farm products especially in the case of poultry farm output. Fifth, livestock farm prices in all regions had larger impacts on livestock retail food prices compared to the effect of field crop farm prices on field crop retail food prices. Finally, the income eff_{ect} was found to be positive for all food commodity groups with poultry products and other food prod-ucts (e.g., cereals and bakery products) having the highest income effects in the South and West regions. The income effect was the highest for meat and other food in the North Central region while Northeast region's highest income effect was on poultry and dairy products. These research results imply the importance of conducting region or state level analysis given the different characteristics associated with regions and states.

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