Analaysis of Food Away from Home and Food at Home Consumption: A Systems Approach*

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Abstract

The demand for food away from home, food at home, and non-food items is investigated using a complete systems approach. Using the linear approximation of the dynamic version of the Almost Ideal Demand System, the results indicate that the share of total expenditure going to food away from home increases as the labor force participation rate of women increases. All expenditure elasticities are positive and all own-price elasticities are negative. Moreover, the demand for food away from home is more price sensitive than the demand for food at home. Seasonal patterns of consumption are also evident.

Background

The changing socio-economic and demographic structure of the U.S. population as well as changes in consumer lifestyles may contribute to the increased popularity of FAFH. Some socio-economic and demographic factors that come to mind are: a growing number of women, married and single, in the work force; the increasing importance of convenience in eating out; more families living on two incomes; the impact of advertising and promotion by large food service chains; and more people in the age group of 25 to 44 who are inclined to eat out often (Putnam and Van Dress, 1984). Only about seven percent of all households now fit the old stereotypical family of a working husband, a wife who does not work for wages, and two children (Kinsey, 1990). Moreover, married couples with children are declining as a share of all households. The one-adult households are growing the most quickly, and are likely to exhibit non-conventional food consumption patterns (i.e. FAFH consumption).

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Table 1. Percent of Disposable Personal Income (Total Food Expenditure) Spent for Food at Home; Food Away from Home: Selected Years, 1970-1989

Year	Food at Home	Food Away from Home
1970	10.8[a] (66.2)[b]	5.5[a] (33.8)[b]
1975	10.5 (63.8)	6.0 (36.2)
1980	9.7 (60.6)	6.3 (39.4)
1985	8.3 (59.9)	6.0 (42.1)
1989	7.6 (55.0)	6.2 (45.0)

[a]Percent of disposable income.
[b]Percent of total food expenditures.

SOURCE: U.S. Department of Agriculture and *Food Retailing Review*, 1991 edition.

The percentage of disposable income going to food away from home (FAFH) has increased from 5.5 percent in 1970 to 6.2 percent in 1989 (Table 1). In contrast, the percentage of disposable income going to food at home (FAH) has declined in monotonic fashion from 10.8 percent in 1970 to 7.6 percent in 1989. Moreover, the share of food spending for FAFH rose from 33.8 percent in 1970 to 45.0 percent in 1989. The share of food spending allocated for FAH, however, dropped from 66.2 percent in 1970 to 55 percent in 1989.

Literature Review

A number of studies on FAFH consumption have been made in recent years (e.g. Prochaska and Schrimper, 1973; Kinsey, 1983; Redman, 1980; McCracken and Brandt, 1987). Many of these studies have focused their analyses on the socio-demographic and economic factors affecting away from home food consumption and expenditures. Common socio-demographic factors considered are income, household size, urbanization, region, race, employment, and education. Some of the results from these studies have differed regarding the relative importance of these factors on FAFH consumption or expenditures, primarily due to the use of different consumption models, databases, and estimation techniques. These studies, however, used cross-sectional data from national samples. Prochaska and Schrimper (p. 603) acknowledged that a broader framework than the models used in cross-sectional analyses is required to understand all the factors affecting FAFH consumption over time and that "little is known about the cross-price elasticities of eating at home and away from home."

A few studies, however, have surfaced in recent years focusing on the demand for both FAFH and FAH. Based on a 1960-61 Survey of Consumer Expenditures, Houthakker and Taylor (1970) revealed that FAFH expenditures were more responsive to total consumption expenditures than FAH expenditures. They also tried to incorporate a dynamic element into their analysis by using income change information from the preceding year as well as time series data. Lamm (1982), however, estimated a translog demand system for purchased meals, food consumed at home, and non-food items using quarterly time series data from 1960 to 1980. His results indicated that the demand for purchased meals is more elastic in price and total expenditure than the demand for food consumed at home. He also found that the rise in away from home food consumption is mainly due to increasing consumer incomes rather than to changing relative prices.

In 1986, Lee and Brown investigated food consumption at home and away from home using the 1977-78 National Food Consumption Survey (NFCS). Based on a switching regression tech-

nique, their results suggested a positive relationship between income and eating away from home. Craven and Haidacher (1987), using annual observations from 1955 to 1978, employed three versions of the linear expenditure system (Leser, Powell, Stone) and estimated expenditure and uncompensated price elasticities for FAH, FAFH, and nine other "non-food" commodities. They found that, from the three systems, the estimates of the FAH expenditure elasticity are smaller than the estimates of the FAFH expenditure elasticity. FAFH appeared as a luxury item in two of the three systems. Also, the uncompensated own-price elasticity estimate for FAFH was generally larger than that for FAH. The demand for FAFH is most responsive to changes in the price of FAH. However, the demand for FAH is least responsive to changes in the price of FAFH.

The studies mentioned above are concerned with either annual or quarterly consumption patterns. Moreover, these studies used relatively older data sets and, therefore, the results may not reflect current market conditions. This paper further investigates the consumption of FAFH and FAH with the use of shorter (monthly) time interval data from 1970 to 1989. Furthermore, this paper employs a demand systems approach in the analyses conducted. A three commodity demand system is developed using the dynamic version of the linear approximation of the Almost Ideal Demand System (AIDS) model. The three commodities are: FAFH, FAH, and non-food.

Theory and Methods

The concept of complete demand systems has evolved considerably in the last three decades. Advantages of using complete demand systems over using a single commodity or sector model approach include explicit recognition of the interrelationships among commodities and formally incorporating theoretical restrictions. Moreover, the systems approach may alleviate, to a large degree, the problem of multicollinearity among prices, income, and other exogenous factors. The systems approach takes into consideration the budget constraint and thus recognizes the fact that increases in the consumption of some goods must be balanced by decreases in the consumption of others. One such demand system which has attracted unprecedented popularity is the AIDS model, first introduced by Deaton and Muellbauer (1980). This model allows for consistent aggregation of microlevel demands up to a market demand function. The AIDS model can be derived from the expenditure function:

$$(1) \quad \log c(u,p) = (1-u) \log a(p) + u \log b(p)$$

where c(u,p) is the expenditure function, p is the vector of prices, and u is the utility. The expressions a(p) and b(p) are selected to ensure that the demand functions have appropriate properties. In particular, the specifications are as follows:

$$(2) \quad \log a(p) = \alpha_0 + \Sigma_k \alpha_k \log p_k + (1/2) \Sigma_k \Sigma_j \gamma_{kj} \log p_k p_j$$

and

$$(3) \quad \log b(p) = \log a(p) + \beta_0 \pi_k p_k \beta_k$$

The Marshallian demand functions for an operational version of the AIDS can be expressed as:

$$(4) \quad w_i = \alpha_i + \Sigma_j \gamma_{ij} \log p_j + \beta_i \log (y/P)$$

where w_i is the expenditure share of the ith commodity, p's are the prices, y is total expenditure on all commodities in the system, and P is a price index defined as:

$$(5) \quad \log(P) = \alpha_0 + \Sigma_k \alpha_k \log p_k + (1/2) \Sigma_j \Sigma_k \gamma_{kj} \log p_k \log p_j.$$

Due to the nonlinearity of parameters in the price index expression, the AIDS model is approximated by using Stone's index in lieu of the price index log(P). Stone's index is defined as:

$$(6) \quad \log (P_t^*) = \Sigma_j w_{jt} \log p_{jt}.$$

With the use of the Stone's index, w_{it-1} is used in this analysis instead of w_{it} to avoid simultaneity problems. This specification allows the linear approximation of the AIDS model (LA/AIDS). The classical restrictions, on the other hand, are expressed as follows:

(7) For adding-up:
$\Sigma_i \alpha_i = 1$; $\Sigma_i \gamma_{ij} = 0$; $\Sigma_i \beta_i = 0$;

(8) For homogeneity: $\Sigma_j \gamma_{ij} = 0$; and

(9) For symmetry: $\gamma_{ij} = \gamma_{ji}$.

These restrictions not only reduce the dimensionality of the parameter space but also ensure that own-price, cross-price, and expenditure elasticities are consistent with neoclassical theory.

When the budget shares in Stone's approximation are lagged, the formula for the uncompensated or Marshallian elasticities is given as:

(10) $e_{ij} = -\delta_{ij} + ((\gamma_{ij} - \beta_i w_j)/w_i)$,

where δ_{ij} refers to the Kronecker delta (1 if i equals j and 0 otherwise). The compensated or Hicksian elasticities can be calculated from the uncompensated elasticities by using Slutsky's equation:

(11) $e_{ij}^* = e_{ij} + w_j n_i$,

where n_i is the expenditure elasticity and is calculated as:

(12) $n_i = 1 + (\beta_i/w_i)$.

Standard errors of the elasticities are calculated in this study by using the method used by Chalfant (1987). This method assumes that the budget shares are exogenous and hence, the standard errors are only approximations.

In most empirical studies, the impact of factors other than prices and income on demand relationships is captured via the use of trend variables. However, according the Kmenta (p. 568), "the term 'trend' is always a camouflage for factors that change over time, and it would certainly be preferable if these factors could be identified and measured." Thus, adjustments are made to allow variables other than prices and income to be incorporated into the LA/AIDS model. These variables are: eleven monthly dummies (S_{kt}) to capture the effects of seasonality with the month of December (arbitrary) as the base and labor force participation rate of women ($RATE_{it}$). Due to the importance of dynamics in food demand, a lagged budget share (w_{it-1}) is also incorporated into the LA/AIDS model. Consequently,

(13) $w_{it} = \alpha_i + \Sigma_j \gamma_{ij} \log p_{jt} + \beta_i \log (y/P) + \Sigma_k \delta_{ik} S_{kt} + \pi_i RATE_{it} + \lambda_i w_{it-1}$.

A hypothesis in this study is that as the labor force participation rate of women increases, the demand for FAFH also increases because of increasing opportunity cost of time of women. The demand for FAH as the labor force participation rate of women increases could either increase or decrease depending on the relative strength of the substitutability between home-cooked food and convenience or prepared foods. As more and more women participate in the labor force, the demand for FAH might decrease if FAFH is substituted for FAH. However, the demand for FAH could also increase if convenience or prepared foods rather than FAFH are substituted for home-cooked meals. Thus, if convenience or prepared foods are only weak substitutes for home-cooked meals, then the overall demand for FAH might decrease. However, if convenience or prepared foods are strong substitutes for home-cooked meals, then the demand for FAH may increase. Unfortunately, it is impossible *a priori* to determine the impact of convenience or prepared foods on the overall FAH demand as women's labor force participation rate increases.

When estimating demand systems, one equation must be omitted. This procedure avoids inherent singularity in the variance-covariance matrix of the residuals across equations. The commodity that is arbitrarily omitted in the model is non-food. The model is estimated using iterative Zellner's seemingly unrelated regression technique (ITSUR) with homogeneity and symmetry restrictions imposed and with a first order serial correlation correction.

Data and Variables

The monthly time series data from 1970 to 1989 consist of FAFH, FAH, and non-food expenditures, consumer price indices, and consumption expenditures. The FAFH expenditure data are derived from monthly retail sales of

eating and drinking places in the United States. Eating and drinking places include restaurants, lunchrooms, cafeterias, and fast-food operations or refreshment places. In 1989, commercial eating and drinking places accounted for two-thirds of the retail equivalent value of expenditures for FAFH (Food Retailing Review, 1991). The other third of the expenditures value for FAFH, not included in our data, came from schools, hotels and motels, military facilities and other facilities. The FAH expenditure data, on the other hand, are derived from monthly retail sales of food stores. Food stores include grocery stores, meat and fish markets, and bakeries. The data source for this analysis is the Bureau of Census. Non-food expenditures are derived by deducting both FAFH and FAH expenditures from total consumption expenditures. Over the sample period, average per capita consumption expenditure (nominal) is $7700.

The consumer price indices for FAFH, FAH, and CPI-less food are used as price variables in the analysis. Also, total personal consumption expenditures data are used instead of disposable personal income, limiting the influence of savings in the analysis. Monthly consumer price indices (CPI) data for FAFH, FAH, and non-food are obtained from Agricultural Outlook Reports and National Food Situation Reports of the Economic Research Service, U.S. Department of Agriculture. All CPI figures used in this study are based on 1967=100 and are used as prices in the dynamic LA/AIDS model.

Monthly personal consumption expenditures data are obtained from the Business Statistics and Survey of Current Business reports by the Bureau of Economic Analysis. Population figures, on the other hand, are acquired from various issues of the Current Population reports and Employment and Earnings issues of the Bureau of Labor Statistics. Another variable used in the analysis is the labor force participation rate of women. These data are also obtained from various issues of Employment and Earnings publications. Labor force participation rate of women is roughly 50 percent on the average over the sample period.

Empirical Results

The dynamic LA/AIDS model is run using the econometric package SHAZAM. Due to the presence of lagged dependent variables in the model, disturbance terms that are autocorrelated will give rise to inconsistent parameter estimates. Additionally, to detect the presence of serial correlation, the Durbin-Watson test is no longer appropriate. In this study, the Runs test is used in testing for serial correlation (Draper and Smith 1981, 157-59). The Runs test, a nonparametric procedure, relies on the examination of strings of positive and negative residuals. Serial correlation exists if the arrangement of signs in the residuals is "extreme." This test statistic is distributed asymptotically as a standard normal random variable. The Durbin-H statistic could have been used as well, but this test breaks down when the product of the sample size times the estimated variance associated with the coefficient of the lagged dependent variable exceeds one. To account for possible serial correlation problems an additional parameter, ρ, reflecting first order serial correlation, is estimated.

The demand system was re-estimated employing alternative specifications (i.e. Rotterdam, Linear and Quadratic Expenditure Systems, State Adjustment Model) to further examine the influence of functional form. Results from these models were, surprisingly, inconsistent with those from the LA/AIDS model and prior expectations. Hence, the LA/AIDS specification is used in this study due to the consistency of the results with prior expectations and economic theory. Furthermore, the consistent aggregation of microlevel to market demand property of the AIDS model removes a possible source of aggregation bias especially in a demand system of broad commodities.

The estimated coefficients and associated standard errors of the dynamic LA/AIDS model are presented in Table 2. The R-squares for the FAFH and FAH equations are roughly 94 and 95 percent, respectively. No serial correlation problems are evident on the bases of the Runs test and the statistically insignificant ρ value of the model. The coefficient associated with the RATE (labor force participation rate of women) variable in the

Table 2. Parameter Estimates of the Dynamic LA/AIDS Model

Variable	Dependent Variable	
	FAFH	FAH
CONSTANT	0.00363*	0.4365*
	(0.00128)	*(0.00661)*
FAFH	0.00106	0.00048
	(0.00083)	*(0.00056)*
FAH	0.00048	0.00572*
	(0.00029)	*(0.00091)*
NON-FOOD	-0.00154	-0.00621
	(0.0021)	*(0.0072)*
EXPENDITURE	-0.00078*	-0.00827*
	(0.00034)	*(0.00135)*
RATE	0.00003*	-0.00006*
	(0.000008)	*(0.00001)*
LAG BUDGET SHARE	0.45901*	-0.11663
	(0.15225)	*(0.16898)*
JAN	-0.0004*	-0.00097*
	(0.00003)	*(0.00016)*
FEB	-0.00041	-0.00172*
	(0.00004)	*(0.00008)*
MAR	0.00012*	-0.00092*
	(0.00006)	*(0.00015)*
APR	-0.00001	-0.00102*
	(0.00003)	*(0.00007)*
MAY	0.00021*	-0.00053*
	(0.00003)	*(0.00008)*
JUN	0.00013	-0.00072*
	(0.00006)	*(0.00011)*
JUL	0.00016*	-0.00041*
	(0.00007)	*(0.00008)*
AUG	0.00021*	-0.00055*
	(0.00008)	*(0.00011)*
SEP	-0.00019*	-0.00093*
	(0.00009)	*(0.00009)*
OCT	0.00001	-0.00078*
	(0.00004)	*(0.00008)*
NOV	-0.00026*	-0.00091*
	(0.00004)	*(0.00008)*
COMMON RHO	0.2775	
	(0.17043)	
R-SQUARE	0.9372	0.9494
RUNS TEST*	0.5011	1.2812
DURBIN-WATSON	2.0591	2.1552
LOG-L.R. TEST FOR MONTHLY DUMMIES	691.67*	

Note: Standard errors are in parentheses. Asterisk denotes statistical significance at the 0.05 level.

*Runs test is used instead of the Durbin-H test.

FAFH equation is statistically significant and positive. Similarly, the associated coefficient of the RATE variable in the FAH equation is statistically significant but is negative. The positive sign of the RATE variable in the FAFH equation, consistent with our hypothesis previously discussed, means that as more enter the labor force, the share of expenditure going to FAFH increases, *ceteris paribus*. On the other hand, the negative sign of the RATE coefficient in the FAH equation means that as the labor force participation rate of women increases, demand for FAH in terms of expenditure share decreases, all other things constant. Since the RATE variable is probably highly correlated with the opportunity cost of time of women, this result implies that women will rely more on FAFH than FAH as their discretionary time becomes more limited.

The seasonality pattern differs between the FAFH and FAH commodities. The budget share for FAFH is higher in the months of March, May, June, July, August, and October but lower in January, February, April, and September relative to the month of December (base month). On the other hand, the budget share for FAH is lower in all the eleven months (January to November) than in December. Seasonality is a significant factor in the FAFH and FAH relationships as indicated by the log likelihood-ratio tests. On the other hand, the negative sign associated with the coefficient of the lagged budget share in the FAH equation, albeit insignificant statistically, might indicate some inventory effects vis-a-vis habit effects in the FAFH equation.

The expenditure elasticities as well as the uncompensated and compensated price elasticity estimates in the dynamic LA/AIDS model are presented in Table 3. Consistent with prior expectations as well as with Lamm's and Craven and Haidacher's studies (see Table 4), the expenditure elasticity estimates are positive. Furthermore, the expenditure elasticity estimate for FAFH is higher than that for FAH. It is important to note that FAFH appeared as a luxury item in the Leser and Powell systems in the Craven and Haidacher study. However, the expenditure elasticity estimate of FAFH in this study yields the interpretation that FAFH is no longer considered a luxury good. Certainly, as mentioned earlier, dramatic changes have occurred in the away from home market since 1978. It is important to note that since the total expenditures on the three broad commodities used in the analysis almost exhausted total income, the expenditure elasticity estimates in this study closely approximate the income elasticity estimates.

The uncompensated and compensated own-price elasticities are negative and generally in the inelastic range. Consistent with Lamm's and with Craven and Haidacher's results (see Table 4), the uncompensated own-price elasticity estimate for FAFH is larger than for FAH. The uncompensated own-price elasticity estimate for FAFH in this study, however, is much larger than Craven and Haidacher's estimate.

The compensated own-price elasticity estimate for FAFH is -0.741 compared to -0.426 for FAH. Hence, the demand for FAFH is more elastic than the demand for FAH. The compensated own-price elasticity for non-food, on the other hand, is very inelastic at -0.006. In accordance with prior expectations, all the compensated cross-price elasticities are positive, significantly different from zero, and inelastic. This result indicates a substitutability relationship among the three broad commodities. However, the compensated cross-price elasticities for the non-food commodity are very inelastic, which indicates that the cross-price effects of FAFH and FAH on the demand for non-food are very marginal. Nevertheless, the cross-price effect of non-food with respect to the demand of either FAFH or FAH is larger than the cross-price effect of either FAFH or FAH on the demand for non-food.

Concluding Remarks

As expected, results indicate that the share of total expenditure going to FAFH increases as the labor force participation rate of women increases. However, the expenditure share for FAH decreases as the labor force participation rate of women increases. These results imply that women tend to rely more on FAFH than FAH as they become more involved in the labor force and their opportunity costs of time become higher. Differences in seasonal patterns are also evident in the FAFH and FAH equations.

Table 3. Expenditure, Uncompensated, and Compensated Elasticities of the Dynamic LA/AIDS Model

	Commodity Group		
	FAFH	FAH	Non-food
Expenditure Elasticity	0.812	0.185	1.009
	(0.080)	(0.137)	(0.002)
Uncompensated Elasticities with respect to			
Price of FAFH	-0.745	0.051	-0.002
	(0.179)	(0.025)	(0.0007)
Price of FAH	0.118	-0.428	-0.006
	(0.060)	(0.092)	(0.002)
Price of Non-food	-0.185	0.192	-1.001
	(0.170)	(0.056)	(0.003)
Compensated Elasticities with respect to			
Price of FAFH	-0.741	0.052	0.003
	(0.178)	(0.024)	(0.0006)
Price of FAH	0.127	-0.426	0.004
	(0.059)	(0.091)	(0.001)
Price of Non-food	0.614	0.374	-0.007
	(0.157)	(0.098)	(0.0015)

Note: Standard errors are in parentheses

Table 4. Expenditure and Uncompensated Own-Price Elasticity Estimates from Other Studies

Expenditure and Uncompensated Own-Price Elasticities	Craven and Haidacher's Study[a]		Lamm's Study[b]	
	FAFH	FAH	FAFH	FAH
Expenditure Elasticity	1.100	0.400	0.995	0.507
Own-Price Elasticity	-0.493	-0.455	-0.701	-0.630

[a]Estimates from Leser's Linear Expenditure System.
[b]Estimates (long-run) from an Indirect Translog System.

In accordance with economic theory, all the expenditure elasticities are positive and all the own-price elasticities are negative. The demand for FAFH is more price sensitive than the demand for FAH based on the compensated own-price elasticities of -0.741 and -0.426 for FAFH and FAH, respectively. Based on the compensated cross-price elasticities, there seems to be general substitutability relationships among the three broad commodities of FAFH, FAH, and non-food. The price of non-food, however, has a larger effect on the demand of either FAFH or FAH compared to the price effects of FAFH and FAH on the demand for non-food.

This study documents the use of monthly time series data in determining the demand for FAFH, FAH, and non-food. Although the results in this study are comparable to those of Craven and Haidacher and those of Lamm, certain differences in the magnitude of the elasticity estimates are apparent (i.e. greater price and expenditure elasticities in the FAFH market) due perhaps to the significant changes that have occurred in the FAFH sector in the past years. Thus, because development of effective marketing policies and programs is one of the primary concerns of the food distribution and retail industry, analyses in this study could be used as an aid in making important pricing and policy decisions. For instance, a rise in consumer incomes or expenditures would signal a continuation in the consumption trend for FAFH relative to FAH. The retail food chain industry has actually recognized this fact in recent years by offering on-premise food services in grocery stores. However, if the U.S. economy's recovery from the recession as well as the rise in consumer incomes continues to be sluggish, the FAFH industry might realize a slowdown in its sales. Furthermore, the model may be used to develop forecasts of budget shares for FAFH and FAH, respectively, which in turn may be used to develop forecasts in expenditures. In this way, this analysis offers direct benefits to the food distribution sector.

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