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Incorporating Demographic Information in Demand Analysis

by

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Abstract

This paper develops a method for incorporating commodity-specific demographic information into the Linear Approximate Almost Ideal Demand System (LA/AIDS). As it turns out, the resulting demand system is a LA/AIDS model with the demographic variables specified as intercept shifters. The model was estimated using household expenditure data from Indonesia.

Incorporating Demographic Information in Demand Analysis

I. Introduction

Economists have long been interested in taking account of demographic characteristics when modeling consumer demand. Demographic characteristics have been shown to be major factors affecting family expenditure patterns. Households differ in size, age-sex composition, race, ethnic origin, and other characteristics and, in general, we expect households with different demographic profiles to have different expenditure patterns. Furthermore, changes in the composition and size of households may change demand for commodities observed over time.

Various methods for incorporating demographic characteristics into demand systems analysis have been developed (Pollak and Wales 1979, 1980, 1981). When the demographic characteristic of interest is the age-sex composition of households, one method that has received considerable attention is the technique of adult equivalent scales. This technique, whose roots go back to Engel's pioneering work on family budgets, has been extensively used over the years primarily in Engel curve estimation (Prais and Houthakker, 1955; Price, 1970; Blokland, 1976; Buse and Salathe, 1978; Tedford et. al., 1986). Ray (1980, 1982) and more recently Wilkinson and Brandt (1989) have used adult equivalent scales in the estimation of the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). However, these models are limited because the scale is a function of household size only and the scale specification is not commodity-specific.

The purpose of this paper is to develop a method for incorporating commodity-specific scales into the AIDS demand system. The method presented here combines a commodity-specific scale specification on household age-sex composition with Ray's demand system. As it turns out, the resulting demand system is an AIDS model with the demographic variables specified as intercept shifters. The proposed model was estimated using household xpenditure data obtained in Indonesia.

The paper proceeds as follows. In section II Ray's demand system and the proposed scale specification are combined. Section III describes the data from Indonesia used in the estimation. Next, results from the estimation are discussed. The paper ends with some concluding comments.

II. AIDS and Commodity-Specific Demographic Effects

Following Barten (1964), Ray (1980, 1982) developed a model that resulted in a demand system described by the following demand equations

$$z_i = z_i(p_1k_1, p_2k_2, \ldots, p_rk_r, X) \; ; \quad i=1, 2, \ldots, r \qquad (1)$$

where $z_i=q_i/k_i$ denotes the quantity of the i^{th} commodity deflated by a scaling variable k_i, p_i denotes the price of the i^{th} commodity, and X denotes income or total expenditure. The scaling variable is assumed to depend on some set of demographic characteristics.

When this principle is applied to the Linear Approximate of the Almost Ideal Demand System (LA/AIDS), it results in the

following demand system:

$$w_i = a_i + \sum_j \tau_{ij} \ln(p_j) + \beta_i \ln(X/P) + \sum_j (\tau_{ij} - \beta_i w_j) \ln(k_j) \qquad (2)$$

where $\ln(.)$ is the natural logarithm operator and P is Stone's price index, i.e.,

$$\ln(P) = \sum_j w_j \ln(p_j).$$

In his studies Ray assumed that $k_j = N^{\delta}$, where N denotes household size and δ is a parameter. The resulting model is given by

$$w_i = a_i + \sum_j \tau_{ij} \ln(p_j) + \beta_i \ln(X/P) + \delta_i \ln(N). \qquad (3)$$

The limitations of this specification are obvious: (i) it ignores household composition and (ii) it is not commodity-specific (Ray, 1982).

Wilkinson and Brandt (1989) attempted to rectify this shortcoming by including information on household composition and using adult equivalent household size instead of N. Adult equivalent household size was based on a single adult equivalent scale for total food estimated exogenously using a method outlined in Buse and Salathe (1978) and in Blokland (1976). However, their model still did not include a commodity specific scale, something that according to them would have been optimal. That is, adjustments for household size were the same for all commodities.

In the model presented here the scaling parameter is specified as

$$\ln(k_j) = \sum_j \delta_{jg} D_g \qquad (4)$$

where D_g (g=1, 2, ..., G) is a set of demographic variables. After substituting into (2) and rearranging terms, the demand system reduces to

$$w_i = a_i + \sum_j \tau_{ij} \ln(p_j) + \beta_i \ln(X/P) + \sum_g \theta_{ig} D_g \qquad (5)$$

where

$$\theta_{ig} = \sum_j \delta_{jg} (\tau_{ij} - \beta_i w_j). \qquad (6)$$

Under this specification, we see that the demographic variables enter the model as intercept shifters and the model is almost identical to the one used by Hein and Pompelli (1989). The relevant theoretical restrictions that can be imposed on this demand system are

Symmetry: $\tau_{ij} = \tau_{ji}$ (i=j ; i,j=1, 2, ..., r) (7a)

Homogeneity: $\sum_j \tau_{ij} = 0$ (i=1, 2, ..., r) (7b)

Adding-Up: $\sum_i a_i = 1$; $\sum_i \beta_i = 0$; $\sum_i \theta_{ig} = 0$ (g=1, 2, ..., G). (7c)

III. DATA

The data set used in this study is from the 1984 National Socio-Economic Survey (SUSENAS) for Indonesia. This was a large survey based on a three-stage sampling design that covered all 27 provinces of Indonesia over one week. The third stage involved the random selection of households from what is commonly referred to as Primary Sampling Units (PSU's), i.e., city blocks or municipalities. Because of the size of the survey (over 50,000 households), only households from the urban areas of Java were used

in this analysis. This also reduces the heterogeneity of the sample and makes the results specific to Java. Other analysis on the entire country has shown the regions to be unique and it appropriate to model urban/rural areas and on/off Java separately.

Household information was aggregated to what hereafter is referred to as a representative household (Ray, 1982). This aggregation was done by averaging over all households within each PSU, i.e., the unit of reference was shifted to the PSU level. This was done mainly for two reasons: (i) to reduce the very large number of records involved, and (ii) to minimize the non-response (zero consumption) rate that is usually high for less developed countries like Indonesia. This resulted in a sample of 578 PSU's for urban Java.

The survey collected information on quantities consumed and their value, as well as other information pertaining to household characteristics such as education of the household head, age and sex of household members, etc. All food items consumed were classified into one of the ten food groups shown in Table 1. Item unit prices were derived by dividing the value of consumption by the corresponding quantity. A technique outlined in Hein and Pompelli (1989) was used to impute missing prices. The price for each food group was defined as a weighted average of the item prices involved, with the weights equal to the share of each item in the total group expenditure.

The demographic variables included in this study are five age-sex categories (children less than 10 years old, female and male

teenagers 10-19 years old, female and male adults 20 plus years old). These definitions were created with the population dynamics of Indonesia in mind (60 percent of that nation's population is under 20 years old). These definitions are also consistent with existing projections of population groups which show that the composition of Indonesia's population is changing rapidly. Regional effects were ruled out since Java is relatively homogeneous by Indonesian standards. Descriptive statistics for all variables involved in the model appear in Table 2.

IV. Estimation

Model (5) was estimated with restrictions (7a) - (7c) imposed. The SAS procedure SYSNLIN and the method of Iterative Seemingly Unrelated Regressions (ITSUR) were used for the estimation. Because the error variance-covariance matrix of the full model is singular, the tobacco and alcoholic beverages equation was dropped from the estimation and its parameters were "recovered" later using the adding-up restrictions. ITSUR results in consistent parameter estimates and is asymptotically equivalent to the Maximum Likelihood Estimation (MLE) which is invariant to the equation being dropped.

The estimated parameters and their asymptotic t-ratios are given in Table 3. In general, the results of the estimation were good. The expenditure coefficient, β_i, measures the effect of an increase in food expenditure on the budget share of the i_{th} food commodity. It will be negative for necessities and positive for

luxuries (Deaton and Muellbauer, 1980). The results given in Table 3 show that rice, palawija crops, vegetables, sugar and condiments, and fats are necessities whereas fruits, prepared food, and tobacco appear to be luxuries.

Price and expenditure elasticities as well as elasticities for demographic effects are given in Table 4. These elasticities were computed at the sample average values of the appropriate variables using the following formulas:

Own-price: $e_{ii} = -1 + (\tau_{ii} / w_i) - \beta_i$

Cross-price: $e_{ij} = (\tau_{ij} / w_i) - (\beta_i w_j / w_i)$; $i \neq j$

Expenditure: $\epsilon_{ix} = 1 + (\beta_i / w_i)$

Demographic: $\epsilon_{ig} = \theta_{ig}(D_g / w_i)$.

As expected, all own-price elasticities are negative and all expenditure elasticities are positive. The demand for rice is highly price inelastic but the demand for palawija, fats, and prepared food appears to be elastic. In general, for those commodities that can be compared to other studies of the Indonesian food sector, the results reported here are close to the ones reported elsewhere, e.g., Deaton (1988).

It is sometimes difficult to directly interpret demographic elasticities. A change in a single demographic characteristic, ceteris paribus, causes a reallocation of expenditure among the food commodities. Since total expenditure remains unchanged, any increase in the consumption of some food commodity must be balanced by decreases in the consumption of others and, in general, the signs of such effects cannot be determined a priori. The reported

elasticities show that, for instance, an increase in the number of male adults will result in increased consumption of all food commodities except fruits and prepared food.

V. Conclusions

This paper has outlined a procedure for incorporating commodity-specific demographic effects into the LA/AIDS demand system. It has been shown that the proposed demand system, in the context of LA/AIDS, is similar to the usual way of introducing demographic effects as intercept shifters. Estimation of the proposed demand system using Indonesian cross-section data resulted in satisfactory estimates of price and expenditure elasticities. This method of incorporating commodity-specific demographic effects into the LA/AIDS demand system can be generalized to time series data as well.

Demographic information is useful in explaining observed variation in consumption patterns. Scaling of demand functions offers important opportunities for investigating the effects of intercountry and temporal demographic factors associated with explaining underlying differences in market data.

Table 1: List of Food Groups and their Description

Name	Description
RICE	Rice and rice products
PALAWIJA	Palawija crops (corn, wheat, other cereals, cassava, potatoes, sweet potatoes, beans, nuts)
FRUITS	Fruits
VEGET	Vegetables
MT & FI	Meat and fish
EG & DA	Eggs, milk, and dairy products
FATS	Fats and Oils
SU & CO	Sugar, sweets, spices, condiments
PR FOOD	Prepared and other food
TOBACCO	Alcoholic beverages and Tobacco products

Table 2: Descriptive Statistics for Model Variables

	Obs	Mean[a]	Std
BUDGET SHARES:			
RICE	586	0.2320	0.0785
PALAWIJA	588	0.0711	0.0404
FRUITS	581	0.0504	0.0263
VEGETABLES	588	0.0880	0.0275
MEAT & FISH	584	0.1260	0.0556
EGGS & DAIRY	584	0.0594	0.0283
FATS	588	0.0586	0.0206
SUGAR & CONDIMENTS	588	0.0511	0.0164
PREPARED FOOD	586	0.1788	0.0945
TOBACCO	584	0.0885	0.0428
DEMOGRAPHIC:			
CHILDREN	588	1.1386	0.4922
FEMALES 10-19	588	0.5971	0.3168
FEMALES 20+	588	1.3151	0.3126
MALES 10-19	588	0.5833	0.3286
MALES 20+	588	1.2217	0.2979
PRICES:			
RICE	588	344.2947	36.2795
PALAWIJA	588	446.3766	112.8477
FRUITS	588	467.3485	206.2737
VEGETABLES	588	203.2400	59.8610
MEAT & FISH	584	1594.0663	541.3129
EGGS & DAIRY	588	891.5171	702.8550
FATS	588	860.3640	194.4286
SUGAR & CONDIMENTS	588	164.6041	41.0682
PREPARED FOOD	588	258.3345	144.1995
TOBACCO	588	357.8848	79.0091
FOOD EXPENDITURE	588	14828.4823	6319.4696

[a]Prices and Expenditure are in Indonesian Rupiahs.

Table 3: Parameter Estimates and Asymptotic T-values.

	FOOD GROUP									
	RICE	PALAWIJA	FRUITS	VEGET	MT & FI	EG & DA	FATS	SU & CO	PR FOOD	TOBACCO
INTERCEPT	0.670379	0.120600	-0.025358	0.122125	0.035754	0.029107	0.121399	0.078184	-0.244369	0.092179
	(22.162)	(6.894)	(-2.006)	(8.478)	(1.330)	(2.507)	(10.788)	(8.480)	(-5.881)	(4.179)
CHILDREN	0.035965	0.001569	-0.005688	0.004184	-0.005303	-0.001793	0.003686	0.001492	-0.044477	0.010365
	(7.165)	(0.546)	(-2.733)	(1.827)	(-1.140)	(-0.894)	(2.119)	(1.035)	(-6.180)	(2.836)
FEMALES 10-19	0.034674	0.000296	-0.002723	-0.000201	0.001835	0.000720	-0.001011	-0.001472	-0.016051	-0.016066
	(4.240)	(0.063)	(-0.802)	(-0.054)	(0.241)	(0.220)	(-0.359)	(-0.628)	(-1.358)	(-2.696)
FEMALES 20+	0.007707	0.005241	0.003832	0.001249	0.017927	0.009641	0.003361	0.003047	-0.023078	-0.028927
	(0.933)	(1.110)	(1.118)	(0.332)	(2.335)	(2.929)	(1.182)	(1.287)	(-1.952)	(-4.806)
MALES 10-19	0.027993	0.007188	-0.003975	0.001683	0.008314	0.002957	0.011063	-0.002292	-0.047079	-0.005851
	(3.602)	(1.614)	(-1.231)	(0.474)	(1.148)	(0.948)	(4.133)	(-1.028)	(-4.192)	(-1.033)
MALES 20+	0.014629	0.004347	-0.009843	0.007003	0.006820	0.006259	0.008390	0.001787	-0.058081	0.018690
	(1.623)	(0.841)	(-2.625)	(1.699)	(0.813)	(1.734)	(2.699)	(0.689)	(-4.464)	(2.843)
PRICES:										
RICE	0.128346	0.021250	-0.022349	-0.000931	-0.039579	-0.016517	0.006638	-0.006155	-0.030630	-0.040074
	(8.949)	(3.362)	(-5.373)	(-0.177)	(-8.326)	(-7.730)	(1.314)	(-1.554)	(-6.628)	(-5.060)
PALAWIJA	0.021250	-0.010170	-0.013991	-0.008704	0.003221	-0.005078	0.003452	-0.002508	0.001287	0.011242
	(3.362)	(-2.034)	(-5.706)	(-2.801)	(1.170)	(-4.115)	(1.234)	(-1.103)	(0.490)	(2.491)
FRUITS	-0.022349	-0.013991	0.019892	-0.004739	0.009911	0.003844	-0.003895	-0.003189	0.009477	0.005038
	(-5.373)	(-5.706)	(8.343)	(-2.332)	(5.069)	(4.299)	(-2.151)	(-2.180)	(5.066)	(1.629)
VEGETABLES	-0.000931	-0.008704	-0.004739	0.011735	0.000281	0.000321	-0.003240	0.002479	-0.003325	0.006123
	(-0.177)	(-2.801)	(-2.332)	(3.149)	(0.131)	(0.332)	(-1.291)	(1.198)	(-1.565)	(1.635)
MEAT & FISH	-0.039579	0.003221	0.009911	0.000281	0.027900	0.007710	0.001152	0.002103	-0.003239	-0.009461
	(-8.326)	(1.170)	(5.069)	(0.131)	(6.209)	(5.214)	(0.642)	(1.495)	(-0.875)	(-2.689)
EGGS & DAIRY	-0.016517	-0.005078	0.003844	0.000321	0.007710	0.013486	0.000106	-0.002347	0.002418	-0.003943
	(-7.730)	(-4.115)	(4.299)	(0.332)	(5.214)	(14.515)	(0.131)	(-3.677)	(1.505)	(-2.426)
FATS	0.006638	0.003452	-0.003895	-0.003240	0.001152	0.000106	-0.006953	0.001032	-0.004198	0.005907
	(1.314)	(1.234)	(-2.151)	(-1.291)	(0.642)	(0.131)	(-2.024)	(0.504)	(-2.613)	(1.786)
SUGAR & COND	-0.006155	-0.002508	-0.003189	0.002479	0.002103	-0.002347	0.001032	0.003516	0.000659	0.004409
	(-1.554)	(-1.103)	(-2.180)	(1.198)	(1.495)	(-3.677)	(0.504)	(1.446)	(0.488)	(1.645)
PREPARED FOOD	-0.030630	0.001287	0.009477	-0.003325	-0.003239	0.002418	-0.004198	0.000659	0.029452	-0.001901
	(-6.628)	(0.490)	(5.066)	(-1.565)	(-0.875)	(1.505)	(-2.613)	(0.488)	(4.514)	(-0.573)
TOBACCO	-0.040074	0.011242	0.005038	0.006123	-0.009461	-0.003943	0.005907	0.004409	-0.001901	0.022658
	(-5.060)	(2.491)	(1.629)	(1.635)	(-2.689)	(-2.426)	(1.786)	(1.645)	(-0.573)	(2.879)
FOOD EXPENDITURE	-0.141941	-0.021544	0.022001	-0.010890	0.003129	-0.002595	-0.024563	-0.008450	0.177828	0.007027
	(-14.879)	(-3.919)	(5.483)	(-2.472)	(0.357)	(-0.687)	(-7.388)	(-3.052)	(12.908)	(1.008)

Table 4: Demographic, Price, and Expenditure Elasticities.

	FOOD GROUP									
	RICE	PALAWIJA	FRUITS	VEGET	MT & FI	EG & DA	FATS	SU & CO	PF FOOD	TOBACCO
DEMOGRAPHIC:										
CHILDREN	0.176	0.025	-0.128	0.054	-0.048	-0.034	0.072	0.033	-0.283	0.133
FEMALES 10-19	0.089	0.002	-0.032	-0.001	0.009	0.007	-0.010	-0.017	-0.054	-0.108
FEMALES 20+	0.044	0.097	0.100	0.019	0.187	0.214	0.076	0.078	-0.170	-0.430
MALES 10-19	0.070	0.059	-0.046	0.011	0.039	0.029	0.110	-0.026	-0.154	-0.039
MALES 20+	0.077	0.075	-0.238	0.097	0.066	0.129	0.175	0.043	-0.397	0.258
PRICE:										
RICE	-0.305	0.369	-0.544	0.018	-0.320	-0.268	0.211	-0.082	-0.402	-0.471
PALAWIJA	0.135	-1.122	-0.308	-0.090	0.024	-0.082	0.089	-0.037	-0.063	0.121
FRUITS	-0.065	-0.182	-0.628	-0.048	0.077	0.067	-0.045	-0.054	0.003	0.053
VEGETABLES	0.050	-0.096	-0.132	-0.856	0.000	0.009	-0.018	0.063	-0.106	0.062
MEAT & FISH	-0.094	0.084	0.142	0.019	-0.782	0.135	0.073	0.062	-0.143	-0.117
EGGS & DAIRY	-0.035	-0.053	0.050	0.011	0.060	-0.770	0.027	-0.036	-0.046	-0.049
FATS	0.064	0.066	-0.103	-0.030	0.008	0.004	-1.094	0.030	-0.082	0.062
SUGAR & COND	0.005	-0.020	-0.086	0.034	0.015	-0.037	0.039	-0.923	-0.047	0.046
PREPARED FOOD	-0.023	0.072	0.110	-0.016	-0.030	0.049	0.003	0.042	-1.013	-0.036
TOBACCO	-0.119	0.185	0.061	0.081	-0.077	-0.063	0.138	0.101	-0.099	-0.751
FOOD EXPENDITURE	0.388	0.697	1.436	0.876	1.025	0.956	0.580	0.835	1.994	1.079

References

Barten, A.P. "Family Composition, Prices, and Expenditure Patterns." In Econometric Analysis for National Planning. Edited by P.E. Hart, G. Mills, and J.K. Whitakker. London: Butterworth, 1964.

Blokland, J. Continuous Consumer Equivalence Scales. The Hague: Martinus Nijhoff, 1976.

Brown, A., and Deaton, A. "Surveys of Applied Economics: Models of Consumer Behavior." Economic Journal 82 (1972):1145-236.

Buse, R.C., and Salathe, L.E. "Adult Equivalent Scales: An Alternative Approach." American Journal of Agricultural Economics 60 (1978):460-469.

Deaton, A. "Price Elasticities from Survey Data: Extensions and Indonesian Results." Woodrow Wilson School, Princeton University, May 1988 (mimeo).

Deaton, A., and Muellbauer, J. Economics and Consumer Behavior. Cambridge: Cambridge University Press, 1980.

Hein, D., and Pompelli, G. "The Demand for Alcoholic Beverages: Economic and Demographic Effects." Southern Economic Journal, Jan. 1989

Johnson, S.R.; Hassan, Z.A.; and Green, R.D. Demand Systems Estimation: Methods and Applications. Ames: Iowa State University Press, 1984.

Phlips, L. Applied Consumption Analysis. North-Holland, 1973.

Pollak, R.A., and Wales, T.J. "Welfare Comparisons and Equivalent Scales." American Economic Review 69 (1979):216-21.

_____ "Comparison of the Quadratic Expenditure System and Translog Demand Systems with Alternative Specifications for Demographic Effects." Econometrica 48 (1980):595-612.

_____ "Demographic Variables in Demand Analysis." Econometrica 49 (1981):1533-51.

Prais, S.J., and Houthakker, H.S. The Analysis of Family Budgets. Cambridge: Cambridge University Press, 1955.

Price, D.W. "Unit Equivalent Scales for Specific Food Commodities." American Journal of Agricultural Economics 52 (1970):224-33.

Ray, R. "Analysis of a Time Series of Household Expenditure Surveys

for India." The Review of Economics and Statistics 62 (1980):595-602.

_____, "The testing and Estimation of Complete Demand Systems on Household Budget Shares." European Economic Review 17 (1982) 349-369.

Tedford, J.R.; Capps, O. Jr.; and Havlicek, J. Jr. "Adult Equivalent Scales Once More - A Developmental Approach." American Journal of Agricultural Economics 68 (1986):322-33.

Wilkinson, A., and Brandt, J. "Incorporating Demographic Information in an Almost Ideal Demand System." Paper presented at the American Agricultural Economics Association Annual Meetings, Baton Rouge, LA, 1989.