The Effects of Household Characteristics on Demand for Insurance: A Tobit Analysis
Author(s): Vince E. Showers and Joyce A. Shotick
Source: *The Journal of Risk and Insurance*, Vol. 61, No. 3 (Sep., 1994), pp. 492-502
Published by: American Risk and Insurance Association
Stable URL: http://www.jstor.org/stable/253572

© The Journal of Risk and Insurance, 1994 Vol. 61, No. 3, 492-502

The Effects of Household Characteristics on Demand for Insurance: A Tobit Analysis

Vince E. Showers
Joyce A. Shotick

ABSTRACT

Tobit analysis is used to analyze the impact of household characteristics on demand for total insurance. This approach examines the marginal change in demand for insurance, as well as the change in the probability of purchasing insurance. Demand effects are dominated by the marginal impacts from existing purchasers of insurance. Although income and number of earners are both positively related to the demand for insurance, the marginal effect from an increase in income is greater for single-earner households than for multi-earner households. Also, as either family size or age increases, the marginal increase in insurance expenditure diminishes.

Introduction

The purchase of a comprehensive insurance package is a complex process. Consumers evaluate their financial needs in order to select various types of insurance. Emerging issues in the area of insurance suggest the need for examining the demand for total insurance. For some, life or health insurance premiums may be subsidized by an employer. Some states have made vehicle insurance mandatory. Also, rising health care costs have brought about higher health insurance premiums, as well as proposals for a national health care system. These and other issues make choosing a total insurance package a perplexing process for consumers. In examining total insurance needs, insurers and government policy-makers can better understand the limitations or opportunities involved in fulfilling the overall risk-reducing needs of a household. Thus, understanding the household's behavior concerning the desired amounts of various types of insurance can play an important role in anticipating both private and public insurance demands.

Vince E. Showers is Assistant Professor of Finance and Quantitative Methods at Bradley University. Joyce A. Shotick is an Instructor at Bradley University and is a Ph.D. candidate in Family and Consumption Economics at the University of Illinois.

The authors thank the University of Illinois for access to data used in this study, and acknowledge the helpful comments of the editor and two anonymous referees.

This article augments the empirical literature on insurance demand by examining the impacts of selected economic and social factors on the purchase of insurance. To account for the fact that not every household purchases insurance, a Tobit procedure is used to estimate marginal impacts on purchasers, as well as the changes in the probability of purchasing insurance.

Insurance Consumption Behavior

Babbel (1985) found that new purchases of whole life insurance are inversely related to changes in a real price index. Mossin (1968) showed that a risk-averse utility maximizer will obtain something less than full insurance coverage if the insurance premium is actuarially unfavorable. Briys and Loubergé (1985), however, reconciled apparent empirical contradictions to Mossin's price sensitivity theory by suggesting that consumers often purchase insurance without being fully informed. Additional studies found that income, net worth (Hammond, Houston, and Melander, 1967), and working wives (Duker, 1969) influence expenditures on insurance.

In finance theory, consumers diversify assets as a means of spreading risk. Demand for insurance arises from incomplete diversification. Under utility maximization, portfolio theory suggests that consumers evaluate several factors simultaneously in their insurance purchasing decision. Doherty (1984) showed that efficient levels of insurance increase with the level of insurable risk and with the weight of the asset in the portfolio. Mayers and Smith (1983) demonstrated that the demand for insurance contracts is determined simultaneously with the demand for other assets in the portfolio. Consumers' expected utility from various assets motivates them to diversify.

Ehrlich and Becker (1972) showed that traditional economic consumer behavior theory can be combined with expected utility within the context of the "state preference" approach to behavior under uncertainty. Although market insurance redistributes income toward the less well-endowed states, the consumer's need for insurance is no different from the consumer's need for any other good or service. They show that the equimarginal principle of consumer behavior is applicable to the purchase of insurance. These consumption behavior studies motivate the development of the total insurance demand model used for this study.

Methodology

Mayers and Smith (1983) presented a version of the classical economic utility model in which utility is a function of end-of-period wealth (W) and variance of end-of-period wealth ($\sigma^2 W$):

$$U_{I,i} = U_i \left(W_i, \sigma^2 W_i\right). \tag{1}$$

Wealth for individual i is defined as a linear composite of all marketable assets (MA), all nonmarketable assets (NA), debt (D), and a vector of different payouts for the insured events (ϕI):

$$W_i = MA_i + NA_i - rD_i + \Sigma\phi_{ij}I_{ij}, \quad (2)$$

where r = one plus the one-period riskless rate of return,
ϕ_{ij} = individual i's proportion of total coverage for event j's losses, and
I = the total potential coverage if event j occurs.

Mayers and Smith's model provides a demand equation for each type of insurance policy, in terms of the proportion of coverage desired (ϕ_j). The model presented here deviates from the Mayers and Smith model in that the insurance coverage vector (ϕI) is summed to form a single variable, total insurance coverage, R.[1] Allowing coverage to represent demand for insurance, one can examine the consumer's desire to minimize risk from all insurable hazards. The household or individual's wealth-based utility function is also altered to include household characteristics. This modified utility function (U_2) for individual i becomes

$$U_{2,i} = U_i\ (W'_i,\ H_i), \quad (3)$$

where H is a vector of household characteristics, and W' is that portion of wealth, as well as the variance in wealth, not attributed to insurance coverage and H. Utility is then maximized subject to the household's income constraint:

$$B_i = p_{Ri}R_i + p_{xi}x_i - d_i, \quad (4)$$

where p_R = the average price of insurance for every dollar of overall demand or coverage (R),
x = a vector of all other market goods,
p_x = a vector of their respective unit prices, and
d = net debt.

The resulting demand function for total insurance (ignoring the household subscript) is, then,

$$R = R(p_R,\ p_x,\ d,\ H). \quad (5)$$

Although service quality and brand or company loyalty may have some effect on price, it is assumed that the insurance industry is highly competitive. Also, the consumer is assumed to be consistent in determining his or her risk premium. The amount of total insurance demanded, then, is represented by the magnitude of the sum of insurance premiums for all types of insurance. The greater the aggregated premium payment, the greater the overall demand, R. This model examines the effects of household characteristics on insurance demand, holding constant debt, the overall unit price of insurance coverage, the price and quantity of all other goods, and the variance in wealth (unexplained by H).

[1] R should not be confused with full insurance coverage. Full coverage occurs only if all ϕ_js for a household equal one.

Household characteristics are commonly used indicators of demand (Magrabi, Chung, Cha, and Yang, 1991). Here, the specific characteristics hypothesized to be related to total insurance demand are household or family size, age, number employed, and income.[2] The total insurance demand model then becomes

$$\text{INS} = d(\text{INC, AGE, FSZ, NUM}, \varepsilon), \tag{6}$$

where INS = actual expenditure on premiums for insurance ,
INC = measure of household income,
AGE = age of head of household (survey respondent),
FSZ = size of the family, and
NUM = number of earners in the household.

The coefficients and residual, ε, for equation (6) are estimated as a Tobit model since INS is truncated at zero. This maximum likelihood estimation procedure yields consistent and asymptotically efficient results (Tobin, 1958, and Amemiya, 1973).

Model Variables

For this study, a household's demand for total insurance, INS, is represented by the sum of its premiums for health, life, auto, and homeowners insurance. The majority of a household's total cash outlay on insurance is attributed to these four types. Also, under the permanent income hypothesis (Friedman, 1957), the total family income variable, INC, is represented by total expenditures incurred by the household less INS. Assuming all four types of insurance are normal goods, this measure of income is expected to have a positive effect on total insurance demand.

The proportion of married women in the labor force has doubled over the past 30 years (U.S. Bureau of the Census, 1991). Duker (1969) found the wife's employment to be inversely related to life insurance consumption. This phenomenon was attributed to the perception that the wife's income was transitory. Today, most households would consider the woman's wages to be a permanent income source. Also, on average, multiearner households will obtain additional and/or higher valued vehicles and live in higher valued homes. Thus, a positive relationship between number of earners and total insurance demand is expected.

Another issue is how the number of earners interacts with income to influence demand. To examine this potential relationship, an interaction term, INC*NUM, is included. Multiearner households may perceive less risk of income loss than single-earner households, even at the same income level. If so, the interaction term's coefficient will be negative.

Past research has found that family size is positively related to expenditures on a specific type of insurance (Hammond, Houston, and Melander, 1967).

[2] Family and household are used interchangeably here because nearly 95 percent of all U.S. households were family units in 1987 (U.S. Bureau of the Census, 1987).

Here, family size is also hypothesized to have a positive relationship with total insurance demand. Research, however, has also demonstrated that economies of scale exist for families with many members (Lazear and Michael, 1988), implying that, as family size increases, demand for insurance would increase, but at a decreasing rate. To test this hypothesis, a quadratic term, FSZSQ, is included.

Finally, the age of the survey respondent is used as a proxy for the general "stage" of the family unit. As a family matures, income level and number of dependents generally rise. As a result, households are likely to increase their demand for insurance. In the later years, however, demand for insurance may diminish when the household faces both a decline in number of dependents and a relative increase in the amount of liquid assets. A curvilinear relationship between the demand for life insurance and age was suggested by Duker (1969). To test for this relationship on total insurance, a quadratic term, AGESQ, is also included in the model.

Empirical Analysis

The data used for this study were obtained from the interview portion of the 1987 Consumer Expenditure Survey (CES) (U.S. Department of Labor, 1987). The CES is the most comprehensive national survey on consumer expenditures (Garner, 1988). The sample used for the Tobit model included households who responded in all four of CES's quarterly surveys during 1987. This included 1,723 households who reported either some or no insurance expenditures for that time period. Selected data used in this study were found to be similar to that reported by the U.S. Bureau of the Census (1989) for 1987.

The model developed here is not meant to encompass all insurance needs or all strategies for reducing risk. Data on risk reducing instruments such as disability insurance, annuities, and employer subsidized insurance were unobtainable. Households will generally be less responsive, for example, when employee benefits include some insurance coverage. This omission of actual insurance expenditures may bias individual coefficients and expected values downward. The model examined here, then, must be recognized as measuring only out-of-pocket expenditures in exchange for some degree of shelter from financial loss of life, health, home, or vehicle.

Results

Correcting for the existence of heteroscedasticity, a model using the square root of the dependent variable, total insurance demand, provided the best fit. Results of the transformed Tobit model are provided in Table 1. All coefficients are significant at $\alpha = 0.01$ and have signs as expected. Parameter estimates in Table 1 represent the change in the desired (i.e., potential or latent) square root of insurance expenditures.

Table 1
Maximum Likelihood Estimation Results of the
Total Insurance Demand Tobit Model

			Averages	
Variable	*Coefficient*	*T-value*	*Purchasers and Nonpurchasers (n = 1723)*	*Purchasers Only (n = 1335)*
NUM	4.70760	7.895*	1.4	1.5
INC*NUM	-0.00037	-5.502*	---	---
AGE	0.58293	5.105*	45.9	47.1
AGESQ	-0.00379	-3.304*	---	---
FSZ	3.29370	4.833*	2.6	2.7
FSZSQ	-0.39265	-4.348*	---	---
INC	0.00135	9.641*	5928.3	6534.1
Intercept	-1.70820			
INS			335.1	432.5

R^2 of observed and expected values = 0.2191
Log-Likelihood Function = -5582.5063

Note: Dependent variable = square root of INS, actual quarterly expenditure on insurance premiums. The square root is used to correct for heteroscedasticity. NUM = number of earners in the household, INC*NUM = an interaction term to determine how the number of earners interacts with income to influence demand for insurance, AGE = age of the head of household (survey respondent), AGESQ = a quadratic term to test the relationship between age and demand for insurance, FSZ = size of the family, FSZSQ = a quadratic term to test the relationship between family size and demand for insurance, INC = quarterly household income.
* Significant at 0.01 level.

Table 2 provides estimates for the marginal effects (partial derivatives) on insurance expenditures when considering only purchasers of insurance ($\delta INS/\delta X_j$), as well as the marginal effects on the probability of purchasing insurance (i.e., $\delta F[z]/\delta X_j$). This decomposition procedure of the original coefficients follows the methods described by McDonald and Moffit (1980) and Maddala (1983). The predicted value of total quarterly insurance expenditures at the mean values of the explanatory variables for current purchasers is \$319.04. Also, there is an estimated 90.26 percent likelihood that a household will reduce risk through the purchase of some type of insurance. Further decomposition found that 71.64 percent of the total effect on insurance expenditures is due to marginal changes in existing expenditures, while the remainder is attributed to changes in the probability of purchasing insurance.

When examining marginal changes of actual purchasers of insurance, it appears that an increase in income may create pressure on the family to purchase additional insurance. That is, financial security for families with greater income may warrant additional protection. In terms of life and health insurance for example, with greater income, the family perceives a greater loss if the income-earner becomes ill or dies. In terms of vehicle and house insurance, one might expect households with higher incomes to insure higher valued vehicles and homes. The increase in the demand for insurance associated with the increase in income, therefore, offsets the potential loss and helps maintain the household's increased level of consumption.

Table 2
Partial Derivatives and Elasticity Estimates
for Total Insurance Demand for Insurance Purchasers Only

Variable	$\delta INS/\delta X_j^a$	*Elasticity*[b]	$\delta F(z)/\delta X_j^c$
NUM	55.2307	0.2308	0.08538
AGE	5.2189	0.7152	0.00807
FSZ	28.5807	0.2184	0.04418
INC	0.0183	0.3244	0.00003
E(INS | INS>0) = 319.04		E(F[z]) = 0.90264	

Note: NUM = number of earners in the household, AGE = age of the head of household (survey respondent), FSZ = size of the family, INC = quarterly household income, and INS = actual quarterly expenditure on insurance premiums.
[a] To account for the interaction and quadratic terms, partial derivatives are provided at appropriate mean values.
[b] Elasticities estimated at mean values of INS and X_j.
[c] Represents a change in the probability of purchasing insurance for a unit change in X_j.

Examining insurance purchasers only, the income elasticity finding for total insurance is relatively low, 0.3244 (Table 2). Hammond, Houston, and Melander (1967) found income elasticity for life insurance alone to be 0.83. As shown in Table 3, even when the effects on nonpurchasers and purchasers are combined, income elasticity is still relatively low at 0.4088. This involves the overall effect due to both marginal changes from current purchasers and changes in the probability of purchasing insurance. In addition, the income elasticity estimate for latent demand (i.e., desired or potential expenditures) is 0.4529. One would expect a more inelastic relationship for total insurance since health, vehicle, and even home insurance are likely to be less responsive than life insurance to income.

The emergence of multiearner households may also explain the inelastic demand with respect to income. The negative sign of the interaction term for income and number of earners (INC*NUM) suggests that the marginal utility from each additional dollar spent on insurance is lower for multiearner households, *ceteris paribus*. In examining the effect from number of earners, the income elasticity of total insurance demand for current purchasers is estimated to be 0.3476 for households with only one earner and 0.2702 for households with two earners, *ceteris paribus*. This difference is due, in part, to a greater likelihood of a single-earner household, originally without insurance, to begin purchasing some type of insurance. Households with only one income earner may feel less secure than households with two or more earners. The marginal value of the additional burden transformed to insurers, therefore, is greater for single-earner households when income rises. Aside from the perception of greater security with more than one source of income, multiearner households may also respond less to income, since multiearner households have a greater likelihood of receiving some type of employer-paid or subsidized life and health insurance.

An increase in age of the head of the household has a positive influence on a household's desire for total risk reduction. The relative effect diminishes,

Table 3
Partial Derivatives and Income Elasticities Representing
Total and Latent Effects on Demand for Insurance

Variable	*Total Effect*[a]		*Latent Effect*[b]
		$\delta INS/\delta X_j$	
NUM	69.5882		77.0944
AGE	6.5756		7.2849
FSZ	36.0104		39.8947
INC	0.0231		0.0256
		Elasticity	
INC	0.4087		0.4529
		Expected Value	
E(INS)	287.98		242.49

Note: NUM = number of earners in the household, AGE = age of the head of household (survey respondent), FSZ = size of the family, INC = quarterly household income, and INS = actual quarterly expenditure on insurance premiums.
[a] Represents the effects from both marginal changes of current purchasers of insurance, as well as the change in the probability of purchasing.
[b] Represents desired or potential changes, if all observed households were purchasers of insurance.

however, as the household matures, *ceteris paribus*. The existence of subsidized health care through Medicare and the accumulation of financial assets may substitute, in part, for an aged household's past insurance needs. Table 4 compares the effect on insurance demand from the independent variables for households whose heads were 30 years old or less with households whose heads were 60 years old or more. The marginal change in insurance expenditure from a one-unit change in either income, number of earners, or family size was substantially smaller for younger households (using the respective mean values for interaction and quadratic terms). The marginal effect from income was smaller due primarily to younger households, on average, having a greater number of earners.[3] As a result, the interaction term would weaken income's effect on insurance demand at a greater rate.

In the same manner, average family size is smaller for older households; therefore, when considering the quadratic term, the marginal effect will be greater for older households. The interpretation of the family size effect for older households perhaps should be more appropriately examined under the decreasing of family size either as children leave the home or as family members pass away. Thus, for those older households already purchasing insurance, it is estimated that, as family size decreases by one person, quarterly insurance expenditure decreases an average of $24.02.

[3] All comparative estimates presented here should be examined with caution. Confidence intervals for E(INS) lose precision as one deviates from the overall averages of the exogenous variables.

Table 4
Partial Derivatives and Averages for Younger and Older Households

	Head of Household 30 or Under		*Head of Household 60 or Over*	
Variable	$\delta INS/\delta X_j$	*Average*	$\delta INS/\delta X_j$	*Average*
NUM	22.4080	1.32	41.3386	0.61
AGE	2.9667	25.09	0.6182	70.47
FSZ	11.4878	2.26	24.0225	1.85
INC	0.0064	4633.86	0.0146	4089.30
		Elasticity		
INC	0.1713		0.1722	
		Expected Value		
E(INS)	163.31		328.25	

Note: NUM = number of earners in the household, AGE = age of the head of household (survey respondent), FSZ = size of the family, INC = quarterly household income, and INS = actual quarterly expenditure on insurance premiums.

Also, for comparative purposes, it was found from the Tobit results that, at each respective age group's average, around 73 percent of the younger households buy some insurance, while only around 58 percent of the older households buy insurance in some form. At the same time, however, the expected quarterly insurance premium per younger household is only \$119.05 for both purchasers and nonpurchasers, as compared to \$190.70 for older households. Excluding nonpurchasers, the predicted expenditures, at the means, are \$163.31 and \$328.24, respectively. Thus, while the probability of purchasing insurance may be smaller due to Medicare as a substitute, greater asset diversity, and/or less need for life insurance, older households who do purchase insurance incur substantially greater premiums due to the higher risks and potential losses borne by the insurer.

Finally, the hypothesis regarding the positive but curvilinear relationship between family size and insurance expenditure was also supported. When including all purchasers of insurance, it was found that, as household size increases by one person, on average, current purchasers of insurance will have a corresponding increase in insurance premiums of \$28.58, *ceteris paribus* (Table 2). This marginal effect diminishes as family size becomes larger.

Conclusion

As the composition of U.S. households evolves, changes in household characteristics will affect the demand for insurance. Specific changes will, in many cases, impact various types of insurance differently. Although the total insurance demand model provides insight into the overall demands on households, disaggregated demand models must also be examined in the future, as they have in the past. The significant relationships found in the total demand model, however, point to the need to examine the disaggregated demand models simultaneously. Such action would more accurately provide parameter estimates for the disaggregated demand models by accounting for two-way causalities and/or correlations among error terms. In addition, future models may be enhanced by including independent variables representing marital status, race, or location of residence.

Understanding how insurance consumers decide upon the different types of insurance is important for policy making in both the private and public sectors. With the issue of socialized insurance, governments must be aware of different effects on the types of insurance from socioeconomic factors. A better understanding of the factors that affect total insurance, as well as individual insurance demand, can provide valuable insights for both the public and private sectors concerning future insurance needs and alternatives.

References

Amemiya, Takeshi, 1973, Regression Analysis When the Dependent Variable Is Truncated Normal, *Econometrica,* 41: 997-1017.

Babbel, David F., 1985, The Price Elasticity of Demand for Whole Life Insurance, *Journal of Finance,* 40: 225-239.

Briys, Eric P. and Henri Loubergé, 1985, On the Theory of Rational Insurance Purchasing: A Note, *Journal of Finance,* 40: 577-581.

Doherty, Neil A., 1984, Portfolio Efficient Insurance Buying Strategies, *Journal of Risk and Insurance,* 51: 205-224.

Duker, Jacob M., 1969, Expenditures for Life Insurance Among Working-Wife Families, *Journal of Risk and Insurance,* 36: 525-533.

Ehrlich, I. and Gary S. Becker, 1972, Market Insurance, Self-Insurance, and Self-Protection, *Journal of Political Economy,* 80: 623-648.

Friedman, Milton, 1957, *A Theory of the Consumption Function* (Princeton, N.J.: Princeton University Press).

Garner, Thesia, 1988, Methodological Issues for Today and Tomorrow, *Family Economics Review,* 3: 2-5.

Hammond, J. D., D. B. Houston, and E. R. Melander, 1967, Determinants of Household Life Insurance Premium Expenditures: An Empirical Investigation, *Journal of Risk and Insurance,* 34: 397-408.

Lazear, E. P. and R. T. Michael, 1988, *Allocation of Income Within the Household,* (Chicago: University of Chicago Press).

Maddala, G. S., 1983, *Limited Dependent and Qualitative Variables in Econometrics,* Econometric Society Monographs No. 3 (Cambridge: Cambridge University Press,).

Magrabi, F. M., Y. S. Chung, S. S. Cha, and S. Yang, 1991, *The Economics of Household Consumption* (New York: Praeger).

Mayers, David and Clifford W. Smith, Jr., 1983, The Interdependence of Individual Portfolio Decisions and the Demand for Insurance, *Journal of Political Economy,* 91: 304-311.

McDonald, John F. and Robert A. Moffit, 1980, The Uses of Tobit Analysis, *Review of Economics and Statistics,* 62: 318-321.

Mossin, Jan, 1968, Aspects of Rational Insurance Purchasing, *Journal of Political Economy,* 76: 553-568.

Tobin, James, 1958, Estimation of Relationships for Limited Dependent Variables, *Econometrica,* 26: 24-36.
U.S. Bureau of the Census, 1987, *Advance Report* (Washington, D.C.: U.S. Government Printing Office).
U.S. Bureau of the Census, 1989, *Statistical Abstract of the United States, 1989,* 109th Edition (Washington, D.C.: U.S. Government Printing Office).
U.S. Bureau of the Census, 1991, *Statistical Abstract of the United States, 1991,* 111th Edition (Washington, D.C.: U.S. Government Printing Office).
U.S. Department of Labor, 1987, Bureau of Labor Statistics, *Consumer Expenditure Survey,* Interview Survey, 1987 (Washington, D.C.: U.S. Department of Labor).