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Appendix

Structure of the WH Model

Underpinning the pair of quasi-reduced-form retail and farm price equations in the text equations 1 for each market is a general market-clearing condition for final industry output and a general market-clearing condition for farm ingredients. They are general because, within the same composite industry, firms' farm demand and firms' output supply will vary across firms. Within the same industry, one firm's production function may be different from other firms' production functions. Hence, the structure of this class of models provides an analytical framework for price analyses of market for which any one industry produces a variety of different final products. The comparative static results developed by Heiner, and extended by Wohlgenant (1989), do not depend on the restriction of identical firms. For a more detailed discussion of this structure, see WH or Wohlgenant (1989).

In the particular setup in the text, a food industry consists of all manufacturing, wholesaling, and retailing firms associated with a composite final demand product (e.g., beef). Each industry faces a final, market-level consumer demand schedule for its products and a market-level supply schedule for the farm ingredients. For tractability, firms in the same industry face the same composite market prices for output and all inputs.

In this setup, if *i* denotes an index associated with a firm in the industry, market clearing for final consumer goods could be generally written as

$$\Sigma_i S_r^i (P_r, P_f, \mathbf{W}) = D_r (P_r, Z) \qquad (i)$$

where S_r^i is the supply of the ith firm, Pr the output price, P_f the farm price, W a vector of non-farm input prices, and Z is a consumer demand shifter. Condition (i) states that the sum of firm-level supply equals final consumer demand for the industry's output. Market clearing associated with farm ingredients is expressed as

$$\Sigma_i D_f^i (P_r, P_f, W) = F \qquad (ii)$$

in which *F* is farm supply, and D_f^i is the *i*th firm's demand for farm ingredients. Condition (*ii*) states that the sum of firm-level demands for farm ingredients equals the market-level supply of farm ingredients. Equations *i* and *ii* represent a general form of the structural model for each market examined in this study.

The structural parameters of equations *i* and *ii* define the A_r and the A_f of equations 1 in the text. The structural parameters of equations *i* and *ii* are found by totally differentiating equations *i* and *ii* and expressing the results in terms of partial elasticities of supply and demand. Totally differentiating equations *i* and *ii* and rearranging, gives

$$(e_{rr} - e)\, d\ lnP_r + e_{rf}\, d\ lnP_f = e_z\, d\ lnZ - e_{rw}\, d\ lnW$$
$$- e_{fr}\, d\ lnP_r - e_{ff}\, d\ lnP_f = e_{fw}\, d\ lnW - d\ ln\ F$$

where e_{rr}, for example, is the weighted sum of the elasticities of firm supply, i.e., $e_{rr} = \Sigma i\ e_{rr}^i\ (Q_r^i/Q_r)$. Wohlgenant and WH solve the two-equation system for $d\ lnP_r$ and $d\ lnP_f$ in terms of *d lnZ, d lnW, and d lnF* and reveal the precise way in which the structural parameters define the coefficients of the quasi-reduced-form flexibilities (the *A* coefficients) in the text. The relationship between the structural parameters and the response coefficients are spelled out in the cited articles, and define the comparative static results discussed in the text.

Data

To the greatest extent possible, we followed the directions of Wohlgenant and Haidacher (WH) when constructing the economic variables used in this study. All of the variables of equations 1-4 in the text were constructed from annual data from 1958 to 1997. All of the potentially superfluous farm supply shift variables except the laying flock (for eggs) were also constructed from annual data from 1958 to 1997. The laying flock variable was constructed from 1960-97 data.

The retail prices are constructed from annual average Consumer Price Index (CPI) data, U.S. City Average, Not Seasonally Adjusted. The particular series used to construct retail prices are:

Beef and veal	Beef and Veal, CPI, U.S. City Average, Not Seasonally Adjusted
Pork	Pork, CPI, U.S. City Average, Not Seasonally Adjusted
Poultry	Poultry, CPI, U.S. City Average, Not Seasonally Adjusted

Eggs	Eggs, CPI, U.S. City Average, Not Seasonally Adjusted
Dairy	Dairy and Related Products, CPI, U.S. City Average, Not Seasonally Adjusted
Fresh fruit	Fresh Fruits, CPI, U.S. City Average, Not Seasonally Adjusted
Fresh veg.	Fresh Vegetables, CPI, U.S. City Average, Not Seasonally Adjusted
Nonfood	All Items Less Food, CPI, U.S. City Average, Not Seasonally Adjusted
Beverages	Non-Alcoholic Beverages and Beverage Material, CPI, U.S. City Average, Not Seasonally Adjusted
Sugar	Sugar and Sweets, CPI, U.S. City Average, Not Seasonally Adjusted
Cereal	Cereals and Bakery Products, U.S. City Average, Not Seasonally Adjusted

Farm level prices are constructed from non-seasonally adjusted annual Producer Price Index (PPI) data for farm products. The series used to construct farm price variables are:

Beef and veal	Slaughter Cattle, PPI, Farm Products, Not Seasonally Adjusted
Pork	Slaughter Hogs, PPI, Farm Products, Not Seasonally Adjusted
Poultry	Slaughter Poultry, PPI, Farm Products, Not Seasonally Adjusted
Eggs	Chicken Eggs, PPI, Farm Products, Not Seasonally Adjusted
Dairy	Fluid Milk, PPI, Farm Products, Not Seasonally Adjusted
Fresh fruit	Fresh Fruits and Melons, PPI, Farm Products, Not Seasonally Adjusted
Fresh veg.	Fresh Vegetables Except Potatoes, PPI, Farm Products, Not Seasonally Adjusted

The raw farm prices for beef and veal and pork (Pf*) are adjusted (as in Wohlgenant and WH) to account for the value of byproducts in the farm prices for slaughter cattle and slaughter hogs. We use the 1982 levels of the gross farm value (GFV) and the byproduct value (BPV), and hence the net farm value (NFV = GFV - BPV) for cattle and for hogs. These data are recorded by USDA/ERS. Using the 1982 values, data on byproduct allowances (Pb) for cattle and hogs are used to adjust the raw PPI farm price series. In general, the log of the adjusted farm price, $ln\ P_f$ is computed as

$$ln\ P_f = (GFV_{82}/\ NFV_{82})\ ln\ P_f^* - (BPV_{82}/\ NFV_{82})\ ln\ P_b$$

In particular, the adjusted farm price formula for beef is

$$ln\ P_f = (155.5/141.1)\ ln\ P_f^* - (14.4/\ 141.1)\ ln\ P_b$$

and is

$$ln\ P_f = (94.3/87.0)\ ln\ P_f^* - (7.3/87.0)\ ln\ P_b$$

for pork.

All CPI and PPI price series were obtained from Bureau of Labor Statistics (BLS) web sites, and the GFV, BPV and byproduct allowances were obtained from ERS data sets with help from Lawrence Duewer.

The price of labor, packaging, transportation, energy, and other inputs from 1968-1997 were obtained directly from published reports (Elitzak). The series was extended back to 1958-1967 by overlapping the 1968-97 data set with a consistent and similar data set covering the 1958-67 period. The data were provided by Howard Elitzak.

The series used to construct farm supply are computed as the product of per capita food disappearance multiplied by U.S. Population, including armed services (July 1). The particular per capita disappearance data series used are:

Beef and veal	Beef plus Veal, Food Disappearance Per Capita, Carcass Weight (lbs)
Pork	Pork, Food Disappearance Per Capita, Carcass Weight (lbs)
Poultry	Total Chicken Plus Turkey, Food Disappearance Per Capita, Carcass Weight (lbs)

Eggs	Eggs, Food Disappearance Per Capita, Farm Weight (lbs)
Dairy	All Dairy Products, Food Disappearance Commercial Sales plus USDA donations (lbs of milk equivalent, milkfat basis)
Fresh fruit	Fresh Fruit (including melons), Food Disappearance Per Capita, Farm Weight (lbs)
Fresh veg.	Commercially Produced Fresh Vegetables Excluding Potatoes and Sweet Potatoes Minus Mushrooms, Commercial Disappearance Per Capita, Farm Weight (lbs)

The farm supply variables for beef and pork were converted from carcass weight to live weight by dividing the disappearance values (in carcass weight) by the annual average ratio of the dressed to live weight under federal inspection. The dressed and live weight data are reported in *Annual Livestock Slaughter*, the Agricultural Statistics Board, NASS, USDA, and were made available by Lawrence Duewer. The dependent variables used in the estimation of the system of consumer demand relationships were constructed using the same food disappearance variables, except no adjustment was made to convert the beef and pork disappearance data to live weight.

The data to compute shifters on consumer demand (other than prices) are:

Population	U.S. Population, including armed services, July 1
Income	Per Capita Personal Disposable Income, Current Dollars, multiplied by Population

The data used to form nonfarm input prices were provided by Howard Elitzak. They are:

Packaging	Food Marketing Cost Index (1982 = 100), packaging component
Transportation	Food Marketing Cost Index (1982 = 100), transportation component
Energy	Food Marketing Cost Index, energy component
Other	Food Marketing Cost Index, advertising, communications, rent maintenance and repair, business services, supplies, property taxes, short-term interest. This variable is used as the deflator in this bulletin.

Data to construct the shifters on the farm supply used to test for oligopsony power tests are:

Beef & veal	S_1: Steers, 1 year and older, January 1 S_2: Price of number 2 yellow corn, Chicago
Pork	S_1: U.S. hog inventory, all hogs and pigs S_2: Price of number 2 yellow corn, Chicago
Poultry	S_1: Price of soybean meal, 48 percent, Decatur S_2: Price of number 2 yellow corn, Chicago
Eggs	S_1: Laying flock, average annual per month
Dairy	S_1: Cows and heifers on farms, 2 years and older, January 1 S_2: Price of soybean meal, 48 percent, Decatur
Fresh fruit	S_1: Average hourly wages paid to all hired farm workers
Fresh vegetables	S_1: Average hourly wages paid to all hired farm workers

Estimates of Consumer Demand and Factor Shares

Appendix table 1 — System of consumer demand equations

Explanatory variable	Per capita consumer demand equation for: Beef	Pork	Poultry	Eggs	Dairy	Fresh fruit	Fresh vegetables
Beef price	-0.065 (-1.02)	0.574 (15.3)	-0.333 (-3.20)	0.191 (5.08)	0.089 (2.37)	-0.621 (-6.5)	-0.481 (-7.3)
Pork price	0.322 (15.0)	-0.745 (-20.0)	-0.085 (-1.2)	0.030 (.91)	0.069 (2.23)	-0.083 (-1.3)	-0.152 (-3.04)
Poultry price	-0.078 (-3.0)	0.029 (-.95)	0.607 (-6.0)	0.091 (2.60)	0.112 (3.36)	0.335 (5.02)	0.207 (3.70)
Egg price	0.045 (4.70)	0.012 (.79)	0.083 (2.31)	-0.064 (-2.18)	0.030 (1.50)	-0.101 (-2.90)	0.014 (.37)
Dairy price	0.053 (1.87)	0.085 (2.06)	0.303 (3.01)	0.084 (1.45)	-0.974 (-14.5)	-0.140 (-1.52)	-0.035 (-0.37)
Fresh fruit price	0.148 (-6.51)	-0.033 (-1.24)	0.327 (4.90)	-0.089 (-2.77)	-0.039 (-1.37)	-0.208 (-2.50)	0.135 (2.63)
Fresh vegetable price	0.093 (-7.22)	-0.050 (-2.89)	0.157 (3.59)	0.015 (.51)	-0.004 (-.17)	0.113 (2.66)	0.054 (.81)
Nonfood price	0.210 (1.93)	0.139 (2.00)	-1.170 (-6.67)	0.388 (5.5)	0.905 (13.8)	-0.008 (-.052)	-0.466 (-4.08)
Beverage price	-0.163 (-3.74)	0.164 (6.37)	0.093 (1.36)	0.012 (.47)	0.110 (4.78)	0.202 (3.12)	0.057 (1.32)
Sugar price	0.410 (4.51)	-0.367 (-6.50)	-0.701 (-4.48)	-0.195 (-3.3)	-0.101 (-1.9)	-0.455 (-3.0)	-0.253 (-2.53)
Cereal price	-0.668 (-4.56)	0.353 (3.57)	0.967 (3.53)	-0.129 (-1.2)	0.235 (2.51)	0.801 (2.92)	0.564 (3.19)
Income/ pop.	0.175 (5.33)	-0.103 (-3.23)	0.965 (12.2)	-0.335 (-9.0)	-0.430 (-13.8)	0.145 (2.10)	0.357 (5.66)
Intercept	1.005 (14.0)	-0.321 (-4.51)	6.291 (36.9)	2.797 (34.3)	5.406 (79.5)	5.010 (33.0)	5.344 (38.7)

Entries are elasticity estimates with symmetry and homogeneity imposed at the sample means. Values in parentheses are t-values. The shares of income used to impose the symmetry restriction at the point estimates are as follows: 0.316 (beef and veal), 0.0180 (pork), 0.008 (poultry), 0.0082 (eggs), 0.0241 (dairy), 0.0075 (fresh fruit), and 0.0062 (fresh vegetables).

Appendix table 2 — Factor shares for the seven industries

Industry	Labor	Packaging	Transport	Energy	Other	Farm
Beef & veal	0.1892	0.0731	0.0430	0.0215	0.1032	0.5700
Pork	0.2904	0.1122	0.0660	0.0330	0.1584	0.3400
Poultry	0.2156	0.0833	0.0490	0.0245	0.1176	0.5100
Eggs	0.1628	0.0629	0.0370	0.0185	0.0888	0.6300
Dairy	0.2244	0.0867	0.0510	0.0255	0.1224	0.4900
Fresh fruit	0.2948	0.1139	0.0670	0.0335	0.1608	0.3300
Fresh vegetables	0.2904	0.1122	0.0660	0.0330	0.1584	0.3400

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