Appendix

A. Data Sources

The Diary sections of Annual Consumer Expenditure Survey (CES) from 1980-97 are used to construct U.S. nominal expenditures (*E*) for each market. We apply BLS-supplied weights to each survey record (household) to compute national estimates. Source: Bureau of Labor Statistics, U.S. Dept. of Labor (BLS).

Supply and utilization (S&U tables) data are used to construct farm supply estimates. Source: Economic Research Service

Farm prices (P_f). Source: National Agricultural Statistics Service

Livestock byproduct adjustment data are used to compute estimates of farm receipts. Source: ERS.

Retail Prices (P_r). Consumer Price Index (CPI) data are used. Source: BLS.

B. General Description of the Computations of the Revised Retail-Farm Price Margins

As stated in the text, we compute estimates of the revised retail-farm price margin by evaluating both the numerator and denominator of equation 5. The U.S. consumer expenditure (*E*) for each market is obtained from weighted Consumer Expenditure Survey data (see above). According to the Generalized Composite Commodity Theorem (GCCT) and equation 3 in the text, *Q* is the ratio of nominal expenditures divided by an average price index for the composite market (i.e., P_{r^*}). We use the BLS estimates of the CPI for the composite market as the price index.

To arrive at an estimate of farm cash receipts generated by domestic at-home food sales, exports and byproducts were subtracted from total receipts to generate a net receipt number. Finally an econometric estimate of the proportion of net farm receipts generated from away-from-home food sales was applied to net receipts to generate net farm cash receipts generated by domestic at-home food sales. This is *FR* in equation 5 in the text. Some of the market-specific computations are detailed in section C below.

Given *E*, *FR*, and *Q*, we compute the series M for each market according to equation 5 in the text. Note the result is a dimensionless number, so that M is expressed as an index (1982-84 = 100). The 1982-84 base period was chosen to coincide with the current base used to report both the CPI and the USDA market basket.

C. Market-Specific Computations

Beef and veal. Composite consumer demand for beef is computed by dividing U.S. annual beef expenditures (CES data) by the CPI for beef and veal. To compute adjustments to farm receipts, we treated the farm supply facing beef producers as homogeneous so that the prices received by beef farmers were independent of whether the cattle were sold to domestic channels or exporters. Hence quantity ratios constructed from ERS supply-utilization data served as adjustment factors to the total farm cash receipts. The export adjustment factor was computed by dividing export quantity by the quantity of total production. Byproducts were removed by means of data developed in conjunction with ERS Choice beef price spread estimates. The value of beef byproducts was divided by the gross farm value for Choice beef in order to calculate the byproduct adjustment factor. Procedures implemented to adjust for the away-from-home market are discussed below.

These procedures were also used to adjust the veal data for exports, byproducts, and away-from-home consumption. However, data for veal farm cash receipts are not reported separately. Therefore, it was necessary to estimate the ratio of adjusted beef and veal production to the farm value of total production based on the supply and utilization tables. This task was accomplished by multiplying the adjusted cattle quantity data by the farm price for cattle to obtain an estimated farm value. Similarly, the adjusted veal quantity was multiplied by the price received by farmers for calves. Total quantities of beef production were then multiplied by the cattle price, while total quantities of veal production were multiplied by the calf price. Estimated adjusted farm values for beef and veal were summed. Estimated aggregate farm values for beef and veal production were also totaled. Adjusted beef and veal farm values were divided by the farm value of total production for these two commodities. Cattle cash receipts were then adjusted by this ratio.

Pork. Composite consumer demand for pork is computed by dividing annual pork expenditures (CES data) by the CPI for pork. To compute adjustments to farm receipts, we treated the farm supply facing pork producers as homogeneous. Hence, quantity adjustment factors were computed in the same way as they were for beef. Byproduct values were obtained from the ERS pork price spread series, and divided by the gross farm value for pork. This figure was multiplied by total hog production in order to remove the proportion of cash receipts allocated to byproducts.

Poultry. Composite consumer demand for poultry is computed by dividing annual poultry expenditures (CES data) by the CPI for poultry. To compute adjustments to farm receipts, we considered the chicken and turkey as separate farm commodities. Hence we combined these receipts using the same procedures we used for beef and veal. Byproducts constitute a negligible proportion of total cash receipts, and were therefore not estimated.

Eggs. Composite consumer demand for eggs is computed by dividing annual eggs expenditures (CES data) by the CPI for eggs. Eggs are perhaps the most homogeneous products of the seven commodity composites considered in this study. However, NASS data indicate that farmers receive higher prices for hatching eggs than for eggs destined for human consumption. Unfortunately, a price series for hatching prices is unavailable. Therefore, we can only partially adjust for hatching eggs by using the farm price for all eggs. The farm value of exports is computed by multiplying the quantity of exports by the price for table eggs. The quantity of hatching eggs is then multiplied by the farm price for all eggs. Next, total egg production is multiplied by the price for all eggs. The farm value of exports and hatching eggs are then deducted from the farm value of total production. This procedure does not adequately differentiate between market and non-market eggs when the total farm value is computed.

Dairy. Composite consumer demand for dairy is computed by dividing annual dairy expenditures (CES data) by the CPI for dairy products. To compute adjustments to farm receipts, we treated the farm supply, calculated on a milk-fat basis, as homogeneous and made similar quantity ratio adjustments to cash receipts as performed above.

Fresh fruits. Since bananas are imported, U.S. consumer expenditures for bananas (CES data) are subtracted from fresh fruit expenditures. Furthermore, the reported CPI for fresh fruit is adjusted so that it excludes the banana component. Hence composite consumer demand for fresh fruits is computed by dividing annual fresh fruit expenditures less banana expenditures divided by the adjusted CPI for fresh fruits. To compute adjustments to farm receipts, we recognized this category as highly heterogeneous. Moreover, the availability of data varies over time. Therefore, exports were removed by using approximately 12 major fruits and melons, which account for the majority of total American fruit consumption. For each selected fruit, exports and total production were each multiplied by the appropriate farm price, and summed across commodities. The estimated farm value of exports for all fruit were then divided by the farm value of total production, and applied to the cash receipts figure for fresh fruit. A special procedure had to be employed for citrus fruits. Citrus fruit production is reported in terms of short tons, while prices are presented in terms of dollars per box. The weight of each box varies, depending on the State where the fruit is grown. The average weight of each box was calculated by:

(1) Determining the percentage of total production in each producing State,

(2) Multiplying this percentage by the average weight of each box in a given State, as reported by NASS, and

(3) Summing the figures obtained in Step 2.

Fresh vegetables. Composite consumer demand for fresh vegetables is computed by dividing annual fresh vegetable expenditures (CES data) by the CPI for fresh vegetables. To adjust farm receipts, we recognized this category as very heterogeneous. Approximately 12 of the most important vegetables (in terms of total production) were used to remove exports from farm cash receipts. These vegetables were assumed to be representative of all vegetables in terms of the ratio of the farm value of exports to the farm value of total production. For each vegetable, estimated farm values were computed by multiplying by total export quantity and by total production. The resulting farm values for exports and total production were then summed across all vegetables. An aggregate ratio of export value to total production value was then used to remove foreign trade from the cash receipts.

D. Composite Commodity Tests

The question of whether at-home consumption of beef, pork, poultry, eggs, dairy, fresh fruit, and fresh vegetables represent valid composites is central to the computation of meaningful retail-farm price margins. The tests proposed by Lewbel are designed to address the question of whether there exists a set of composite or group demands that accurately reflects consumer preferences for the elementary products that consumers actually purchase. The procedures are designed to test whether a variable formed as the log of the ratio of an elementary product price divided by the average price for the hypothesized group is independent of the deflated (by all food CPI) average price for the group. Evidence of pairwise independence between the log of the deflated elementary product price and the deflated average price is a necessary condition for the existence of a valid composite.

Given that unit roots appeared to be driving most of the data, five tests of cointegration represent tests of pair-wise independence. Two are designed to test the null that the relative elementary product prices are independent (i.e., are not cointegrated) of the average deflated group price index. Three are designed to test the null that the relative elementary is *not* independent (i.e., is cointegrated) of the average deflated price index for the group.

For each composite, we performed tests on the following elementary product price series. For the beef composite, we tested for independence between the deflated CPI (by the CPI for all food) for beef and the prices of ground chuck, ground beef, round roast, T-bone steak, and round steak. For pork, we tested for independence between the deflated CPI for pork and the prices of bacon, chops, fresh sausage, and ham. For poultry we tested for independence between the deflated CPI for poultry and the price of whole fresh chicken, chicken breast, chicken legs, and turkey. For dairy we tested for independence between the deflated CPI for dairy and the price of fresh whole milk, cheese, and ice cream. For fresh fruit we tested for independence between the deflated CPI for fresh fruit and the price of apples, bananas, grapefruit, lemons, and oranges/tangerines. For fresh vegetables we tested for independence between the deflated CPI for fresh vegetables and the price of potatoes, lettuce, tomatoes, cabbage, celery, carrots, onions, peppers, and cucumbers. Without presenting a detailed set of test results we found for each group, the tests suggested pointwise independence. Hence the tests strongly indicated that the groups form valid composites.

E. Farm Receipts Generated From At-Home Food Sales

Because we are computing retail-farm price margins for at-home commodities, it is necessary to estimate the level of farm receipts (FR) generated from a market's at-home sales. Since the proportion of consumer expenditures of food away from home has steadily increased over time (Putnam and Allshouse, 1997), it seems likely that the proportion of farm expenditures attributable to at-home food sales has also grown over time for many, if not all, of the seven product categories. However since actual farm-receipt data generated from at-home food sales are unavailable, they must be estimated econometrically. For the purposes of this study, we estimated a longrun point estimate of the proportion of farm receipts generated from at-home sales. The variable *FR* is then the product of the estimate and domestic farm receipts.

The estimates are obtained from the estimation of a market model proposed by Wohlgenant (1989) and Wohlgenant and Haidacher (1989) in which firms and products are diverse. In the reduced-form model of at-home retail and farm prices, the farm supply variable would ideally measure the farm supply allocated to at-home food production. However, the variable that has been used is total domestic farm supply (commercial disappearance). Note that if *F* denotes total domestic farm supply, *H* denotes farm supply allocated to at-home food production and *A* denotes farm supply allocated to away-from-home food production, then $F = H + A$ and in percent changes

$$dln\ F = \phi\ dln\ H + (1 - \phi)\ dln\ A \qquad (i)$$

where for example, $dln\ Z = dZ/Z$, and ϕ denotes the ratio of domestic farm supply used in at-home production. The idea is to compute a point estimate of ϕ for each market and use it to adjust total domestic farm receipts.

In the Wohlgenant and Wohlgenant and Haidacher framework, let p_r and p_f denote retail and farm prices and let the vector *X* denote the vector of marketing input prices and consumer demand shift variables. A correct specification of the model would be

$$dln\ P_r = \beta_1\ dln\ X + \beta_2\ dln\ H$$

$$(ii)$$

$$dln\ P_f = \alpha_1\ dln\ X + \alpha_2\ dln\ H$$

where the unobservable farm supply allocated to at-home industry production would be used instead of commercial disappearance (i.e., *F*).

If (*ii*) were observable and markets were competitive, a symmetry (price-taking) restriction and a constant returns (zero-profit) restriction would hold and could be imposed. However by solving *(i)* for *dln H* and substituting the result into *(ii)* gives the observable representation

$$dln\ P_r = \beta_1\ dln\ X + \phi^{-1}\ \beta_2\ dln\ F - \gamma\beta_2\ dln\ A$$

$$(iii)$$

$$dln\ P_f = \alpha_1\ dln\ X + \phi^{-1}\alpha_2\ dln\ F - \gamma\alpha_2\ dln\ A$$

where *g = (1-f)/f*. To keep things as simple as possible, we assume *ln A* is stationary around a deterministic time trend (*T*), so that an estimable form of *(ii)* would be

$$ln\ P_r = \beta_1\ ln\ X + \phi^{-1}\ \beta_2\ ln\ F + \beta_3\ T + \varepsilon_1$$

$$(iv)$$

$$ln\ P_f = \alpha_1\ ln\ X + \phi^{-1}\alpha_2\ ln\ F + \alpha_3\ T + \varepsilon_2$$

in which ε_1, ε_2 are stationary error terms. Note that ϕ^{-1} is not identified in (*iv*). However by imposing the symmetry or constant returns restrictions we would identify ϕ^{-1} a linear specification of *(iv)*.

We estimated (*iv*) as a linear-in-parameters Seemingly Unrelated Regression model using data from 1958-97. In particular, the variables in (*iv*) are constructed in the same way as they were in a previous study (Reed and Clark, 1997). Given various combinations of restrictions that could be imposed, we chose the point estimates of ϕ^{-1} that delivered the most reasonable estimates of the proportion of farm supply allocated to at-home food production (i.e., ϕ). Finally if total domestic farm receipts is denoted as *TFR*, then farm receipts derived from at-home food sales, *FR*, is simply $FR = \phi\ TFR$. Point estimates of (1-ϕ) are: 0.514 (beef), 0.213(pork), 0.225 (poultry), 0.506 (eggs), 0.294 (dairy), 0.698 (fresh fruit), 0.155 (fresh vegetables).