

## **CHAPTER 4**

### **METHOD**

The purpose of this chapter is to develop a specified model for clothing and shoes demand analysis. Thus, the chapter presents a model specification for the empirical analysis of U.S. demands for clothing categories and shoes. The first section discusses the choice of demand system and the model specification incorporating the demographic variables. The second section describes the data and the variables. The third section discusses the estimation method employed in the study.

#### **Model Specification**

##### **Choice of Model**

Many clothing consumption models are identified in the literature: stock adjustment model, ECM model, tobit model, and simple logarithmic models. For time-series analysis, Norum (1990) and Mokhtari (1992) proposed dynamic clothing consumption models (stock adjustment model and ECM model) incorporating demographic variables. Studies which have applied these models have been good attempts at clothing demand estimations; however, extensions of those studies were suggested. Fan, Lee, and Hanna's (1996) use of the AIDS model was a good attempt to employ a complete demand system approach, but their assumption that households in certain region/city size combinations faced the same price may not be realistic. They ignored cross price effects between apparel and other goods, despite including twelve other expenditure categories in the model.

The literature contains several specifications of systems of demand equations: the Linear Expenditure System, the Rotterdam model, the Indirect Translog model, and the Almost Ideal Demand System model. These functional forms of demand systems have been extensively applied to demand estimations for decades. After studying the various models mentioned above, the AIDS model was chosen as the most suitable for this

research. This system has many advantages. The AIDS model provides an arbitrary first approximation to any demand system. It is also easy to estimate and can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters. The demand system expresses the dependent variable as a budget share, which has advantages. Budget shares are dimensionless, so they are useful to compare across consumer units and time. Since the sum of the budget shares is one, consumer budget allocations among goods are easily compared, and shares for different types of consumer units also can be compared in the same time period.

### **Proposed Model**

Along with consistency with the theoretical restrictions, a major consideration in this research was the incorporation of selected demographic variables in the AIDS model for the investigation of the effects of demographic changes on clothing and shoes demand. The proposed AIDS model is

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \log p_{jt} + \beta_i (\log x_t - \log P_t) \quad 4.1$$

$$\log P_t = \alpha_0 + \sum_k \alpha_k \log p_{kt} + 1/2 \sum_j \sum_k \gamma_{kj} \log p_{kt} \log p_{jt} \quad 4.2$$

where  $w_{it}$  is the budget share of good  $i$  in period  $t$ ,  $p_{jt}$  is the price of good  $j$  in period  $t$ , and  $x_t$  is the total expenditures in period  $t$ . Moschini (1995) suggested that the Stone price index is not appropriate for the “linearized” AIDS (LAIDS) model because of problems in units of measurement. In the present study, the price index  $\log P_t$  is transformed into the log-linear Laspeyres price index which transforms the AIDS model to the LAIDS. Hence, the price index is

$$\log p_t = \sum_i w_i^0 \log p_{it} \quad 4.3$$

where  $p_{it}$  is the price of good  $i$  in time  $t$  divided by the mean price of good  $i$ , and  $w_i^0$  is the base budget share, that is, the budget share of good  $i$  in time  $t-1$ . To incorporate the demographic variables into the LAIDS, the variables are scaled by loglinear transformation,  $\log \lambda_i = \sum_k d_{ik} \log D_k$ , because demographic translation with translating parameters in a subsistence term is not reasonable for the model. With the addition of a dummy variable for World War II, the LAIDS becomes

$$w_{it} = \lambda_i(p_{it}q_{it}/x_t) = \alpha_i + \sum_j \gamma_{ij}(\log p_{jt} + \sum_k d_{jk} \log D_k) + \beta_i \{ \log x_t - \sum_j w_j^0 (\log p_{jt} + \sum_k d_{jk} \log D_k) \} + \kappa_i ww2 \quad 4.4$$

where  $\alpha_i$ ,  $\beta_i$ ,  $\gamma_{ij}$ ,  $d_{jk}$ , and  $\kappa_i$  are parameters,  $D_k$  is the value of a demographic variable  $k$ , and  $ww2$  is the dummy variable for World War II. A dummy variable was included in the model to investigate the possibility of a structural shift in expenditure budget shares for clothing and shoes caused by World War II, taken to encompass 1942 to 1945 (1941 < war time < 1946). The value of the dummy was set at 1 for the World War II period and 0 otherwise. The following restrictions hold globally for the above model:

$$\text{Adding up: } \sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0, \sum_i \kappa_i = 0, \quad 4.5$$

$$\text{Homogeneity: } \sum_j \gamma_{ij} = 0, \text{ and} \quad 4.6$$

$$\text{Symmetry: } \gamma_{ij} = \gamma_{ji}. \quad 4.7$$

Elasticity expressions for the above LAIDS are given by:

$$\text{Income: } \eta_i = 1 + \beta_i/w_i \quad 4.8$$

$$\text{Price: } \epsilon_{ij} = -\delta_{ij} + (\gamma_{ij} - \beta_i w_j^0)/w_i \quad \text{where } \delta_{ij} = 1 \text{ for } i=j, \delta_{ij} = 0 \text{ otherwise.} \quad 4.9$$

Demographic variable  $k$  ( $D_k$ ):

$$\epsilon_{dk_i} = \partial q_i / \partial D_k \cdot D_k / q_i = \frac{x(\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj})}{P_i q_i} = \frac{\sum_j \gamma_{ij} d_{kj} - \beta_i \sum_j w_j^0 d_{kj}}{w_i}. \quad 4.10$$

Appendix A shows the derivation of the elasticity equations. Buse (1994), however, suggested that equation 4.9 is not appropriate for price elasticity calculations with LAIDS. Thus, Buse proposed an alternative price elasticity calculation; see Buse (1994) for more details. In the present study the alternative calculation was employed:

$$\text{Price elasticity: } \epsilon_{ij} = -\delta_{ij} + \{ \gamma_{ij} - \beta_i (w_j^0 + \sum_k \gamma_{kj} \log p_j) \} / w_i. \quad 4.11$$

## Data and Variables

All the data used for estimations in this study are listed in the tables in Appendix B. The dependent variables are the annual aggregate budget shares of total nondurable goods

expenditures for men's and boys' clothing, women's and children's clothing, shoes, and other nondurable goods in the United States. Annual time-series data, 1929-1994, on per capita personal consumption expenditures (PCX) for clothing categories, shoes and other nondurables (i.e., PCX / U.S. total population) in The National Income and Product Accounts of the United States (NIPA) were used in calculating the budget shares. Current dollar and constant dollar (1987) PCX data on men's and boys' clothing, women's and children's clothing, shoes, and other nondurable goods were obtained from the NIPA. The annual PCX estimates are available on a continuous basis from 1929 to 1994 and provide detailed information on the composition of consumers' expenditures. PCX includes goods and services purchased by persons resident in the United States. Expenditures for women's and children's clothing and expenditures for men's and boys' clothing include expenditures on accessories. Data on the aggregated expenditures for women's and children's clothing and for men's and boys' clothing were used because more disaggregated expenditure data on these clothing categories are not available in the NIPA.

Prices were implicit prices created for each expenditure category in the NIPA by dividing the current dollar expenditure series by its constant (1987) dollar counterpart;  $(\text{current dollar expenditures} / \text{constant dollar expenditures}) * 100$ . These implicit prices, divided by their mean values, were put into the right-hand side of equation 4.3 for the estimation of price effects. Per capita total consumption expenditure for nondurable goods is the sum of current dollar expenditures on each category. Budget shares for each category represent the portion of total consumption expenditure for nondurable goods allocated to that item.

For the demographic variables of the median age of the U.S. population and the proportion of non-Whites in the U.S. population, annual data from 1929 to 1994 were extracted from various sources. The data sources include Historical Statistics of the United States: Colonial Times to 1970 issued by the U.S. Bureau of the Census; Statistical Abstract of the United States (National Data Book) annually published by the U.S. Bureau of the Census; and Current Population Reports Series P-25, various issues published by

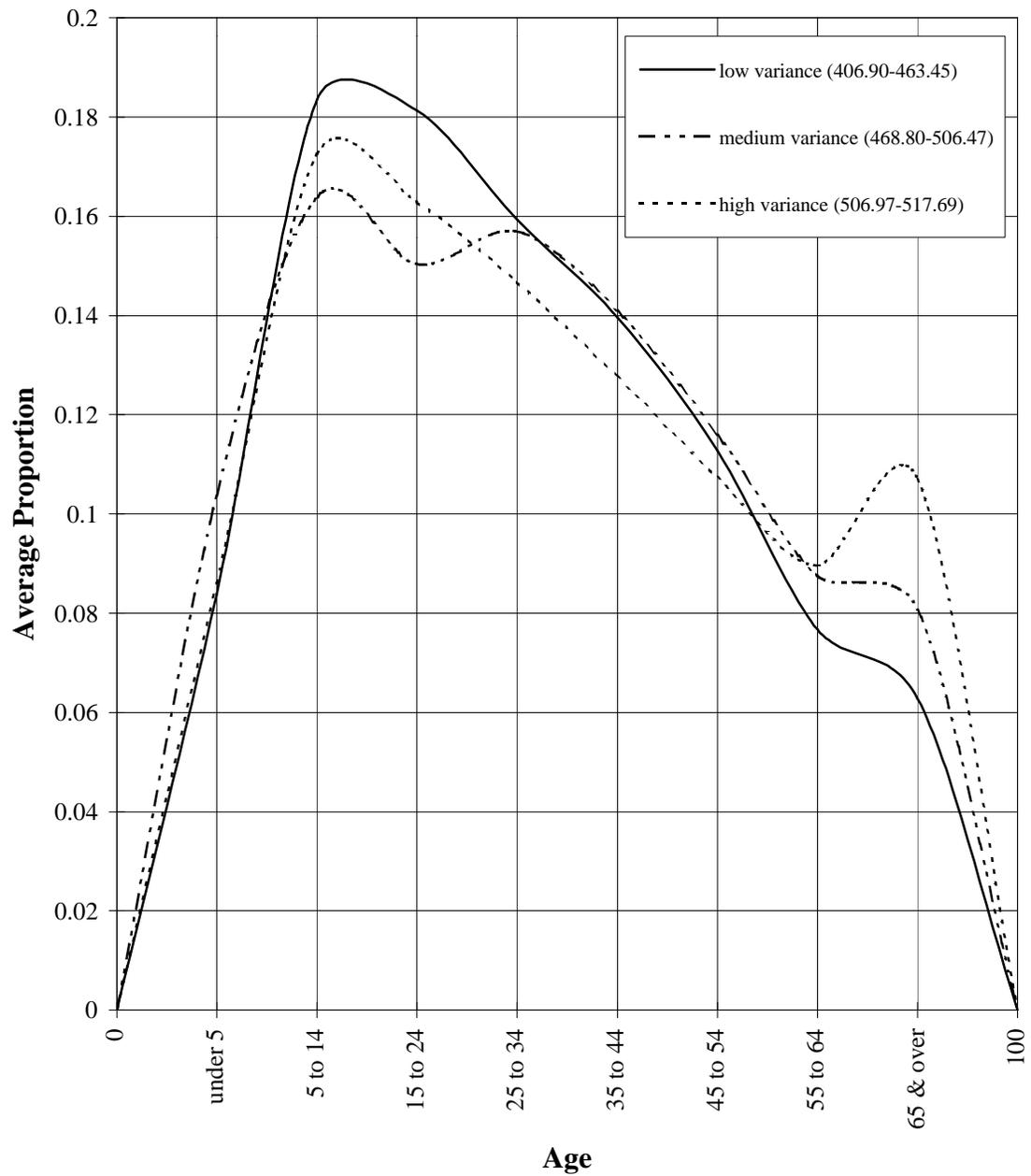
the U.S. Bureau of the Census. The median ages of the U.S. population as of July 1 of each year from 1929 to 1970 were calculated by the author using the data for the U.S. population from Historical Statistics of the United States: Colonial Times to 1970. The formula for the median of grouped data, proposed by Ott (1993), was used to calculate those median ages (see Appendix A). The median ages in the other years were obtained from various issues of Statistical Abstract of the United States and Current Population Reports Series P-25. From 1929 to 1939 and from 1980 to 1994, the median ages are of the resident population, but, due to data availability, in the other years the median ages also take into account Armed Forces overseas. The non-White population for the present study includes Asian and Pacific Islanders; Blacks; and American Indians, Eskimos, and Aleuts. The U.S. Bureau of the Census (1992) classifies race/ethnicity into four major groups: White; Black; American Indian, Eskimo, and Aleut; and Asian and Pacific Islander. The Bureau of the Census defines a Hispanic as a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race. Persons of Hispanic origin can be of any group: White, Black, American Indian, or Asian. All four of the race groups are crossed by Hispanic origin (U.S. Bureau of the Census, 1992). A White person is defined as one having origins in any of the original peoples of Europe, North Africa, or the Middle East, in accordance with the classification used by the Bureau of the Census.

Besides median age and the proportion of non-White population, the second central moment (variance) and the third central moment (skewness) of the age distribution of the U.S. population were included as demographic variables. The variance was calculated by the formula  $\sigma^2 = E[(t-\mu)^2] = \sum(t-\mu)^2 f(t)$ , where  $t$  is the value of a random variable  $T$ ,  $\mu$  is the mean of the values of the random variable, and  $f(t)$  is the probability distribution of  $t$ . Skewness refers to the third central moment,  $\mu_3 = E[(t-\mu)^3] = \sum(t-\mu)^3 f(t)$ ; the normalized skewness coefficient is  $\mu_3/\sigma^3$ , where  $\sigma$  is standard deviation. Since the calculated third moment values tend to explode as the moment grows (Greene, 1997), the normalized measure  $\mu_3/\sigma^3$  was used as the demographic variable for skewness of the age

distribution of the population. Statistics theory says that a sample distribution with a low variance (i.e., low dispersion) has relatively higher frequency around the mean or median than that does a sample distribution with a high variance. Skewness is a statistical measure of the degree of asymmetry of distribution where a positively skewed distribution has a tail going to the right (toward older age in the present research), and a negatively skewed distribution has a tail going to the left. The calculated skewness values of annually observed U.S. population distributions are all positive. The more positive the skewness of the population distribution, the less the relative number of elderly in the population. The median age variable is to indicate the influence of the overall aging of the population; the variance is to provide information about the effect of the changes in the relative number of elderly or of median age group people (age 25-34) on aggregate clothing categories and shoes consumption; and the skewness is to incorporate the effects of the older generation on the consumption of clothing categories and shoes. To calculate the variance and the skewness of population age distribution, first, the age data were broken down into approximately 10-year intervals as follows: under 5, 5 to 14, 15 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 and over (65+). The midpoints of the first seven age groups were used as the ages of those groups. For the 65+ group, the mean age from a triangular distribution with minimum at 65 and maximum at 100 was used (total probability adding to 1 and density equal to 0 at 100). And then the proportion of the total population in each age group was used as the probability weight to calculate the first (mean), the second, and the third moments of the population age for each year. The higher the variance of age distribution, the more the people in the elderly group. The higher (more positive) the skewness of age distribution, the less the people in the elderly group.

Figures 4.1 and 4.2 depict the degrees (high, medium, and low) of the variance and skewness, over the period 1929 to 1994, of each of the U.S. population age intervals described above. Figures 4.1 and 4.2 show the different average proportions of those age groups according to the degree of variance and the degree of skewness, respectively. The steps to plot the graphs in Figures 4.1 and 4.2 were as follows. Using the calculated values

for the years 1929-1994 (one value per year; see Table B.6 in Appendix B), the annual population distributions were categorized in three levels of variance and of



**Figure 4.1.** Average proportions of U.S. age groups in years, from 1929 through 1994, having low, medium, and high variance in the population age distribution. The average proportions were calculated as described in the text.

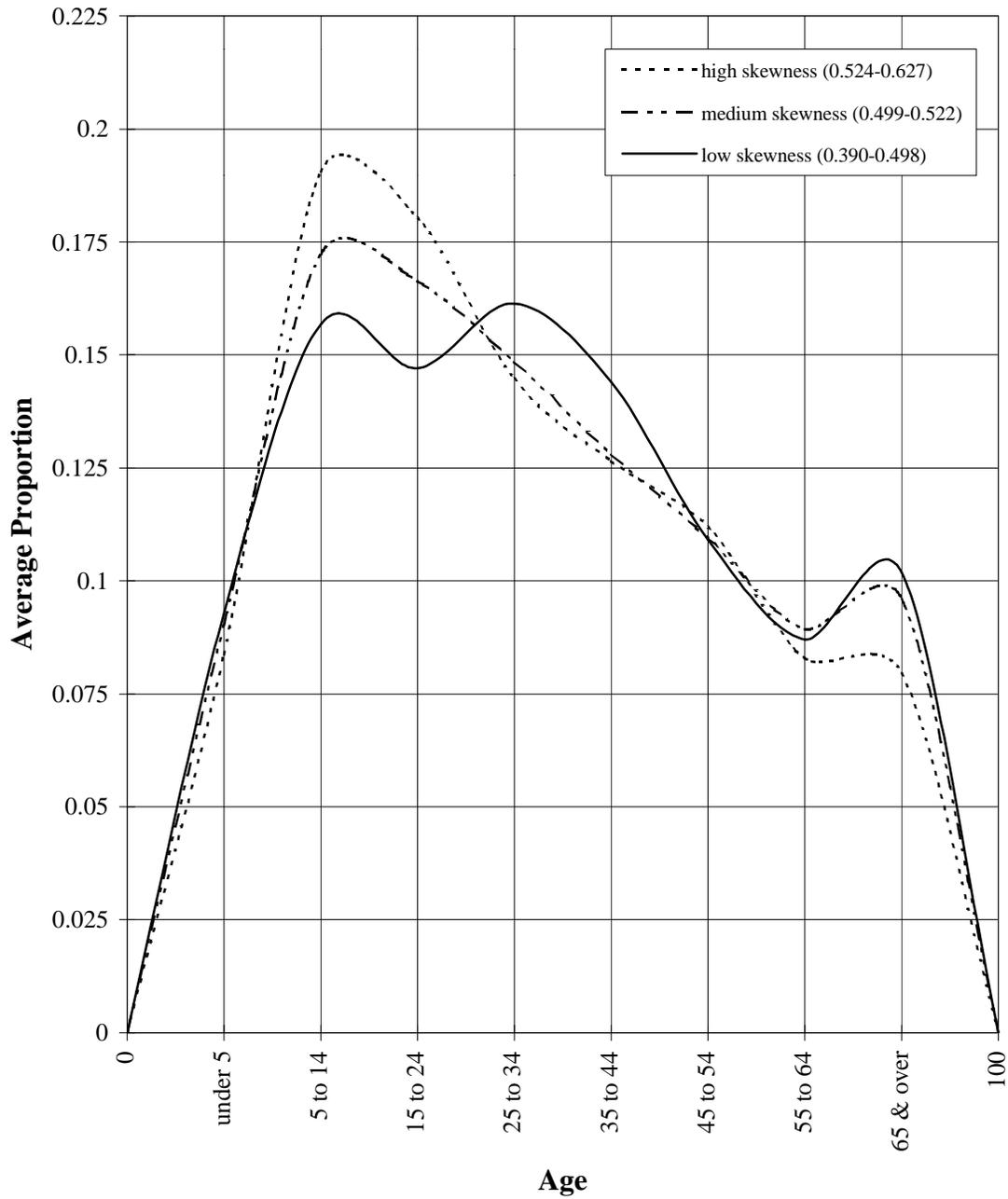


Figure 4.2. Average proportions of U.S. age groups in years, from 1929 through 1994, having low, medium, and high skewness in the population age distribution. The average proportions were calculated as described in the text.

skewness: low=406.90-463.45, medium=468.80-506.47, and high=506.97-517.69 for variance; low=0.390-0.498, medium=0.499-0.522, and high=0.524-0.627 for skewness. The years having values within each of the three ranges (high, medium, and low) were identified and grouped. Then, according to each of the ranges and within each age group (see Table B.5 in Appendix B), the author calculated across years the average proportion of that age group in the respective range. The vertical axes of Figures 4.1 or 4.2 refer to the average proportion values.

Women's labor force participation rate was included in the model as one of the demographic variables. The definition of the term "demographic variables" varies from one piece of research to another. It is sometimes used only to include personal characteristics such as age, race, and sex. In a wider sense, occasionally it is used to include such variables as social class, income level, and region location. In the present study, it is used in its wider sense. Women's labor force participation is referred to as a demographic variable. Labor force participation rate is defined as the ratio of the labor force, including the resident Armed Forces, to the total noninstitutional population (Bureau of Labor Statistics, 1989). Labor force participation rate of women is the ratio of the labor force of women to the noninstitutional population of women. Annual data, from 1948 to 1994, for the labor force participation rate of women were obtained from the Handbook of Labor Statistics published by the U.S. Department of Labor in 1989, and from various issues of Statistical Abstract of the United States published by the U.S. Bureau of the Census. The observation period of the data is not consistent with the period of the data for the other variables; therefore, the estimation with this variable was conducted with separate LAIDS models.

A dummy variable for the World War II period included in the model was set at 1 for the World War II period and 0 for other years to investigate the possibility of a structural shift in the mean level of the aggregate budget shares for clothing categories and shoes. Generally, it is regarded that the World War II period for the U.S. encompasses from the Japanese Pearl Harbor attack on December 7, 1941 to V-J day on August 14,

1945, but the effective beginning year of price control programs, rationing programs, and regulations of clothing production by the U.S. government was 1942 and the cessation of high-level wartime economic effort was 1945 (American War Production Board, 1942; Harris, 1976; Polenberg, 1970; Vatter, 1985). Thus, in the present study, the wartime period was set from 1942 to 1945 (i.e.,  $1941 < \text{wartime} < 1946$ ).

The descriptive statistics of the variables are presented in Table 4.1. In summary, the variables included in the models estimated in this research are:

- Per capita total consumption expenditure for nondurable goods ( $x$ )
- Budget share of women's and children's clothing in per capita total expenditures for nondurable goods ( $w_1$ )
- Budget share of men's and boys' clothing in per capita total expenditures for nondurable goods ( $w_2$ )
- Budget share of shoes in per capita total expenditures for nondurable goods ( $w_3$ )
- Budget share of other nondurable goods in per capita total expenditures for nondurable goods ( $w_4$ )
- Implicit price of women's and children's clothing ( $p_1$ )
- Implicit price of men's and boys' clothing ( $p_2$ )
- Implicit price of shoes ( $p_3$ )
- Implicit price of other nondurable goods ( $p_4$ )
- Median age of U.S. population ( $D_1$ )
- Proportion of non-White population to the U.S. population ( $D_2$ )
- Variance of the age distribution of the U.S. population ( $D_3$ )
- Skewness coefficient of the age distribution of the U.S. population ( $D_4$ )
- Labor force participation rate of women ( $D_5$ )
- Dummy for World War II ( $ww2$ ).

Other nondurable goods include: food; gasoline and oil, fuel oil and coal; tobacco; toilet articles and preparations; semidurable house furnishings; cleaning preparations; miscellaneous household supplies and paper products; drugs and sundries; nondurable toys

and sport supplies; stationery and writing supplies; magazines and newspapers; sheet

Table 4.1.

Descriptive Statistics of Variables (N = 66)

Variable	Mean	Standard Deviation	Minimum	Maximum
w <sub>1</sub>	0.100	0.008	0.085	0.124
w <sub>2</sub>	0.058	0.009	0.046	0.079
w <sub>3</sub>	0.030	0.005	0.024	0.045
w <sub>4</sub>	0.811	0.021	0.750	0.843
p <sub>1</sub>	1.000	0.490	0.289	2.025
p <sub>2</sub>	1.000	0.560	0.288	2.155
p <sub>3</sub>	1.000	0.669	0.240	2.371
p <sub>4</sub>	1.000	0.816	0.225	2.910
x	1622.212	1558.121	177.580	5347.990
D <sub>1</sub>	29.398	1.753	26.200	34.000
D <sub>2</sub>	0.121	0.020	0.101	0.169
D <sub>3</sub>	482.172	37.740	406.904	517.686
D <sub>4</sub>	0.497	0.053	0.379	0.627
<sup>a</sup> D <sub>5</sub>	0.4496	0.8502	0.327	0.588

<sup>a</sup>n = 47.

music; flowers and seeds; and potted plants.

### **Estimation Method and Procedure**

In this research, first, two separate models were considered according to observation periods (observation periods 1929-1994 and 1948-1994). This is because of data availability of the women's labor force participation variable. Then each model was separated again in two different models (Model A, Model B), assuming of collinearity of the variables of variance and skewness for the population age distribution because these two variables are functionally related in calculation. Thus, for the present research four different LAIDS models were set: Model 29A, Model 29B, Model 48A, and Model 48B. In the notations of the models, "29" and "48" indicate different data observation periods, and "A" and "B" indicate the including of the variance variable and skewness variable alternatively in the four models. The variable  $D_2$  (proportion of non-White population) was omitted in Model 48A and Model 48B because of the relatively small variation in this variable in the short period of time (1948-1994) and because of the need for maintaining adequate degrees of freedom. The variables included in the four different models are described in Table 4.2.

The adding-up, homogeneity, and symmetry restrictions, as defined earlier in equations 4.5, 4.6, and 4.7, were imposed in all four models. The demand system in the case of Model 29A is given by:

$$\begin{aligned}
 w_1 = & \alpha_1 + \gamma_{11}(\log p_1 - \log p_4 + (d_{11} - d_{14})D_1 + (d_{21} - d_{24})D_2 + (d_{31} - d_{34})D_3) \\
 & + \gamma_{12}(\log p_2 - \log p_4 + (d_{12} - d_{14})D_1 + (d_{22} - d_{24})D_2 + (d_{32} - d_{34})D_3) \\
 & + \gamma_{13}(\log p_3 - \log p_4 + (d_{13} - d_{14})D_1 + (d_{23} - d_{24})D_2 + (d_{33} - d_{34})D_3) \\
 & + \beta_1 \{ \log x - w_1^0 (\log p_1 + d_{11}D_1 + d_{21}D_2 + d_{31}D_3) - w_2^0 (\log p_2 + d_{12}D_1 + d_{22}D_2 + d_{32}D_3) \\
 & - w_3^0 (\log p_3 + d_{13}D_1 + d_{23}D_2 + d_{33}D_3) - w_4^0 (\log p_4 + d_{14}D_1 + d_{24}D_2 + d_{34}D_3) \} + \kappa_1 w w_2 + e_1 \\
 w_2 = & \alpha_2 + \gamma_{21}(\log p_1 - \log p_4 + (d_{11} - d_{14})D_1 + (d_{21} - d_{24})D_2 + (d_{31} - d_{34})D_3) \\
 & + \gamma_{22}(\log p_2 - \log p_4 + (d_{12} - d_{14})D_1 + (d_{22} - d_{24})D_2 + (d_{32} - d_{34})D_3)
 \end{aligned}$$

$$+\gamma_{23}(\log p_3 - \log p_4 + (d_{13} - d_{14})D_1 + (d_{23} - d_{24})D_2 + (d_{33} - d_{34})D_3)$$

$$+\beta_2\{\log x - w_1^0(\log p_1 + d_{11}D_1 + d_{21}D_2 + d_{31}D_3) - w_2^0(\log p_2 + d_{12}D_1 + d_{22}D_2 + d_{32}D_3)\}$$

Table 4.2.

Variables Included in the Four LAIDS Models

Variables	<u>1929-1994 Model</u>		<u>1948-1994 Model</u>	
	Model 29A	Model 29B	Model 48A	Model 48B
w <sub>1</sub>	*	*	*	*
w <sub>2</sub>	*	*	*	*
w <sub>3</sub>	*	*	*	*
w <sub>4</sub>	*	*	*	*
x	*	*	*	*
p <sub>1</sub>	*	*	*	*
p <sub>2</sub>	*	*	*	*
p <sub>3</sub>	*	*	*	*
p <sub>4</sub>	*	*	*	*
D <sub>1</sub>	*	*	*	*
D <sub>2</sub>	*	*		
D <sub>3</sub>	*		*	
D <sub>4</sub>		*		*
D <sub>5</sub>			*	*
ww2	*	*		

Note. Model 29A includes the demographic variables D<sub>1</sub>, D<sub>2</sub>, and D<sub>3</sub>. Model 29B includes the demographic variables D<sub>1</sub>, D<sub>2</sub>, and D<sub>4</sub>. Model 48A includes the demographic variables D<sub>1</sub>, D<sub>3</sub>, and D<sub>5</sub>. Model 48B includes the demographic variables D<sub>1</sub>, D<sub>4</sub>, and D<sub>5</sub>.

\*indicates variables included in the models.

$$\begin{aligned}
& -w_3^0(\log p_3+d_{13}D_1+d_{23}D_2+d_{33}D_3)-w_4^0(\log p_4+d_{14}D_1+d_{24}D_2+d_{34}D_3)\}+\kappa_2ww2+e_2 \\
w_3 = & \alpha_3+\gamma_{31}(\log p_1-\log p_4+(d_{11}-d_{14})D_1+(d_{21}-d_{24})D_2+(d_{31}-d_{34})D_3) \\
& +\gamma_{32}(\log p_2-\log p_4+(d_{12}-d_{14})D_1+(d_{22}-d_{24})D_2+(d_{32}-d_{34})D_3) \\
& +\gamma_{33}(\log p_3-\log p_4+(d_{13}-d_{14})D_1+(d_{23}-d_{24})D_2+(d_{33}-d_{34})D_3) \\
& +\beta_3\{\log x-w_1^0(\log p_1+d_{11}D_1+d_{21}D_2+d_{31}D_3)-w_2^0(\log p_2+d_{12}D_1+d_{22}D_2+d_{32}D_3) \\
& -w_3^0(\log p_3+d_{13}D_1+d_{23}D_2+d_{33}D_3)-w_4^0(\log p_4+d_{14}D_1+d_{24}D_2+d_{34}D_3)\}+\kappa_3ww2+e_3
\end{aligned}$$

where  $w_i$ ,  $D_i$ ,  $x$ ,  $p_i$ , and  $w_i^0$  are the variables defined previously;  $\alpha_i$ ,  $\gamma_{ij}$ ,  $d_{ij}$ ,  $\beta_i$ , and  $\kappa_i$  are parameters to be estimated; and  $e_i$  is the error term. Model 29B differs from Model 29A only in the variable  $D_4$  instead of  $D_3$ . Model 48A and Model 48B differ from each other in that same way; and they differ from Model 29A and 29B by excluding  $D_2$  and  $ww2$  and including  $D_5$ .

After separating the models, a model misspecification test, the small-sample-adjusted-likelihood-ratio test (Rao Test) suggested by Rao (1973), was conducted to select a correctly specified model (see McGuirk, Driscoll, Alwang, & Huang, 1995; Rao, 1973). The question addressed here was essentially whether the variance or the skewness should be used in the models. Thus, those two population distribution variables, the variance and the skewness, were tested by the Rao Test. The Rao Test statistic,  $F = [(1-\Lambda)^{1/t})/(\Lambda^{1/t})][rt-2z/pq]$ , is distributed approximately  $F(pq, rt-2z)$ , where  $\Lambda = \left| \hat{\Omega} \right| / \left| \tilde{\Omega} \right|$  is the ratio of the determinants of the unrestricted and restricted variance-covariance matrices;  $r = v - [(p+q+1)/2]$  and  $v$  is the degrees of freedom for the error;  $z = (pq-2)/4$ ,  $p$  is the number of parameters tested and  $q$  is the number of equations in the model; and  $t = [(p^2q^2-4)/(p^2+q^2-5)]^{0.5}$  if  $(p^2+q^2-5) > 0$  or  $t = 1$  otherwise (McGuirk, Driscoll, Alwang, & Huang, 1995). The result of the test revealed that the skewness variable was misspecified and not significant in either Model 29B or Model 48B. Thus, Model 29A and Model 48A were chosen for the LAIDS models being analyzed in the study.

Another concern in the model specification was the possible endogeneity of the

total nondurables expenditure variable because endogeneity of a variable on the right hand side of the equation results in simultaneous-equations bias in conditional demand models (Capps, Tsai, Kirby, & Williams, 1994). In the present study, the Wu-Hausman test (Greene, 1997; Hausman, 1978) was used to test for the endogeneity of the variable for total expenditures on nondurable goods. If endogeneity of the total nondurables expenditure variable were found by the test, the LAIDS model in the present study should not be estimated by the iterative seemingly unrelated regression (ITSUR) method as proposed, but rather with another estimation method such as the iterative three-stage least squares (IT3SLS) method including an auxiliary regression equation of instrumental variables. The Wu-Hausman test statistic is  $m = (\hat{b}_{OLS} - \hat{b}_{IV})'(\hat{V}_{OLS} - \hat{V}_{IV})^{-1}(\hat{b}_{OLS} - \hat{b}_{IV})$ , which approximates a chi-square distribution, where  $\hat{b}_{OLS}$  and  $\hat{b}_{IV}$  are parameter estimates, and  $\hat{V}_{OLS}$  and  $\hat{V}_{IV}$  are variance-covariance matrices of parameters of unrestricted and restricted models with instrumental variables, respectively. Each unrestricted model is an ordinary least squares equation for the LAIDS budget share equation for each category (i.e., WC, MB, and shoes). Individual restricted models for WC, MB, and shoes are iterative two-stage least squares (IT2SLS) models including each LAIDS budget share equation and an auxiliary regression equation. Instrumental variables included in the auxiliary regression equation were total consumption expenditures and prices of durable goods, nondurable goods, and services. The dependent variable in the auxiliary regression equation was per capita total nondurables expenditure ( $x$ ); i.e.,  $x = f$  (prices of durable goods, nondurable goods, and services, total consumption expenditures). Data for the instrumental variables were also obtained from the NIPA. If we fail to reject the null hypothesis in a chi-square test on  $m$  (where  $H_0$ : no endogeneity;  $H_a$ : endogeneity), then there exists no simultaneity or endogeneity of the total nondurables expenditure variable.

The Wu-Hausman test was conducted only on Model 29A because of insufficient degrees of freedom in Model 48A. The test result showed no endogeneity of the total

expenditures for nondurable goods, at the 0.05 level of significance; the critical value of the chi-square distribution of  $m$  with 17 degrees of freedom was 27.5871. All the calculated chi-square values were much less than the critical value, indicating failure to reject the null hypothesis. Thus, the total expenditure for nondurable goods was considered an exogenous variable in the models, implying that the iterative seemingly unrelated regression could be utilized for the parameter estimation.

The iterative seemingly unrelated regression (ITSUR) estimation method was used for the estimation of the LAIDS model. The adding-up condition in the AIDS model implies that the contemporaneous variance-covariance matrix is singular. One of the equations, consequently, must be deleted (Barten, 1969). Thus, the demand equation of other nondurable goods was omitted in the LAIDS model of the present research. ITSUR estimators are invariant with respect to the deleted equation since they are asymptotically equivalent to maximum likelihood estimators. The computer program SAS, version 6.11 was used in the estimations. For the demographic variables and the dummy variable, the most common null hypotheses were set, as follows:

$$H_{01}: d_{1j} = 0 \quad \text{versus} \quad H_{a1}: d_{1j} \neq 0$$

$$H_{02}: d_{2j} = 0 \quad \text{versus} \quad H_{a2}: d_{2j} \neq 0$$

$$H_{03}: d_{3j} = 0 \quad \text{versus} \quad H_{a3}: d_{3j} \neq 0$$

$$H_{05}: d_{5j} = 0 \quad \text{versus} \quad H_{a5}: d_{5j} \neq 0$$

$$H_{06}: \kappa_i = 0 \quad \text{versus} \quad H_{a6}: \kappa_i \neq 0$$