Staff Papers Series

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ESTIMATION OF A DEMAND SYSTEM FOR U.S. FOOD

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September 1991

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ABSTRACT

This paper estimates a complete demand system for food for the United States using an extension of the Almost Ideal Demand System (AIDS) with household and aggregate data. The major purpose is to explore the implications of aggregation over consumers. Empirical evidence, based on data from the 1980-87 Continuing Consumer Expenditure Surveys, shows that the regression results and demand elasticities of the household and aggregate models and data can be very similar. Further results reveal factors which affect the similarity of the household and aggregate estimates.

I. INTRODUCTION

Most of the existing literature on the estimation of complete demand systems is based on time-series data. These studies provide price and income effects for all consumers or households as a whole, but yield few implications concerning the effect of relevant demographic characteristics on demand. The degrees of freedom also are typically small. Moreover, most time-series studies treat the data as if they relate to a single consumer. As Deaton and Muellbauer (1980b) observe, "if the data are available for only aggregates of households, there are no obvious grounds why the theory, formulated for individual households, should be directly applicable" (p. 148).

There are few studies in the literature on complete demand systems which have utilized micro (household) data, which is generated by cross-sectional or panel surveys. Micro data make possible the estimation of disaggregate income

and price elasticities for specific population groups, allow the opportunity to analyze the importance of socioeconomic and demographic factors on consumption decisions, and provide a large number of observations so there is not a problem of degrees of freedom. However, because price information is frequently not collected in these surveys or in a single-period survey there might not be price variation, price parameters would be estimable only under strong assumptions regarding preferences.

Pollak and Wales (1978,1980,1981), Ray (1982), Muellbauer (1980), and Rossi (1984) utilized data which cross-classified household expenditures by income and household characteristics from the original household data, generating a time-series of cross-sectional data. However they did not have access to the actual household data in their work. They, therefore, combined the budget survey data with price observations and used cell means as household observations to estimate household demand systems. Even though these studies incorporated demographic variables in the demand system, they did not take into account the aggregation problem over consumers with the data based on cell means.

Fortunately, the United States Bureau of Labor Statistics (BLS) has been conducting the Continuing Consumer Expenditure Survey (CCES) which includes consumer expenditures, income, and demographic data on 5,000 households per year since 1980. These data help solve the data limitations discussed above and provide the opportunity to compare household and aggregate

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models. The estimation of demand systems with data both at the household level and aggregate level will permit us to compare the estimated demand parameters and study the empirical implications of aggregation over consumers.

This analysis uses data from eight years of the Diary portion of the BLS CCES (1980-1987) to estimate a demand system for six food commodities: cereal and bakery goods, meats including poultry and fish, dairy products, fruits and vegetables, other at-home foods, and food away from home. Price data are not collected in the CCES, nor are quantities provided. To introduce prices, the Consumer Price Index (CPI) for each of the above categories was matched with the household observations by month and region (Northeast, North-central, South and West). In addition to the household data, the observations were aggregated by month and region and the resulting 384 cell means were analyzed for comparison.

After studying various demand models, the Almost Ideal Demand System (AIDS) was considered the most suitable one for this study. The iterative Zellner's seemingly unrelated regression technique was applied to estimate the parameters of the demand system. In addition, translating procedures were used to incorporate demographic variables into the complete demand system.

The plan of this paper is as follows. Section 2 presents a review of the theory of aggregation. Section 3 introduces an application of this theory to the Almost Ideal Demand System and the incorporation of demographic variables. A

brief description of the data and estimation procedure is presented in section 4. Empirical results are presented and evaluated in section 5. We end with some conclusions in section 6.

II. AGGREGATION OVER CONSUMERS

"The role of aggregation theory is to provide the necessary conditions under which it is possible to treat aggregate consumer behavior as if it were the outcome of the decisions of a single maximizing consumer"; this is called "exact aggregation" (Deaton and Muellbauer, 1980b, p. 148). In the present section different approaches to aggregation over consumers will be discussed.

Denote q_{ih} the demand for good i of household h as

$$q_{ih} = f_{ih}(x_h, p) \tag{1}$$

where x_h is the total expenditure of the household, and p is a price vector. If there are H households, the average demand $\bar{q}$ will be

$$\bar{q}_i = q_i(x_1, \ldots, x_H, p) = \frac{1}{H} \sum_h f_{ih}(x_h, p). \tag{2}$$

Exact aggregation is possible if we can write (2) as

$$\bar{q}_i = f_i(\bar{x}, p) \tag{3}$$

where $\bar{x}$ is the average total expenditure (Deaton and Muellbauer, 1990b, p. 150).

Gorman: Parallel Linear Engel Curves

For (3) to hold, Gorman (1961) showed that the individual cost (expenditure) function must have the form:

$$c_h(u_h, p) = a_h(p) + b(p) u_h \qquad (4)$$

a specification known as the Gorman Polar form.

Note that if aggregation is possible for all possible income (total expenditure) distributions, then the parallel linear Engel curves must pass through the origin so that $a_h(p)$ in (4) is zero and preferences are identical and homothetic. This form of (4) is too restrictive to allow the use of average (mean) income (total expenditure) in the aggregate demand function.

Muellbauer: Representative Consumer

Muellbauer (1975, 1976a, 1976b) in order to relax the restriction of using the mean of total expenditure in the aggregate demand, developed a necessary and sufficient condition called Generalized Linearity. Under this condition, the aggregate demand (or aggregate budget share) depends on prices and a representative level of total expenditure which itself can be a function of the distribution of expenditures and of prices.

Exact aggregation requires a "representative" level of total expenditure, say x_o, to exist such that the aggregate budget share can be written as

$$\overline{w}_i = \frac{\sum_h x_h w_{ih}}{\sum_h x_h} = w_i \left(x_o \left(x_1, \ldots \ldots, x_H, p \right), p \right). \qquad (5)$$

where w_{ih} is the budget share for good i of household h. For (5) to hold, Muellbauer showed that the cost function of each household must have the Generalized Linear (GL) form:

$$C_h(u_h, p) = G_h(u_h, H(p))B(p) + g_h(p) \tag{6}$$

where $\Sigma_h g_h(p) = 0$, H is homogeneous of degree one, and B homogeneous of degree zero.

A subset of this class is price independent generalized linearity (PIGL) when the representative expenditure level is independent of prices and depends only on the distribution of expenditures (Deaton and Muellbauer, 1980b, pp 155-56). The cost function of PIGL is

$$c_h(u_h, p) = k_h [a(p)^\alpha (1 - u_h) + b(p)^\alpha u_h]^{\frac{1}{\alpha}} \tag{7}$$

where k_h and α are scalars. The parameter α is crucial in determining the nonlinearity of the Engel curves and hence in determining the relationship between representative and average expenditures. In Muellbauer's model of the representative consumer, individual preferences are identical but not necessarily homothetic.

Lau: Fundamental Theorem of Exact Aggregation

Lau (1982) considered a more general form of aggregation than that required by expression (3). He considered individual demand functions of the form $f_h(x_h, p, a_h)$ for total expenditure x_h, prices p, and attributes (demographic factors) a_h. Lau developed a theory of exact aggregation that makes it possible to incorporate differences in individual preferences. The Fundamental Theorem of Exact Aggregation states that under the assumptions of zero aggregate demand for zero aggregate expenditure and non-negative individual demand functions, an aggregate demand function can be written as:

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$$\sum_h f_h(p, x_h, a_h) = F(p, g_1(x_1, \ldots, x_H, a_1, \ldots, a_H), \ldots,$$

$$g_K(x_1, \ldots x_H, a_1, \ldots, a_H)) \qquad (8)$$

if and only if

1)

$$F(p, g_1(x_1, \ldots, x_H, a_1, \ldots, a_H), \ldots, g_k(x_1, \ldots, x_H, a_1, \ldots, a_H)] =$$

$$\sum_k h_k(p) \sum_h g_k^*(x_h, a_h) \qquad (9)$$

and,
2)

$$f_h(p, x_h, a_h) = \sum_k h_k(p) g_k^*(x_h, a_h) \quad for\ all\ h \qquad (10)$$

where the index functions $g_k^*(x_h, a_h) = g(x_h, a_h) - g(0, a_h)$, $g(0, a_h)$ = 0, and $g_k^*(.)$ and $h_k(p)$ are linearly independent functions (Jorgenson, Lau, and Stoker, 1982).

The Gorman parallel linear Engel curves and the representative consumer conditions are special cases of the Fundamental Theorem of Exact Aggregation. The former condition is possible with only one index function while the latter with two index functions under the assumption of identical preferences over consumers. This theorem encompasses more than two indexes and can be applied to consumers with different preferences.

In this theory the assumption that the impact of individual expenditures on aggregate demand can be represented by a single function of individual expenditures, such as

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aggregate or per capita expenditure, is replaced by the assumption that there may be a number of such functions. These functions may depend not only on individual expenditures but also on attributes of individuals, such as demographic characteristics, that give rise to differences in preferences. Thus, it is possible to overcome the limitations of the model of a representative consumer (Jorgenson, Lau, and Stoker, 1982).

III. AGGREGATION OVER CONSUMERS AND DEMOGRAPHIC VARIABLES IN AIDS

For the ith commodity the Almost Ideal Demand System of Deaton and Muellbauer (1980a) takes the following form:

$$w_i = \alpha_i + \beta_i \log(\frac{X}{P}) + \sum_j \gamma_{ij} \log p_j \tag{11}$$

$$\log P = \alpha_o + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_j \sum_k \gamma_{jk} \log p_j \log p_k \tag{12}$$

where $w_i = p_i q_i / X$ is the budget share of the ith commodity whose price and quantity demanded are given respectively by p_i and q_i, $X = \sum_i p_i q_i$ (total consumer expenditure or income), and log P is a price index.

Adding up, homogeneity, and Slutsky restrictions can be imposed on the system as follows:

1) $\sum_i \alpha_i = 1; \sum_i \gamma_{ij} = \sum_i \beta_i = 0$ (13)

2) $\sum_j \gamma_{ij} = 0$ (14)

3) $\gamma_{ij} = \gamma_{ji}$.   (15)

For linearity purposes, Stone's price index is used to approximate log P by $\log P^* = \sum_i w_i \log p_i$. In which case,

equation (11) is known as the Linear Approximate/Almost Ideal Demand System (LA/AIDS).

Demographic Scaling and the Representative Consumer

Ray's study (1982) is an application of the representative consumer theory and, at the same time, is the first research that introduces demographic variables in AIDS, using the demographic scaling approach. Ray defines the scale function as $k_h = N^\theta$ where N represents the number of household members and the size effect (θ).

The household AIDS is

$$w_{ih} = \alpha_i + \beta_i \log(\frac{X_h}{P}) + \sum_j \gamma_{ij} \log p_j + \delta_i \log N_h, \qquad (16)$$

where $\delta_i = \theta(\sum_j \gamma_{ij} - \beta_i)$ and log P is the original price index. If $w_i = \sum_h e_h w_{ih}/\sum_h e_h$ denotes the budget share of the representative household, where e_h is real total expenditure, then

the aggregate AIDS is

$$w_i = \eta_i + \beta_i \log(e) + \sum_j \gamma_{ij} \log p_j + \delta_i \log N \qquad (17)$$

where $\eta_i = \alpha_i + \beta_i \log(H/Z) + \delta_i \log(H/Z')$, $e = \sum_h e_h/H$, $N = \sum_h N_h/H$; H is the number of household members; log Z and log Z' are the measure of expenditure and demographic distributions of the aggregated households, respectively.

This approach has some limitations: it restricts the size effect to be identical across commodities; it ignores other relevant household characteristics (i.e., household composition); in the aggregate model the expenditure and demographic distributions of the aggregated households must be assumed

constant over time to justify their absorption within the intercept (not demographic flexibility); and although Ray estimated both equations (16) and (17) for the household model, cell means were utilized as household observations.

Demographic Translation and Lau's Theorem of Aggregation

Rossi (1984,1988) applied Lau's theorem to the AIDS, incorporating demographic variables through the translation technique ($d_i = \Sigma_n \delta_{in} a_n$, where a_n are household characteristics). The household AIDS is

$$w_{ih} = \alpha_i + \beta_i \log\left(\frac{X_h}{P_h}\right) + \sum_j \gamma_{ij} \log p_j + \sum_n \delta_{ni} a_{hn} \qquad (18)$$

The price index log P_h is approximated by Stone's price index, $\log P_h^* = \Sigma_i w_{ih} \log p_i$.

Adding up, homogeneity, and Slutsky restrictions are imposed as follows:

1) $\Sigma_i \alpha_i = 1; \Sigma_i \gamma_{ij} = \Sigma_i \beta_i = \Sigma_i \delta_{in} = 0$ $\qquad$ (19)

2) $\Sigma_j \gamma_{ij} = 0$ $\qquad$ (20)

3) $\gamma_{ij} = \gamma_{ji}$. $\qquad$ (21)

The aggregate budget share is

$$w_i = \frac{\sum_h X_h w_{ih}}{\sum_h X_h} = \alpha_i + \beta_i \frac{\sum_h X_h \log X_h}{\sum_h X_h} - \beta_i \log \tilde{P} + \sum_j \gamma_{ij} \log p_j$$

$$+ \sum_n \delta_{ni} \frac{\sum_h X_h a_{hn}}{\sum_h X_h} \qquad (22)$$

where

$$\log \tilde{P} = \sum_i \sum_h \left(\frac{X_h w_{ih}}{\sum_h X_h}\right) \log p_i = \sum_i w_i \log p_i.$$

In (22), aggregate budget shares depend on the price vector p, on the distribution of expenditures over all consuming units through the function $\dfrac{\sum_h X_h \log X_h}{\sum_h X_h}$, and on the joint distribution of expenditures and household characteristics through the expression $\dfrac{\sum_h X_h a_{hn}}{\sum X_h}$. The latter expression is the channel through which changes in the distribution of expenditures among households with different characteristics produce their impact on aggregate consumer behavior. In addition, the aggregate model also defines a demand system if adding-up, homogeneity, and symmetry constraints are satisfied and specified as above (expressions 19,20,21).

Equation (22) turns out to be quite similar to the translog aggregate demand system of Jorgenson, Lau, and Stoker (1982). In fact, it can be shown that the aggregate model (equation 22) satisfies the finite basis property, which allows exact aggregation without requiring the notion of a representative consumer, as does Jorgenson, Lau, and Stoker's model (Rossi, 1988). In this study, a major difference from Rossi who used cell means as household observations, is that the household model (equation 18) will be estimated with household data and the aggregate model (equation 22) with aggregate household data.

The estimation of equations (18) and (22) is based on the assumption of a two-stage budgeting procedure. In this way, X_h in equations (18) and (22) is total food expenditure and

can be studied separately from the first-stage allocation of income to food and nonfood expenditure (Phlips, 1974, pp. 66-74). The Diary CCES does not collect information on total consumer expenditures. The Interview portion of the CCES does, but it is a separate survey. Initial work using income as the independent variable yielded poor results. Income is notorious for serious measurement error problems.

IV. ESTIMATION PROCEDURE AND DATA

The iterative Zellner's (1962) seemingly unrelated regression (ITSUR) technique was applied to estimate the consumption parameters for the household and aggregate models (equations 18 and 22). The iterative Zellner's estimator is consistent and asymptotically efficient in the context of a multivariate normal distribution. In addition, it has the property that estimates of parameters are invariant to the choice of equation for deletion (Chalfant 1987). The models (aggregate and household) will be determined with the adding-up, homogeneity, and symmetry restrictions imposed.

Because the budget shares sum to one, a demand system composed of individual expenditure share equations would be singular. Therefore, one of the equations must be deleted to estimate the equations as a system. The miscellaneous (other) food category was chosen for deletion in this study. However, the parameters for the omitted share equation can be calculated by using the adding-up restriction from (19).

The aggregation over households creates a problem of heteroscedasticity. The number of households combined by

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month and region to generate an aggregate (cell mean) observation varies In order to correct this problem, as suggested by Rossi (1984, 1988), both sides of the aggregate model are multiplied by the term:

$$[\ (\textstyle\sum_h x_t^h)^2 / \textstyle\sum_h (x_t^h)^2]^{\frac{1}{2}},$$

where t represents not only time period as in Rossi (1984, 1988), but also region.

The Diary part of the BLS CCES survey collects data for two one-week periods from consumer units (households) and provides information on expenditures (specifically for food), income, and demographic data. Households which were located in rural areas, failed to participate for both weeks of the diary survey, were temporarily absent during the interview, or had reported no annual income (or incomplete income reporting) were deleted from the sample. In addition, only households that reported expenditures on all six commodity groups were selected for the analysis. As a result, the sample size to be utilized in this study included 23,490 households.

It is important to note that the number of purchasers or non-zero level expenditures is substantial. For cereal and bakery 91.7% were purchasers; meats (89.0%); dairy (91.0%); fruits and vegetables (89.5%); other products (92.6%); and food away from home (87.0%). The number of non-purchasers (zero dependent variables) is small for the six food categories and there is every reason to believe that non-purchasers are randomly, rather than systematically

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determined. Therefore, no bias is introduced by ignoring the limited dependent variable issue.

The demographic variable included is an adult equivalent scale for each consumer unit, which is a continuous variable and combines age, sex, and household size. The adult equivalent scales were extracted from Tedford, Capps, and Havlicek (1986).

The prices employed in this study are regional, monthly, seasonally unadjusted series of the CPI-U for all urban consumers. Household observations could be matched with the appropriate CPI data by month and region. The regional CPI are all set equal to 100 in the base period, and hence do not reflect price level differences across regions. In order to capture not only the effect of price level variation across regions but also geographic effects, regional dummy variables are introduced in the model.

V. EMPIRICAL RESULTS

Household System

Table 1 presents the parameter estimates of the restricted household model calculated with 23,490 observations. In general, 52 out of the 72 parameters (74%) are statistically significant at the 5% level. The system weighted R^2 is .15, which is respectable for household data. The parameter α is the intercept, the γ's are price coefficients (own and cross), β_i is the coefficient for total food expenditure, δ_{i1} is the coefficient for adult equivalent household size, and δ_{i2} through δ_{i4} are the regional dummy

variable effects for the Northeast, Northcentral, and South respectively, with the West omitted.

Table 2 provides the uncompensated price, food expenditure, and adult equivalent elasticities for the restricted demand system. The elasticities are evaluated at the means of the budget share and adult equivalent variable. Most of the uncompensated own-price elasticities show the anticipated negative sign. Only the meats category has a positive sign, but a low price responsiveness. One possible explanation could be that the price of meats has one of the lowest variations during the sample period.

The estimated food expenditure elasticities indicate that five out of six categories are relative necessities[1]. The only category which has a food expenditure elasticity greater than one is food away from home, as was expected. The meats category is more expenditure elastic than cereal and bakery and dairy products. Meats include seafood. This outcome is in line with expectations.

The adult equivalent elasticities indicate a positive effect on household consumption of necessities and a negative influence on luxuries. Food away from home is the only category with a negative elasticity for adult equivalents. This result indicates that the larger the household size in

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[1] The terms "relative" necessity and "relative" luxury will be used in this study to indicate that some food categories have food expenditure elasticities less than unity or greater than one, respectively. However, we understand that necessity and luxury classifications typically refer to income or total expenditure elasticities.

adult equivalents, the more likely the household would consume food at home.

Table 3 shows the tests of the restrictions. In all three tests, the exact F-test and the asymptotic tests: Wald and Likelihood Ratio (LR), both homogeneity and symmetry are rejected which is not an unusual result in empirical demand studies[2]. Phlips (1974) says there is no reason to be surprised when empirical demand results do not comply with the general restrictions. He argues that regardless of such test results the general restrictions should be imposed since they "result from the fact that a demand system is obtained by utility maximization" (Phlips, 1974, pp. 32, 53, and 55).

Aggregate Model by Regions and Time

The aggregate model was estimated using cell means cross-classified by the four regions and by the month of observation. The 1980-1987 surveys covered 96 months, so there are 384 observations (4 regions times 96). The estimated parameters of the aggregate model, in Table 4, reveal that 74% of the coefficients are statistically significant. The restrictions were again imposed. The system weighted R^2 is .98. A high R^2 is to be expected with aggregate data.

If the coefficients of the household model in table 1 are treated as the true parameters (as constants), an F-test can be used to test the overall equality of the household and

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[2] Many previous studies that used AIDS reported rejection of the constraints: Deaton and Muellbauer (1980), Ray (1982), Blanciforti and Green (1983), Swamy and Binswagner (1983), Rossi (1984), and Eales and Unnevehr (1988).

aggregate demand equations in tables 1 and 4. The F-statistic of 1.20 is below the critical value of 1.40 at the 5 percent level of significance. Therefore, the hypothesis of equality can not be rejected[3].

Table 5 presents the uncompensated price, expenditure, and adult equivalent elasticities for the aggregate restricted demand system. When compared to the results in table 2, five of the own-price elasticities are extremely close and are exactly the same to the nearest hundredth in two cases. The largest difference exists for meats (.13 vs .29), and even those estimates are not very far apart. The expenditure elasticities are all very close; the greatest dissimilarity is again for meats (.96 vs 1.11), which is certainly not large. Most of the cross-price elasticities also compare very favorably as do the adult equivalent elasticities where the largest difference is for fruits and vegetables (.001 vs .12).

The own-price and food expenditure elasticities in tables 2 and 5, with the exception of the price elasticity for meats, are within the general range of the values estimated in previous U.S. food demand studies (Blanciforti and Green, 1983; Huang, 1985; Huang and Raunikar, 1987; Kokoski, 1986; Lee, 1990; and Young, 1987).

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[3] A test which accounts for the variance of the household model as well as the covariance between the household and aggregate models might be possible based on a bootstrap or jackknife procedure. However, it imposes a very large computational burden (Efron and Gong, 1983 and Efron, 1988).

Further Empirical Results

For reasons of length, only a brief discussion of other relevant empirical findings is presented in this subsection[4]. The household and aggregate models were also estimated without imposing homogeneity and symmetry constraints. The elasticities of the unrestricted demand systems were less in accordance with consumer theory and the empirical results of previous studies, particularly for the aggregate model. For example, two own-price elasticities were positive in the aggregate model.

The household model (equation 18) was also estimated with the aggregate data (the 384 cell means). This approach ignores the aggregation issue, which is what most previous demand studies based on time-series data or aggregate (cell means) household data have done. The results obtained were similar to those from the household model (equation 18) with the household data and the aggregate model (equation 22) with the aggregate data, as reported in tables 1,2,4, and 5.

An F-test was used to test the overall equality of the household model demand equations estimated with the household and aggregate data. With an F-statistic of .31 and a critical value of 1.40 at the 5 percent significance level, the hypothesis of equality can not be rejected. The estimated elasticities were also very similar to those shown in table 2. Although the own-price elasticity of dairy products was

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[4] These results will be provided by the authors when requested.

positive, its magnitude only went from -.07 to +.04, in both cases very close to zero.

These results support Pollak and Wales' (1980 and 1981) argument that aggregate data (cell means) can be treated "as if they were consumption patterns of households" and that ignoring the aggregation issue is "relatively harmless" (1981, p. 1541), at least when the demand system is linear in expenditure. The Linear Approximate AIDS fulfills this criteria. The aggregation issue might not be so harmlessly ignored if the demand system is not linear in expenditure (Pollak and Wales, 1980, p. 600).

An aggregate model with the data classified only by time period (month), which had 96 cell means as observations, was also estimated. The national monthly CPI price series were used in this case. In this case, the test of overall equality with the household results (table 1) was rejected based on an F-statistic of 1.72 and a critical value of 1.51 for a 5% level of significance. The results with this model were very poor, particularly in terms of price elasticities. Four of the uncompensated own-price elasticities were positive. The primary reason is undoubtedly the loss in price variability without the regional variation in prices. If aggregation eliminates too much of the variation in the variables, an aggregate model can not be expected to yield results similar to the household model, or in line with expectations based on the theory and previous results.

VI. CONCLUSIONS

This study has focused on comparing the performance of aggregate and household demand models and data, in order to learn if aggregate consumer behavior is similar to household consumer behavior and to answer empirically whether the regression results and demand elasticities with aggregate data are equivalent to those with household data. To this end a household demand system based on an extension of the AIDS model and an aggregate demand system that is not only theoretically plausible, but also allows distribution of expenditures among households with different characteristics and preferences, were presented and estimated. The models were estimated for six food commodities pooling eight years of BLS Continuing Consumer Expenditure Survey data and matching the observations with the CPI price series by month and region.

The aggregate model yields results equivalent to the household model based on an F-test of the regression results and a comparison of the demand elasticities. On the same basis, the estimates generated by the aggregate data with the household model also appear equivalent. Two additional insights were gained from further empirical analysis. The imposition of the theoretical restrictions (homogeneity and symmetry) seem to be particularly important for the performance of the aggregate model. Moreover, a model estimated with the data aggregated into just 96 monthly observations performs very poorly. If much of the variability

of certain variables is eliminated by aggregation, aggregate models should not be expected to perform well.

Given the enormous number of demand studies that have been conducted with aggregate time-series data, the results of this study are, generally, quite reassuring. Aggregate demand data may yield empirical results equivalent to those obtained with disaggregated (household) data. This can hold true not only for the estimates generated by a theoretically consistent aggregate demand model, but also for those from a basic household model estimated with aggregate data. At least for demand systems that are linear in expenditure, ignoring the aggregation issue may have minimal consequences and, therefore, be acceptable.

TABLE 1.   DEMAND SYSTEM: HOUSEHOLD MODEL

Parameter Estimates (10^{-2})

Goods	1	2	3	4	5	6
α_i	14.84	17.5	16.81	17.81	22.24	10.79
	(71.7)	(38.1)	(78.5)	(66.2)		(14.0)
γ_{i1}	6.65					
	(2.35)					
γ_{i2}	0.79	22.0				
	(0.74)	(12.3)				
γ_{i3}	-4.94	1.03	8.26			
	(-3.56)	(0.96)	(5.5)			
γ_{i4}	-1.08	-0.15	1.98	7.80		
	(-1.14)	(-0.15)	(2.41)	(6.35)		
γ_{i5}	3.04	-0.62	-5.99	-3.08	2.82	
	(1.32)	(-0.35)	(-2.9)	(-2.27)		
γ_{i6}	-4.47	-23.1	-0.35	-5.47	3.83	29.54
	(-2.02)	(-11.4)	(-0.22)	(-3.22)		(7.18)
β_i	-2.41	-0.88	-2.87	-1.77	-1.79	9.73
	(-38.1)	(-6.25)	(-43.8)	(-21.5)		(41.2)
δ_{i1}	1.08	1.66	1.16	0.00	0.89	-4.79
	(33.6)	(23.3)	(34.9)	(0.08)		(-40.1)
δ_{i2}	0.85	2.94	0.16	-0.18	-1.70	-2.07
	(8.25)	(13.5)	(1.56)	(-1.4)		(-5.7)

TABLE 1 Continued

Goods	1	2	3	4	5	6
δ_{i3}	0.23	1.18	-0.51	-1.15	0.33	-0.09
	(2.52)	(5.7)	(-5.3)	(-9.5)		(-0.26)
δ_{i4}	-0.14	2.55	-1.08	-0.82	-0.46	-0.05
	(-1.47)	(12.3)	(-10.9)	(-6.72)		(-0.15)
DW	1.97	1.94	1.98	1.97		1.92

Ratio of parameter estimates to standard errors in parentheses. DW: Durbin Watson test. i=1: Cereal & Bakery; i=2: Meats; i=3: Dairy; i=4: Fruits & Vegetables; i=5: Others; i=6: FAFH. System Weighted R^2 = 0.15.

TABLE 2.DEMAND SYSTEM: HOUSEHOLD MODEL
Uncompensated Price-Elasticities

Goods	1	2	3	4	5	6
W_i	9.28	19.67	9.14	11.13	17.85	32.93
E_{1i}	**-0.26**	0.04	-0.51	-0.08	0.18	-0.16
E_{2i}	0.14	**0.13**	0.17	0.02	-0.01	-0.76
E_{3i}	-0.51	0.06	**-0.07**	0.19	-0.32	-0.03
E_{4i}	-0.09	-0.003	0.25	**-0.28**	-0.16	-0.19
E_{5i}	0.36	-0.02	-0.60	-0.25	**-0.82**	0.06
E_{6i}	-0.39	-1.16	0.07	-0.44	0.25	**-0.20**
E_i	0.74	0.96	0.69	0.84	0.90	1.30
E_{Ai}	0.27	0.20	0.29	0.001	0.12	-0.34

i-1: Cereal & Bakery; i-2: Meats; i-3: Dairy; i-4: Fruits & Vegetables; i-5: Others; i-6: FAFH. W_i: budget share evaluated at means and is expressed in 10^{-2}, E_{ij}: uncompensated price elasticities, E_i: expenditure elasticity, E_{Ai}: adult equivalent elasticity.

TABLE 3.TEST RESULTS

	F-Test	Wald	LR
Homogeneity(5)	4.60	23.01	18.07
Symmetry(10)	5.35	53.47	53.42

The figures in parentheses indicate the degree of freedom. The critical values for a 5% significance level are: $F(5,117405) = 2.21$, $F(10,117405) = 1.83$, $\chi^2(5,0.05) = 11.07$, $\chi^2(10,0.05) = 18.31$.

TABLE 4.DEMAND SYSTEM:AGGREGATE MODEL BY REGIONS AND TIME
Parameter Estimates (10^{-2})

Goods	1	2	3	4	5	6
α_i	15.57 (11.5)	5.74 (1.40)	16.18 (11.5)	17.42 (9.32)	29.05	16.04 (2.46)
γ_{i1}	6.29 (2.03)					
γ_{i2}	0.27 (0.22)	26.47 (10.67)				
γ_{i3}	−4.04 (−2.7)	2.05 (1.70)	7.27 (4.73)			
γ_{i4}	−0.52 (−0.50)	0.69 (0.55)	0.88 (0.99)	7.41 (5.00)		
γ_{i5}	1.63 (0.65)	−2.97 (−1.41)	−6.00 (−2.8)	−3.53 (−2.25)	3.68	
γ_{i6}	−3.62 (−1.51)	−26.5 (−9.3)	−0.14 (−0.08)	−4.93 (−2.48)	7.20	28.00 (5.34)
β_i	−2.69 (−7.22)	2.29 (1.99)	−2.46 (−6.4)	−1.98 (−3.86)	−3.98	8.83 (4.93)
δ_{i1}	1.22 (6.24)	1.53 (2.59)	0.78 (3.89)	0.47 (1.74)	1.40	−5.42 (−5.79)
δ_{i2}	0.76 (6.65)	2.99 (8.8)	0.19 (1.64)	−0.29 (−1.97)	−1.68	−1.98 (−3.73)

TABLE 4 Continued

Goods	1	2	3	4	5	6
δ_{i3}	0.15	1.69	-0.43	-1.21	0.22	-0.41
	(1.30)	(4.78)	(-3.7)	(-7.7)		(-0.74)
δ_{i4}	-0.27	2.66	-0.94	-0.91	-0.62	0.08
	(-2.3)	(7.80)	(-8.08)	(-5.92)		(0.15)
DW	1.72	1.76	1.90	1.76		1.71

Ratio of parameter estimates to standard errors in parentheses. DW: Durbin Watson test. i=1: Cereal & Bakery; i=2: Meats; i=3: Dairy; i=4: Fruits & Vegetables; i=5: Others; i=6: FAFH. System Weighted R^2 = 0.98.

TABLE 5.DEMAND SYSTEM:AGGREGATE MODEL BY REGIONS AND TIME
Uncompensated Price-Elasticities

Goods	1	2	3	4	5	6
W_i	8.83	20.08	8.59	10.59	17.23	34.68
E_{1i}	**-0.26**	0.003	-0.45	-0.03	0.11	-0.13
E_{2i}	0.09	**0.29**	0.30	0.10	-0.13	-0.82
E_{3i}	-0.43	0.09	**-0.13**	0.10	-0.33	-0.03
E_{4i}	-0.03	0.02	0.13	**-0.28**	-0.18	-0.17
E_{5i}	0.24	-0.17	-0.65	-0.30	**-0.75**	0.16
E_{6i}	-0.30	-1.36	0.08	-0.40	0.49	**-0.28**
E_i	0.70	1.11	0.71	0.81	0.77	1.25
E_{Ai}	0.37	0.21	0.24	0.12	0.22	-0.41

i-1: Cereal & Bakery; i-2: Meats; i-3: Dairy; i-4: Fruits & Vegetables; i-5: Others; i-6: FAFH. W_i: budget share evaluated at means and is expressed in 10^{-2}, E_{ij}: uncompensated price elasticities, E_i: expenditure elasticity, E_{Ai}: adult equivalent elasticity.

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