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AN INFREQUENCY OF PURCHASE MODEL OF GREEK HOUSEHOLD CLOTHING AND FOOTWEAR CONSUMPTION WITH ERROR DEPENDENCE

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Abstract

Almost 22% of the total number of households in the 1993/94 Household Budget Survey report zero clothing and footwear expenditures in the survey period. This paper tests for the underlying causes of zero observations and estimates the clothing and footwear expenditure equations and the resulting consumption profiles. The results of the statistical testing indicate that the appropriate vehicle of analyzing Greek household clothing and footwear consumption is the "infrequency of purchase" limited dependent variable model adjusted for non-normality, heteroskedasticity and error dependence. The estimated results indicated that clothing and footwear consumption in Greece is income inelastic and that the household size in adult equivalents affects, as expected, positively the level of clothing and footwear expenditures (JEL: C21, C24, D11).

1. Introduction

According to National Statistical Service of Greece (NSSG), clothing and footwear consumption in Greece accounted for 10.7 per cent of the 1994 average total domestic consumption of households. This expenditure share is 1.8 and 2.5 per cent lower than the 1985 and 1980 shares, respectively.

Karagiannis and Velentzas (1995) have attempted to explain the variability of clothing and footwear expenditure shares utilizing times series data covering the period 1960-1991. They estimated the basic demand parameters (price and expenditure elasticities), which they found to be 0.26 and 1.19, respectively. Both variables were found to be significant in determining changes in clothing and footwear expenditure shares over time.

This paper examines clothing and footwear consumption by Greek households using cross sectional data (for the first time in Greece) from the 1993/94 National Household Budget Survey that was carried out by the

NSSG, comprising 6747 households. The specific objectives of the present study is to estimate the expenditure elasticity, as well as the average effects of the socioeconomic and demographic characteristics of the households surveyed, using the appropriate version of the Limited Depended Variable models properly adjusted for non-normality, heteroskedasticity and error dependence. The advantages of these models are that: a) they provide unbiased estimates of the parameters, b) they provide estimates of the probability of observing a purchase in the market of the product under examination and estimates of the demand parameters for those households that have purchased the product and, last, c) they are amenable to the basic econometric problems of heteroskedasticity and non-normality that are very frequently present in cross sectional studies. Their major advantage, however, is that they allow for the presence of zero observations, which in the case of clothing and footwear consumption is a significant proportion of households. During estimation, clothing and footwear adult equivalent scales and the household size in adult equivalents, will be estimated using the Tedford-Capps-Havlichek model (Tedford et al., 1986; Demoussis and Mihalopoulos, 2001).

Thus, an examination of Greek clothing and footwear consumption behaviour is expected to provide valuable information about the underlying explanatory factors and a better understanding of the Greek clothing and footwear industry. This is more likely considering the fact that Greek clothing and footwear consumption has not been investigated to any extent so far.

The paper is structured as follows. The next section explains the model selection procedure and presents in detail the empirical model used. Section 3 contains the descriptive statistics of the major variables and the results of estimation. This section also contains the estimated clothing and footwear probability, conditional and unconditional elasticities. The paper concludes with a synopsis of the major findings.

2. Methodological considerations

2.1 Model selection

The presence of zero observations in cross sectional consumption data is a very common phenomenon. It is attributed to a) corner solutions, b) true non-consumption and c) infrequency of purchase (Pudney, 1989). Corner solutions imply that the consumer chooses not to consume the particular product at the existing prices and income. True non-consumption means that the consumer has decided not to participate in the market of the product in question and this decision is independent of income and price levels. Last, observed zero consumption may be attributed to purchase infrequency, i.e., the product under examination has a purchase cycle longer than the survey period length. Thus, one cannot a priori distinguish if the observed zero clothing and footwear expenditure represents corner solution or true non-participation or infrequent purchases.

Since a large proportion of values of the dependent variables are clustered at zero, a straightforward application of OLS will yield biased and inconsistent estimates (Amemiya, 1984). Thus, the appropriate econometric method for explaining the observed clothing and footwear expenditure variability necesarily involves one of the Limited Dependent Variable models properly adjusted for non-normality (with application of the Inverse Hyperbolic Sine, IHS, transformation), heteroskedasticity (with parameterization of the standard deviation) and error dependence. If zero observations are caused by corner solutions then the "IHS Tobit" model is more suitable (Reynolds and Shonkwiler, 1991). If the underlying cause of zero observations is a combination of corner solution and non-participation, then the appropriate model is the "IHS double hurdle participation" model (Yen and Jones, 1997). Finally, if they are the combined result of corner solution and infrequent purchases then the "IHS infrequence of purchase" model should be employed.

The model selection procedure adopted in this study involves two phases. First a comparison between the two non-nested models i.e., the "IHS double hurdle participation" and the "IHS infrequence of purchase" with a Vuong test (Vuong, 1989) and second a comparison between the appropriate non-nested model and the "IHS Tobit" model with a LR test (Greene, 1990, pp. 388). The procedure shows that the "IHS infrequence of purchase" model is the appropriate estimation model, which is presented in the following subsection. This model assumes that every household participates in the clothing and footwear market and zero observations represent corner solutions and infrequent purchases.

2.2 The IHS infrequency of purchase model with error dependence

The model "infrequency of purchase with error dependence"(Gould, 1992) contains a "selection" and an "outcome" equation:

$$Z_h^* = Q_h\gamma + e_h \text{ where } e_h \sim N(0,1) \text{ (selection equation)}$$

$$Y_h^* = X_h\beta + u_h \text{ where } u_h \sim N(0,\ \sigma_u^2) \text{ (outcome equation)} \quad (1)$$

where, the latent variable Y_h*, represents the household consumption of clothing and footwear and the latent variable Z^*_h the decision of the h[th] consuming household to purchase the product. The two sets of explanatory variables Q_h and X_h, usually include the same variables and it is assumed that they influence differently the decision to purchase and the decision on the level of consumption. In the present application the set Q_h contains: a) social and demographic dummy variables like urbanization, the household head's marital status and education and the presence of children < 17 years old in the household, b) total household expenditures and c) the household size in adult equivalents.

In this model, zero ovservations occur if consumption is actually zero ($Y_h^* \leq 0$) i.e., corner solution, or if consumption is positive ($Y_h^* > 0$) but a purchase has not been made in the reference period ($Z_h^* \leq 0$). Therefore, the relationship between the observed depended variable Y_h (which represents the household expenditures for the product) and the latent variables is given by (Gould, 1992, pp. 454):

$$Y_h = \frac{Y_h^*}{\Phi(Q_h\gamma \mid Y_h^*)} \quad \text{or} \quad Y_h.\Phi(Q_h\gamma|Y_h^*) = Y_h^* = X_h\beta + u_h \text{ for } Z_h^* > 0 \text{ and } Y_h^* > 0$$

$$\text{and} \qquad Y_h.\Phi(Q_h\gamma|Y_h^*) = 0 \qquad \text{otherwise} \quad (2)$$

where, $\Phi(Q_h\gamma|Y_h^*)$ is the probability of observing a purchase conditional on the level of consumption, i.e., the higher the consumption level the higher the probability of observing a purchase, and it is equal to (Anderson, 1974, pp. 27-28):

$$\Phi(Q_h\gamma|Y_h^*) = \Phi\left[\left(Q_h\gamma + \varrho.\frac{u_h}{\sigma_u}\right) \Big/ \sqrt{1-(\varrho)^2}\right] \quad (3)$$

where, ϱ is the correlation coefficient between e_h and u_h.

To incorporate non-normality in (2) the IHS transformation of $Y_h.\Phi(Q_h\gamma|Y_h^*)$ (Burbidge et al., 1988) is employed:

$$T[Y_h.\Phi(Q_h\gamma|Y_h^*)] = \frac{\log\left[\Theta.\left(Y_h.\Phi(Q_h\gamma|Y_\eta^*)\right)+\left(\Theta^2(Y_h.\Phi(Q_h\gamma|Y_h^*))^2+1\right)^{1/2}\right]}{\Theta} \quad (4)$$

where, Θ is the non-normality parameter, to be estimated. Since the transformed variable is symmetric about 0 in Θ, we consider only $\Theta \geq 0$.

Based on the above transformation (4) and following Blundell and Meghir (1987) and Gould (1992), the likelihood function for the model "IHS infrequency of purchase with error dependence" takes the form:

$$L=\prod_0\left[1-\Phi\left(\frac{X_h\beta}{\sigma^u}\right).\Phi(Q_h\gamma|Y_h^*)\right].\prod_+\left[\Phi\left(\frac{X_h\beta}{\sigma_u}\right).\Phi(Q_h\gamma|Y_h^*).f(u_h|e_h>-Q_h\gamma,u_h>-X_h\beta).J\right] \quad (5)$$

where, the conditional density function and the Jacobian are given by:

$$f(u_h|e_h>Q_h\gamma,\ u_h>-X_h\beta)= \frac{1}{\sigma_u}.\varphi\left[\frac{T[\Phi(Q_h\gamma|Y_h^*).Y_h]-X_h\beta}{\sigma_u}\right].\left[\Phi\left(\frac{X_h\beta}{\sigma_u}\right)^{-1}\right] \quad (6)$$

$$J=\left|\frac{d\left[T\{\Phi(Q_h\gamma|Y_h^*).Y_h\}-X_h\beta\right]}{dY_h}\right|=\frac{\Phi(Q_h\gamma|Y_h^*}{1-\frac{\varphi(Q_h\gamma|Y_h^*).Y_h.\varrho}{\sigma_u\sqrt{1-\varrho^2}}}.\left(1+\Theta^2Y_h^2(\Phi(Q_h\gamma|Y_h^*)^2\right)^{-1/2} \quad (7)$$

where, $\prod_0$ and $\prod_+$ refer to the group of zero and positive observations of Y_h, respectively. The term $\Phi\left(\frac{X_h\beta}{\sigma_u}\right).\Phi(Q_h\gamma|Y_h^*)$ represents the probability of observing positive expenditures ($Z_h^*>0$ and $Y_h^*>0$) and, thus, its complement probability, i.e., $1-\Phi\left(\frac{X_h\beta}{\sigma_u}\right).\Phi(Q_h\gamma|Y_h^*)$ represents the probability of zero expenditure.

In order to incorporate heteroskedasticity into (5), the parameterization of the standard deviation (Godfrey, 1978) is applied:

$$\sigma_u \quad = \quad \exp(D_h.\xi|) \qquad (8)$$

where, D_h is a row vector of exogenous variables and ξ is a column parameter vector.

The above likelihood function nests a number of interesting models: When $\sigma_{ue}=0$, the "IHS infrequency of purchase with error dependence" model reduces to the "IHS infrequency of purchase with error independence"model (Su and Yen, 1996), when $\Theta=0$ to the "infrequency of purchase with error dependence"model (Gould, 1992), when $\Theta=0$ and $\sigma_{ue}=0$ to the "infrequency of purchase with error independence" model (Deaton and Irish, 1984; Blundell and Meghir, 1987), when $\sigma_{ue}=0$ and $\Phi(Q_h\gamma|Y_h^*)=1$, to the "IHS Tobit model"(Reynolds and Shonkwiler, 1991), and when $\sigma_{ue}=0$, $\Theta=0$ and $\Phi(Q_h y \mid Y_h^*)=1$, to the simple "Tobit model" (Blaylock and Smalwood 1983; Cornick et al., 1994; Mc Dowell et al., 1997).

3. Data and results of estimation

3.1. Descriptive statistics

The data used in this paper have been obtained from the 1993/94 Household Budget Survey, which was carried out by the National Statistical Service of Greece (NSSG). The survey data contain detailed information on household clothing and footwear expenditures during a month, as well as data on the socioeconomic and demographic characteristics of the household. The sample employed in this study contains 6747 households.

Table 1 presents the descriptive statistics of the basic variables. Almost 22 percent of the households report zero clothing and footwear expenditures during the survey period. It is worth noticing that on average clothing and footwear consuming households have higher total expenditures than non-consuming ones and that the average household size in adult equivalents for the full sample is 5.671 and for the clothing and footwear consuming one is 6.019. In addition, a) 70.8% of clothing and footwear consuming households live in urban areas and 29.2% in rural ones, b) 78.2% of clothing and footwear consuming households have household head married, and, c) 76.9% of Greek households without children under 17 years old, do not participate in the market of cloths and shoes.

TABLE 1

Descriptive sample statistics

Variable	Full Sample	Consuming households	Non-consuming households
Clothing and footwear expenditures[a]	30881	39461	0
	(43106)[b]	(45120)	
Household size in adult equivalents	5.671	6.019	4.416
	(3.636)	(3.635)	(3.354)
Household size in number of persons	2.942	3.056	2.530
	(1.379)	(1.372)	(1.324)
Total household expenditures[a]	342433	380009	207191
	(233572)	(240117)	(141566)
Dummy variables (yes=1, no=0)			
Urban household	0.700	0.708	0.675
Household head married	0.761	0.782	0.686
Education of household head (<6 years)	0.191	0.166	0.281
Education of household head (6-9 years)	0.481	0.472	0.514
Education of household head (>9 years)	0.327	0.361	0.205
No child < 17 years old in the household	0.639	0.603	0.769
One child < 17 years old in the household	0.157	0.172	0.103
Two children < 17 years old in the household	0.162	0.181	0.092
More than two children < 17 years old in the household	0.042	0.043	0.036
Sample size	6747 (100%)	5280(78.3%)	1467 (21.7%)

a Monthly expenditures in Greek drachmas.

b Standard deviations in parentheses.

Source: National Household Budget Survey 1993/94, National Statistical Service of Greece, Athens, 1996.

3.2 Results of estimation

The econometric software LIMDEP 7 (Greene, 1997) was used to maximize the log likelihood function of the "IHS infrequency of purchase with erro dependence" model. In the process, clothing and footwear adult equivalent scales (AES) were estimated using the Tedford-Capps-Havlicek method (Tedford *et al,* 1986). Household equivalent scales were estimated using 17 age-gender dependent weighted variables (Tedford *et al,* 1986:333).

The estimation results show that the average household size in clothing and footwear adult equivalents is 5.67. This is quite different than the average number of persons per household, 2.94 (see Table 1). Using the estimated clothing and footwear AES and the typical AES scale function (Tedford *et al.,* 1986) the male and female AES profiles are formulated. Figure (1) shows clearly that the male and female AES profiles increase rapidly until the age of 10. After the age of 10, the male profile lies below the female profile and starts a steady decline, which is steeper at the ages 10-18 and 35-40. In contrast, the female profile increases slowly after the age of 5 and peaks a few years later at the age of 30. After the age of 30 starts to decline slowly.

The estimation results of the IHS infrequency of purchase model with heteroskedasticity and error dependence are presented in Table 2. The IHS parameter Θ and the heteroskedasticity parameters of the continuous variables (third column of Table 2) are statistically significant, implying the presence of both, non-normality and heteroskedasticity of the error terms. In addition, taking into account the log-likelihood values for the error dependent model (LL=-4293.67) and the error independent model (LL=-4320.92), a Likelihood Ratio test (LR=54.5) indicated that the null hypothesis of error independence is rejected at the 0.05 level of significance. Thus, the reported results come from the IHS infrequency of purchase model adjusted for non-normality, heteroskedasticity and error dependence. It is interesting to note that 8 out of 11 estimated coefficients of the selection equation and 8 out of 11 coefficients of the outcome equation are statistically significant.

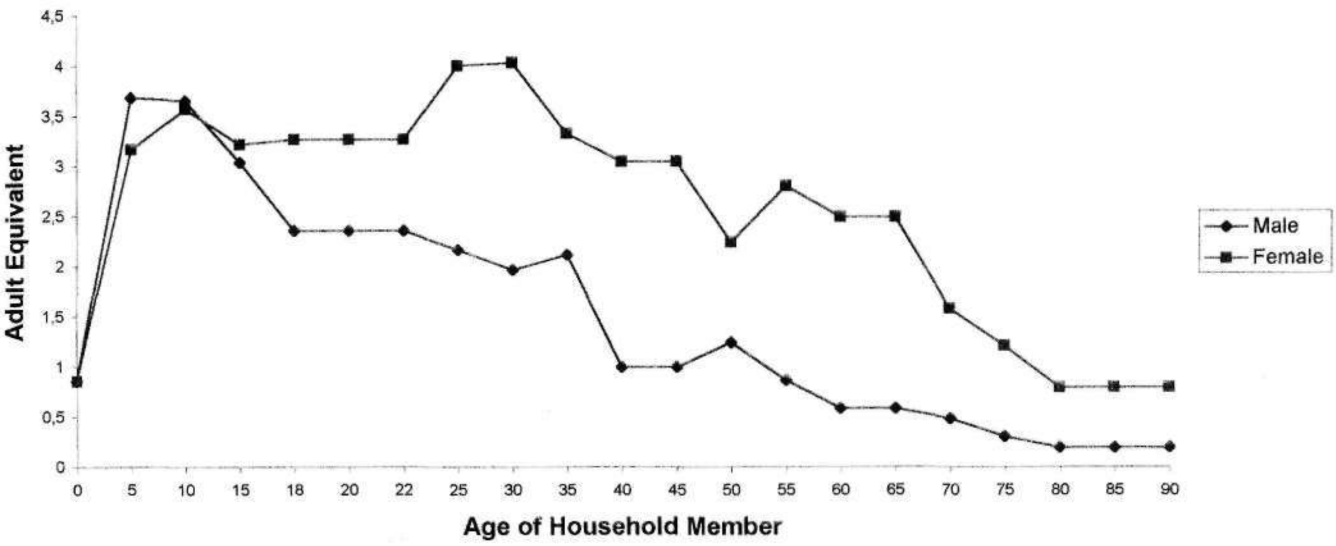
The effects of the independent variables on the frequency of purchase and the level of expenditure are presented in the form of elasticities in Table 3. The probability elasticity and the unconditional and conditional elasticities with respect to the continuous variables were computed at the sample means of the variables. The effects of dummy variables were obtained by calculating the changes in probability that result from a change from 0 to 1 in the variables, ceteris paribus.

The IHS transformation, the heteroskedastic error specification and the error dependence make the decomposition of total effect of independent variables especially important. The unconditional mean of the dependent variable Y_h. (Karlin and Taylor, 1975) is

$$E(Y_h)=pr(Y_h>0).E(Y_h|Y_h>0)=E(Y_h|Y_h>0).\Phi(Q_h\gamma|Y^*).\Phi\left(\frac{X_h\beta}{\sigma_u}\right) \tag{9}$$

FIGURE 1

Adult Equivalent Profiles for Expenditures on Clothing and Footwear



where, the probability of a positive observation is

$$pr(Y_h>0)=pr(Z_h^*>0|Y^*).pr(Y_h^*>0)=\Phi(Q_h\gamma|Y^*).\Phi\left(\frac{X_h\beta}{\sigma_u}\right) \tag{10}$$

and the conditional mean of Y_h is (11)

$$E(Y_h|Y_h>0)= \left[\Phi\left(\frac{X_h\beta}{\sigma_u}\right)\right]^{-1}\int_0^\infty Yh.\frac{1}{\sigma_u}.\varphi\left(\frac{\mathrm{T}\left[\Phi(Q_h\gamma\,|\,Y_h^*).Y_h\right]-X_h\beta}{\sigma_u}\right).$$

$$\frac{\Phi(Q_h\gamma\,|\,Y_h^*)}{1-\dfrac{\varphi(Q_h\gamma\,|\,Y_h^*).Y_h^*.\varrho}{\sigma_u\sqrt{1-\varrho^2}}}\left\{1+\left[\Theta.Y_h.\Phi(Q_h\gamma\,|\,Y_h^*)\right]^2\right\}^{-1/2}dY_h$$

In order to derive the marginal effects and to calculate the probability elasticity and the unconditional and conditional elasticities, equations (9), (10) and (11) are differentiated with respect to the independent variable of interest.

For the continuous variables the following points are worth making. The probality elasticity with respect to total household expenditures is statistically non-significant showing that total household expenditures have no impact on clothing and footwear purchase frequency. In contrast, the conditional elasticity is statistically significant and positive and its value (=0.575) shows that a 10% increase in household expenditures increases clothing and footwear expenditures by 5.75%. This estimate is half the size of that reported by Karagiannis and Velentzas (1995), with time series data (1.19).

Household size in "cloth and shoe" adult equivalents has a positive impact, 38.4%, on clothing and footwear expenditures. In other words, if the household size increases by one adult equivalent then the clothing and footwear expenditure is expected to increase by 38.4%.

With respect to the dummy variables of the model we observe the following: Urban households and those with household head married purchase clothes and shoes more frequently (5.5% and 8.2%, respectively) than rural and single person households. The education of household heads increases purchase frequency. The number of children under 17 years old increases clothing and footwear household expenditures.

TABLE 2

Maximum likelihood estimates of Greek household clothing and footwear expenditures
(Inverse Hyperbolic Sine infrequency of purchase model with error dependence)

Variable	Selection equation (Coefficient γ)	Output equation (Coefficient β)	Heteroskedastic equation (Coefficient ξ)
Constant	2.433***(0.433)	-0.221***(0.027)	
Total household expenditures	0.128(0.355)	0.915***(0.030)	-0.240***(0.028)
Household size in adult equivalents	0.082(0.104)	0.008***(0.001)	-0.120***(0.002)
Urban household	0.461***(0.141)	0.003 (0.010)	
Household head married	0.779*(0.445)	-0.010 (0.018)	
Education of household head (6-9 years)	0.866***(0.147)	0.023 (0.017)	
Education of household head (>9 years)	0.501***(0.152)	0.030*(0.017)	
One child < 17 years old in the household	-0.188(0.356)	0.069***(0.013)	
Two children < 17 years old in the household	-0.994*(0.559)	0.093***(0.013)	
More than two children < 17 years old	-1.277***(0.337)	0.118*(0.016)	
Θ	1.535***(0.076)		
σ_{ue}	2.902***(0.750)		
LogL	-4293.67		

Standards errors in parentheses.
***Coefficient significant at the 0.01 level.
** Coefficient significant at the 0.05 level.
* Coefficient significant at the 0.10 level

TABLE 3

Elasticity estimates of household demand for clothing and footwear in Greece

	Probability elasticity	Conditional elasticity	Unconditional elasticity
A. Elasticities with respect to continuous variables			
Total household expenditures	0.016	0.575***	0.591***
	(0.044)	(0.019)	(0.220)
Household size in adult equivalents	0.011	0.384***	0.395**
	(0.014)	(0.064)	(0.178)
B. Average effects of dummy variables			
Urban household	0.055**	0.001	
Household head married	0.082*	-0.005	
Education of household head (6-9 years)	0.082***	0.005	
Education of household head (> 9 years)	0.042***	0.006*	
One child < 17 years old in the household	-0.001	0.014***	
Two children < 17 years old in the household	-0.001*	0.020***	
More than two children < 17 years old	-0.007***	0.025*	

Notes: Standard errors in parentheses. «**,**,* indicate significant at the 0.01, 0.05 and 0.10 level, respectively. Groups of dummy variables compare against:rural household, household head unmarried, education of household head < 6 years and household without child < 17 years old.

4. Summary and implications

The objective of this paper was to analyze clothing and footwear consumption expenditure by Greek households using cross sectional data from the 1993/94 Household Budget Survey. Relevant statistical testing revealed that the appropriate model for analyzing Greek household clothing and footwear expenditure is the "Inverse Hyperbolic Sine infrequency of purchase model with heteroskedasticity and error dependence".

The wide gap between the male and female clothing and footwear consumption profiles after the age of 10 is due to a rapid decline of the male profile at the ages 10-18 and 35-40. Thus, the declining share of clothing and footwear consumption in total domestic consumption can be explained by a) the overall decreasing consumption tread, after the age of

10 for males and 30 for the females, and b) the steady decrease in the proportion of persons younger than 30 years old in the population. A marketing strategy designed to increase the clothing and footwear consumption should targer males and primarily those in the 10-18 and 35-45 age brackets.

According to the estimated results, total household expenditure (income), household size in adult equivalents and the presence of children under 17 years old in the household have a significant and positive effect on clothing and footwear expenditure. These variables appear to have no impact on purchase frequency. Purchase frequency is positively affected by the socio-demographic variables of urbanization, marital status and education of the household head. In other words, urban households with married and educated heads purchase clothing and footwear more frequently.

These findings offer a rather uncertain picture for the future of the Greek clothing and footwear industry. Household income is anticipated to grow but household sizes are expected to decline and the same holds for the proportion of young people in the population. It is quite uncertain whether household income increases will compensate for reduced household sizes and an aging population. On the other hand, the frequency of purchase, which is important for the planning of the industry organization, shows signs of stabilization given that urbanization is leveling off, the number of single person households is on the rise and a greater proportion of population acquires higher level of education.

Notes

1. The Vuong test statistic is: $\Lambda = n^{-1/2}.\omega^{-1}.\sum_{h=1}^{n} log \frac{L(participation)}{L(\inf requency)}$ where, the variance of the difference between the two likelihood functions is given by:

$$\omega^2 \equiv \frac{1}{n}\sum_{h=1}^{n}\left[log\ \frac{L(participation)}{L(\inf requency)}\right]^2 - \left[\frac{1}{n}\sum_{h=1}^{n} log\ \frac{L(participation)}{L(\inf requency)}\right]^2$$

If $\Lambda > C_{a/2}$, where $C_{a/2}$ is the critical value of the standard normal distribution, then the "IHS double hurdle participation" model is preferred to the "IHS infrequency of purchase" model, whereas if $\Lambda < -C_{a/2}$, the reverse holds. When $|\Lambda| \leq C_{a/2}$, then there is no difference between the two models.

2. The values of the log-likelihood functions of the IHS double hurdle participation model, IHS infrequency of purchase model and IHS Tobit model are -4371, -4293 and -4381 respectively. Thus, the value of the Vuong test statistic is - 2.17, which is minor than the relevant critical value of -1.96, indicating that the appropriate non-nested model is the IHS

infrequency of purchase model. The comparison between this model and the simple IHS Tobit is carried out using a likelihood ratio test. The value of the test statistic is 176 while the critical value of the χ distribution with 33 degrees of freedom is 47.4. Therefore, the null hypothesis that there is no difference between the two nested models is rejected by the data.

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