American Journal of Applied Sciences 6 (1): 124-129, 2009
ISSN 1546-9239

A Multinomial Logit Based Evaluation of the Behavior of the Life Insureds in Romania

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Abstract: The Romanian life insurance market is in full expansion. There exists competition between insurance companies as well as between different products of the same company. In this article we describe a study using data that we collected from clients of a Romanian insurance company. We have observed two types of variables: attributes of the insurance products (e.g., profitability, risk), as well as characteristics of the individuals (e.g., sex, age, income). Using elements of economic theory and a multinomial logit model we explain the behavior of the life insureds. We estimate the variations in the market shares of life insurance products using marginal effects. The variations are due to possible changes in the values of some attributes or characteristics.

Key words: Life insurance demand, multinomial logit

INTRODUCTION

The study of the life insured's behavior has attracted the interest of a number of researchers in the past. Theoretical models on life insurance demand have been developed and empirical studies also have been conducted extensively to examine the influence of specific factors on the demand for life insurance.

This research proceeds to review the literature related to life insurance demand, to present the Romanian life insurance market, to describe the data and estimation model, to present and discuss the empirical results and to conclude with the findings of this study.

Economic theory predicts that households will save and insure in order to enjoy the same living standard over time and in the event of the death of a household head or spouse. Economic theory in this case accords with common sense and every day observation. "We save to be able to maintain our life styles in retirement. And we buy life insurance to make sure our survivors can continue to live at the same standard to which they have become accustomed"[1].

There is no unique theory for life insurance demand. Yaary[2] was the first to develop a theoretical framework to study the uncertainty of lifetime and the demand for life insurance. He predicted that investors make asset allocations decisions and life insurance purchase to maximize their lifetime utilities of wealth and consumption. Almost all of the theoretical works which study the impact of wealth and bequest motives on life insurance demand developed later have expanded their models based on the study of Yaary[2].

There are a number of empirical studies of life insurance demand that have been developed in the past. Bernheim[3] uses estimates of the demand for life insurance to assess the strength of bequest motives. He finds that a significant fraction of total saving is motivated by the desire to leave bequests. Browne and Kim[4] present evidence on life insurance demand across 45 countries. They find that the main determinants of country variations in the demand for life insurance are the dependency ratio (the number of dependents per potential life insurance consumer), income, inflation and price of insurance.

The findings of Browne and Kim[4] and Outreville[5] confirm that the income level affects significantly the life insurance demand. Life insurance becomes more affordable when income increases. Hwang and Greenford[6] examine some of the key factors affecting life insurance consumption in China, Hong Kong and Taiwan. Income and life insurance consumption are found to be strongly correlated, which is consistent with previous studies. In a comparative study, Truett and Truett[7] examine the variables affecting life insurance demand in Mexico and in U.S. The results have shown that age, education and income impact the demand for life insurance.

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Over time, the life insurance decisions and the asset allocation have been analyzed separately, both in theory and practice. However, results from Headen and Lee[8] indicate that the demand for insurance is a function of variables such as savings, consumer sentiment and conditions if the financial market. Mayers and Smith[9] do not agree that wealthier consumers demand less insurance and find that the benefits of an insurance policy are identified with the returns of other financial assets. These results imply that decisions to purchase insurance are not independent of decisions to make other investments.

The human capital is the factor that makes the linking between insurance and investments decisions, because it affects both the optimal asset allocation and the demand for life insurance - Ibbotson & all [10]. They defined the human capital as the present value of an investor's future labor income.

An investor's human capital contains a unique mortality risk, which is the loss of all future income and wages in the unfortunate event of premature death. Life insurance has been used for long time to hedge against mortality risk. The greater the value of human capital is, the more life insurance the family demands.

Younger investors have far more human capital than financial capital. This is because younger investors have more years to work and they have had few years to save and accumulate financial wealth. On the other hand, young investors tend to have more financial capital than human capital, since they have fewer years ahead to work but have accumulated financial capital over a long career.

The allocation of capital in risky asset decreases as the investor ages. This result[11] is due to the dynamic between human capital and financial wealth over time. When an investor is young, the investor's total wealth is dominated by the human capital. Since human capital in this case is less risky than the financial risky asset, young investors will invest more financial wealth into risky assets to offset the impact of human capital on the overall asset allocation. As the investor gets older, the allocation to risky assets is reduced, as human capital gets smaller.

The volume of literature on life insurance demand indicates the importance of the consumer demand for life insurance in the financial services industry. With the growing importance of insurance companies as major participants in financial markets, as well as increasing competition for investment from nontraditional institutions, this topic is likely to continue to be a popular research topic for the developed and for the developing countries.

MATERIALS AND METHODS

Our application involves clients of a Romanian insurance company, whose name will remain unrevealed, out of competition reasons. In July-August 2005, we considered a sample consisting of 203 subjects who possess insurance polices at that company. Three insurance products have been taken into consideration[12], [13]: term life insurance, endowment life insurance and unit linked insurance, which altogether represent 80% of the turnover of the company.

We mention that the application is based on a middle size sample, so the conclusions must be regarded with precaution. Our target is to realize a prospective study concerning the behavior of the insured persons.

The individuals from the sample have been questioned about two kinds of variables: attributes that characterise the insurance products and characteristics of the individual that characterise the insured person[14].

The Model: Supposing that each one of the individuals of the sample chooses only one type of life insurance, the decision of choosing the product is discreet. Consequently, the model chosen for explaining the choice of an insurance product is a discreet one, so the estimation is made using the econometrics of qualitative variables. The model is a multinomial one because the qualitative dependent variable y has more than two values, $y_i = j$, $j = 0,1,\ldots, m$, respectively. In our application, the values of y represent the insurance products.

The Multinomial Logit Model. The multinomial Logit is actually an extension of the binary Logit model, having more than two values for the dependent variable. Let $(p_0, p_1,\ldots, p_m)$ be the probabilities of m+1 alternatives of choice. The probability of an individual i to choose the alternative j is given by:

$$p_{ij} = P(y_i = j) = \frac{\exp(x_i b_j)}{1 + \sum_{j=1}^{m} \exp(x_i b_j)} \quad j = 1,2,...,m \qquad (1)$$

where, x_i is the vector of the independent variables associated to the individual i and b_j is the vector of parameters associated to the alternative j.

The Conditional Multinomial Logit Model. The generalization of the Logit model for the multinomial case is made by taking different parameters b_j depending on the alternatives of choice (products), such that the idependent variables x_i remain constants depending on the products. Still, there is another possibility: the McFadden conditional Logit model which considers a constant vector of parameters b and allows the independent variables x_{ij} to depend on the alternatives (McFadden[15],[16]). The probability of an individual i to choose the product j is given by:

$$p_{ij} = P(y_i = j) = \frac{\exp(x_{ij}b)}{\sum_{k=1}^{m}\exp(x_{ik}b)} = \frac{\exp(x_{ij}^{*}b)}{1+\sum_{k=1}^{m}\exp(x_{ik}^{*}b)} \qquad j = 1,2,...,m \tag{2}$$

where, $x_{ij}^{*} = x_{ij} - x_{i0}$ and the ratio of the probabilities is:

$$\frac{P(y_i = j)}{P(y_i = l)} = \frac{\exp(x_{ij}^{*}b)}{\exp(x_{il}^{*}b)} = \frac{\exp(x_{ij}b)}{\exp(x_{il}b)} = \exp[(x_{ij} - x_{il})b] \qquad \forall j,l = 1,2,...,m \tag{3}$$

which, as in the case of the multinomial Logit is independent of the other alternatives of choice.

When computing the marginal effects, we are interested in the estimated variation of the probability of an individual i to choose the product j, when the independent variable k associated to a product varies. We have:

$$p_{ij} = \frac{\exp\left(\sum_{k=1}^{K} x_{ijk}b_k\right)}{1+\sum_{h=1}^{m}\exp\left(\sum_{k=1}^{K} x_{ihk}b_k\right)} \tag{4}$$

the marginal effect $\frac{\partial p_{ij}}{\partial x_{ilk}}$ being:

$$\begin{cases} b_k p_{ij}(1-p_{ij}) & \text{if } j = l \\ -b_k p_{ij}(1-p_{il}) & \text{if } j \neq l \end{cases} \tag{5}$$

The General Multinomial Logit Model. Due to the fact that our application involves both attributes of the products and characteristics of the individual, we use a more general model, which contains both the multinomial and the conditional logit models[15],[17],],[18]. The probability for an individual i to choose the alternative j is given by:

$$p_{ij} = P(y_i = j) = \frac{\exp(x_{ij}b + x_i b_j)}{\sum_{k=1}^{m}\exp(x_{ik}b + x_i b_k)} \qquad j,k = 0,1,2,...,m \tag{6}$$

Once the parameters have been estimated, by replacing the values of the explicative variables with the mean values from the sample, we can obtain an estimation of the probability $\tilde{p}_j$ that a randomly chosen individual (average individual) will choose the product j. By multiplying this number by the total number of consumers N, an estimation of the demand (or of the market share) for the product j can be obtained:

$$\tilde{D}_j = \tilde{p}_j \times N \tag{7}$$

We can also obtain simulated market shares for products, computed for other values of the explicative variables, thus facilitating the foundation of some product policies.

The variables:

Profitability-values from 1 to 10
Risk-values from 1 to 10
Age-years
Sex-0 if the individual is a woman, 1 if it is a man
Income-RON/month
Term-dummy variable. Equal to 1 if the term life insurance product is chosen, 0 otherwise
Endowment-dummy variable. Equal to 1 if the endowment insurance product is chosen, 0 otherwise
Unit linked-dummy variable. Equal to 1 if the unit linked insurance product is chosen, 0 otherwise
Age_term = Age×Term
Age_endowment = Age×Endowment
Age_unit linked = Age×Unit linked
Sex_term = Sex×Term
Sex_endowment = Sex×Endowment
Sex_unit linked = Sex×Unit linked
Income_unit linked = Income× Unit linked
Income_endowment = Income×Endowment
Income_unit linked = Income×Unit linked

RESULTS AND DISCUSSION

Before estimating the parameters of the model, we present some descriptive statistics regarding the data from the sample (Table 1).

The estimation of the model: For estimating the parameters we use the econometric software LIMDEP

7.0 and the Newton-Raphson method like estimation algorithm (Table 2).

The values of the parameters are according to expectations. The positive sign for profitability shows an increased probability of choosing the product when the value of the variable increases. The negative sign for risk shows a decrease of probability. The negative signs for age_endowment and age_unit linked show that when age increases, it decreases the probability of choosing the endowment insurance and unit linked insurance products, with respect to the reference product, the term insurance. The parameter of the sex_ endowment variable is not statistically significant. The positive sign for sex_unit linked shows that it is more likely for men to choose unit linked insurances than women. The negative signs for income_endowment and income_unit linked show that when income increases, it increases the probability of choosing the endowment insurance and unit linked insurance products, with respect to the reference product, the term insurance.

Table 1: The average values of variables in the sample

	Variables				
	Profitability	Risk	Age	Sex (% of males)	Income (RON/month)
Term	4.70	5.87	59.3	34.0	807
Endowment	3.01	1.87	50.0	48.6	934
Unit linked	8.37	6.71	40.6	63.9	1109

Table 2: Parameters estimates. Discrete choice (multinomial logit) model

Variable	Coefficient	Standard dev.	t-statistic
Profitability***	0.5977	0.1421	4.206
Risk***	-1.1344	0.1809	-6.268
Age_term	0.000	Fixed parameter	-
Age_endowment***	-0.0978	0.0193	5.068
Age_unit linked***	-0.1785	0.0258	6.915
Sex_term	0.000	Fixed parameter	-
Sex_endowment	0.5516	0.5199	1.061
Sex_unit linked**	1.2394	0.6143	2.017
Income_term	0.000	Fixed parameter	-
Income_endowment**	0.0027	0.0013	2.102
Income_unit linked***	0.0084	0.0015	5.641
N = 203 R^2 = 0.485			

***: p<0.01, **: p<0.05, *:p<0.10

Table 3: Predicted probabilities

Indiv.	Term	Endowment	Unit_linked
1	0.9330*+	0.0666	0.0004
2	0.7582*+	0.1785	0.0633
3	0.1264*	0.6861+	0.1875
…	…	…	…
55	0.0441	0.1667*	0.7892+
56	0.2634	0.6446*+	0.0920
…	…	…	…
201	0.2787	0.2461	0.4751*+
202	0.0030	0.0649	0.9321*+
203	0.3869	0.4878+	0.1253*

*: Marks chosen,+: Marks prediction

Table 4: The marginal effects (%) for the variable profitability

		The marginal effect over the Product		
		Term insurance	Endowment	Unit linked
The product	Term	4.79	-3.59	-1.20
for which	Endowment	-3.59	8.92	-5.33
profitability varies	Unit linked	-1.20	-5.33	6.53

For each individual, we can compute according to the formula (6) the probability of choosing each of the three insurance products (Table 3).

A study of the estimated probabilities shows that the model is a pertinent one from the point of view of predictions, the percentage of correct predictions in the sample being 72.9%.

The applicability of the model: We may consider the case when the values of the explicative variables change. We compute the marginal effects, the percentage variations of the share markets of the products respectively, when the profitability and risk variables are increased by 1 (Table 4).

The results obtained are according to expectations: the increase of the profitability for a product determines the increase of its market share and the decrease of the market shares for the other products, but of different values. For instance, the increase of profitability for the

Table 5: The marginal effects (%) for the variable risk

		The marginal effect over the product		
		Term insurance	Endowment	Unit linked
The product	Term	-9.10	06.82	02.28
For which	Endowment	6.82	-16.93	10.11
risk varies	Unit Linked	2.28	10.11	-12.39

Table 6: Estimated market shares for the insurance products (group age: 50-60 years)

	Income (RON/month)							
	700	800	900	1000	1100	1200	1300	1400
Term	39.6	31.9	24.4	17.4	11.3	06.7	03.6	01.8
Endowment	55.4	58.7	59.0	55.1	47.1	36.5	25.7	16.7
Unit Linked	05.0	09.4	16.6	27.5	41.6	56.8	70.7	81.5

Table 7: Estimated market shares for the insurance products (income = 1.000 RON/month)

	Age								
	35	40	45	50	55	60	65	70	75
Term	01.2	02.6	05.3	09.9	17.4	27.8	40.6	54.3	66.9
Endowment	28.2	36.4	44.7	51.6	55.1	54.2	48.6	39.8	30.1
Unit Linked	70.6	61.0	50.0	38.5	27.5	18.0	10.8	5.9	03.0

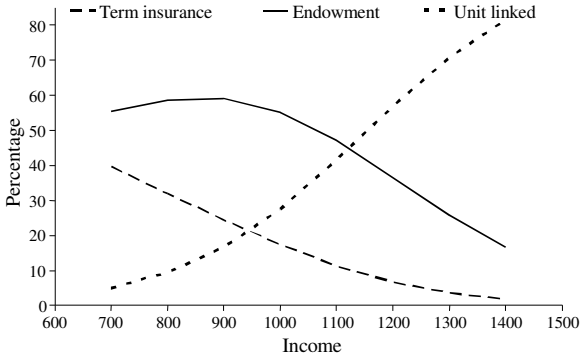

Fig. 1: The evolution of the insurance products with respect to the income (55 years old person)

term insurances will have a greater impact on the endowment insurances than on the unit linked ones (Table 5).

For the risk variable, the results are very similar, but of opposite sign: when the risk of a product increases its market share decreases and the market share for the other products increase (Table 6, Fig. 1).
The model can be also used for building some product strategies (advertising, promotion). Considering this, we estimate the markets shares of the three insurance products, for different values of the variables income and age. The variables profitability and risk keep their average values from the sample (Table 7, Fig. 2).

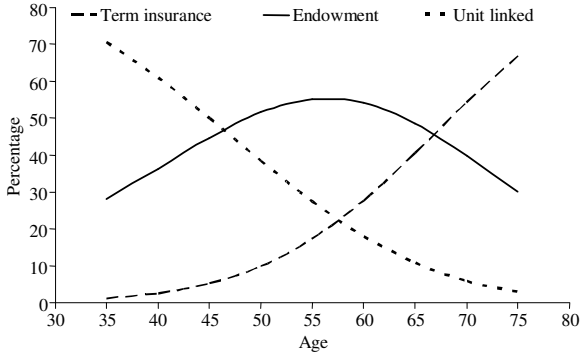

Fig. 2: The evolution of the insurance products with respect to the age (income = 1000 RON/month)

CONCLUSION

All in all, we have succeeded to explain through multinomial logit model different aspects of the behavior of the life insureds in a company from the Romanian insurance market. The results obtained in the application match perfectly to the theory presented previously. The demand for products with lower risk level increases, as a person is getting older, to the detriment of the products of higher risk level. Moreover, the income is a major factor that influences the choice of a specific insurance product: as income increases, there exists an increased affordability for the higher risk products.

The demand for each product is well predicted as well as the attributes of the products (and characteristics of the individuals) that determine the choice. The model can be used by modifying the characteristics of the life insurance products, in order to obtain among these a relation that would maximize the profit of the company. One insurance product may be more profitable than another, while the achievement of a demand structure, as profitable as possible for the company, can be determined based on the estimations of the marginal effects of the risk and of the profitability of insurance products.

This study is a prospective one; the sample is not highly significant. Although, the model can explain the behaviour of the life insured and can be a base for further studies capable to estimate more precisely the demand for different types of insurances.

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