1986

Orange Juice Coupon Redemption

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Citrus juices, Frozen

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AAEA paper, 1986

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Abstract

The Poisson regression model was used to estimate the relationship between the number of times a household uses orange juice coupons annually and selected household variables -- education, employment, family composition, race, and income. The estimated model reflects the consumption - leisure choice involved with using coupons and preferences for shopping frequency.

Orange Juice Coupon Redemption

In recent years, product promotion and advertising related to coupons has grown dramatically. For example, coupons distributed by manufacturers rose from 16 billion in 1970 to slightly over 100 billion in 1981 (A. C. Nielsen Co.). For marketing a product, coupons have several attractive features. Through coupons, price reductions can be offered directly to the consumer without having to rely on intermediaries to pass the savings along. Furthermore, the basic price does not have to be changed, since the concession is only for a temporary period. Coupons also can be directed to specific areas where a problem exists. The ultimate impact on consumption can be significant as shown by Ward and Davis, and Lee and Brown.

Coupon programs are initially implemented by dropping or mass distributing coupons via a number of alternative media. Once the distribution is made, consumers redeem the coupons over the life of the program. The redemption process is the focus of attention in this study. In an earlier study, Davis examined the relationship between coupon redemption and program variables (total number of coupons distributed, distribution media, coupon value, and time since the initial distribution). In this study, coupon redemption for orange juice is examined with respect to specific household characteristics, some of which are hypothesized to be related to the leisure/work trade-off involved in using coupons. The redemption process was indirectly examined in a recent study by Lee and Brown. They studied the impact of coupons on frozen concentrated orange juice consumption using a switching regression model with separate consumption equations

for coupon users and nonusers and a decision equation that indicated the probability coupons are redeemed.

The paper is organized as follows. First, theoretical considerations related to coupon redemption are discussed. Then the statistical model used to study the redemption process is presented. Next, the data used in the analysis are described. The results are then discussed and, finally, a summary is provided.

Theoretical Considerations

In this study, the redemption of coupons for orange juice is studied. The extent to which such coupons are used by a household depends largely on the benefits and costs associated with using coupons. Coupons for orange juice enable the household to purchase the product at a reduced price. On the other hand, the usage of coupons generally involves searching for them in newspapers, magazines, and on or in product packages (occasionally coupons are simply sent in the mail); cutting them out, saving them, and finally presenting them at grocery stores.

The simple neoclassical model of labor supply (Deaton and Muellbauer, pp. 86-96, 273-281) sheds light on the issue. Adapting this model to explain coupon redemption, a household chooses a utility maximizing leisure-consumption bundle subject to an income constraint that allows leisure to be changed into coupon related income by searching for and collecting coupons. The bundle chosen depends on the household's preferences for leisure and consumption as well as the household's ability to change leisure time into coupon related dollars. The selection of a given leisure-consumption bundle implies

the collection of a given amount of coupons which in turn implies a given number of shopping trips in which coupons are used. Hence, the leisure-consumption choice impacts on the number of times coupons are used. In addition, other factors not explicitly included in this simple model such as preferences for shopping frequency are likely to have an impact on the number of times coupons are used.

In this study, the extent to which coupons are used by a household is measured by n -- the number of shopping occasions in a year that coupons are used to purchase orange juice. The number n is hypothesized to depend on specific household variables -- education, employment status, age of female head, presence of a male head, race, and income -- which are believed to indicate the costs/benefits associated with coupon usage. The number of times coupons are used will also depend on the household's shopping habits with regard to trip frequency and quantity purchased per trip. However, these latter variables are also probably dependent on the previously stated specific household variables so that the explanatory variables in the reduced form equation for n are just the specific household variables mentioned (the price of orange juice and other goods may also be factors but were treated as constant for the given cross section of households studied).

Statistical Model

The equation analyzed in this study is

(1) $n_h = n\ (z_h)$

where n_h is the number of shopping occasions in the year (July 1984 through June 1985) in which household h used orange juice coupons and

z_h is a vector of explanatory variables for the household (the variables are explicitly defined in the data section).

The number n in equation (1) is a discrete variable that can only take values of 0,1,2, . . . ; it can not take negative or fractional values. As such equation (1) is not consistent with the ordinary least squares (OLS) regression model where the expected value of the dependent variable is a linear combination of the explanatory variables and can take negative and fractional values for specific explanatory variable values. A more consistent model for equation (1) would be the Poisson regression model (Jorgenson; Frome et al.; Maddala; Hausman et al.; Marlow et al.; and Terza).

Consider then n_h to be a Poisson random variable with probability

$$(2) \quad \text{Prob}\,(n_h) = \exp(-\lambda_h)\frac{\lambda h^{n_h}}{n_h!}$$

where $\lambda_h = \exp\,(z_h\beta)$, z_h is the previously stated vector of exogeneous variables with dimension 1 x k and β is a k x 1 vector of parameters to be estimated. The expected value of n_h in equation (2) is λ_h. The exponential specification for λ_h ensures $\lambda_h > 0$.

The likelihood function for equation (2) is

$$(3) \quad L = \prod_h \exp\,(-\lambda_h)\,\frac{\lambda h^{n_h}}{n_h!}$$

and maximum likelihood estimates of β can be found by the Newton-Raphson method (Maddala). This estimation technique was employed in the present study.

Data and Variables

Panel data provided by NPD Research, Inc., for 567 households residing in the Northeast (New England, New York, and the Middle Atlantic region) for July 1984 through June 1985 are used in the analysis.

The variables employed in the analysis are defined in Table 1. Descriptive statistics for these variables are as shown in Table 2.

Results

The maximum likelihood estimates of the parameters for the Poisson model are shown in Table 3 (the Newton-Raphson method converged after 9 iterations).

The parameter estimates in Table 3 indicate how the selected household variables z affect the expected value of the number of times coupons are used E(n): $E(n) = \exp(z\beta)$ and $\partial E(n)/\partial z_k = \beta_k \exp(z\beta)$. The signs of the parameter estimates therefore indicate the directions of the effects. Based on the asymptotic t - statistics, all the parameter estimates are significant at most reasonable levels of significance except possibly the estimates for the female age and male head dummy variables.

The signs on the parameter estimates are largely in agreement with expectations. Other factors constant, the expected number of times coupons are used E(n) is greater for households with more educated female heads, perhaps indicating greater exposure to coupons as a result of more extensive reading and a recognition of their

Table 1. Definitions of variables used in this study.

Variable	Name	Definition
n	Coupon Usage	The number of shopping occasions in the year (July 1984 through June 1985) in which coupons for orange juice were used by the household.
z_1	Female Education	Education level of the female head: z_1 = 1 if the level is greater than the high school level, 0 otherwise.
z_2	Female Unemployment	Employment status of the female head: z_2 = 1 if unemployed, 0 otherwise.
z_3	Female Age	Age of the female head: z_3 = 1 if the age is equal or greater than 45, 0 otherwise.
z_4	Male Head	Presence of a male head: z_4 = 1 if no Male head, 0 otherwise.
z_5	Race	Race: z_5 = 1 black, 0 otherwise.
z_6	Income	Household income in thousands of dollars.
z_7	Income Squared	The square of z_6: z_6^2

Table 2. Descriptive Statistics[a]

Variable	Mean	Standard Deviation	Range
Coupon Uasge (n)	5.219	7.208	0-52
Female Education (z_1)	.462	.499	0-1
Female Unemployment (z_2)	.591	.492	0-1
Female Age (z_3)	.549	.498	0-1
Male Head (z_4)	.095	.294	0-1
Race (z_5)	.039	.193	0-1
Income (z_6)	26.632	13.617	6.5-65

[a]Sample Size was 567.

cummulative value. E(n) is also greater for households with unemployed female heads. This may indicate that unemployed female heads have more time to spend obtaining and using coupons or alternatively working female heads value their leisure time too greatly to give it up to search for coupons. Households with female heads equal or older than 45 tend to use coupons more often, although the result is not highly significant. Still the result may possibly indicate a learning and experience effect related to age or a preference for convenience by younger household heads. The absence of a male head has a negative impact on E(n). Perhaps the absence of a male head places a greater demand on the female's time to perform various household duties. To the extent the latter is true, less time is available for coupon related activities. The E(n) is smaller for black households perhaps indicating lifestyle preferences. The income effect is positive at low income levels and decreases as the income level increases, becoming negative at income levels greater than $34,000. Perhaps higher income households have a greater preference for convenience and are less willing to forego the leisure time required for coupon activities.

The above interpretations related to the estimated parameters, however, must be qualified by the possibility that the estimated parameters may also reflect preferences for shopping frequency. The present model is in reduced form and such preference effects can not be distinguished.

Table 3. OLS and Poisson Parameter Estimates for the Relationship Between Household Coupon Usage (n) and Selected Household Variables.[1,2]

Variable	OLS		Poisson	
Intercept	.814	(4.434)	.426	(4.087)
Female Education (z_1)	.166	(2.136)	.284	(7.084)
Female Unemployment (z_2)	.220	(2.873)	.276	(6.786)
Female Age (z_3)	.118	(1.618)	.157	(4.076)
Male Head (z_4)	.088	(.702)	-.090	(-1.232)
Race (z_5)	-.004	(-.020)	-.218	(-1.946)
Income (z_6)	.028	(2.614)	.061	(9.894)
Income Squared (z_7)	-.0004	(-2.342)	-.001	(-9.428)
Dummy (n_h=0)	-1.474	(-18.607)		
Coefficient of Determination	.41			

[1]Sample size is 567 households residing in the Northest (New England, New York and the Middle Atlantic region) for July 1984 through June 1985.

[2]T-Statistics are given in parentheses.

[3]For the OLS estimates, the dependent variable is the $\log(n_h)$, where $\log(n_h)$ is set to zero and a dummy variable is used when $n_h = 0$.

Summary

The Poisson regression model was used to estimate the relationship between the number of times a household uses orange juice coupons in a year and selected household variables. The results indicate that the female head's education, employment status, and age positively affect coupon usage, while the absence of a male head and race (black = 1) negatively affect usage. Income positively affects usage at low income levels and negatively affects usage at high income levels. These results may reflect the consumption - leisure choice and inconvenience in using coupons. The estimated parameters may also indicate to some extent preferences for shopping frequency.

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