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背景風險對家計單位風險趨避程度及保險需求之影響

Degree of Risk Aversion and Demand for Insurance of Households in the Presence of Background Risk

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本論文係林豐騰君（學號 D92723014）在國立臺灣大學財務金融學系、所完成之博士學位論文，於民國九十八年六月二十三日承下列考試委員審查通過及口試及格，特此證明

口試委員：田峻吉
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系主任、所長 陳明賢

誌謝

能完成博士論文首先必須感謝曾郁仁教授的指導，不論是課堂上的授業亦或是研究上的討論及解惑，曾老師都給予了我完成本論文最寶貴的意見跟知識;此外必須感謝石百達教授、王仁宏教授、黃瑞卿教授及田峻吉教授的審查意見，讓論文能修改得更加的完整。在台大財金六年的博士生涯中，不乏許多人的扶持與幫助，包括所有老師們以及珮琪助教、玉珠助教及鍾小姐等幫助過我的人，在此也要一併感謝。在取得五十六個畢業要求學分的過程，要感謝岳賢、建志、志忠、育展、鴻崑、正皇及仁和等同學及其他學長學弟們在修業過程中的幫忙，在準備三個艱難資格考的歲月裡，要不是一起奮鬥的戰友們的互相支持與勉勵，我一定無法堅持到最後並能順利過關，在最後論文口試階段，要感謝嘉威、彥行、懿宸、柏欣及宏瑋等優秀的學弟還有胡羚學姊的協助與資訊提供，未來在學術這條路上，先在此與你們相約，我們一同努力一同成長。另外，當然要感謝父母這一路來的鼓勵，終於不用讓你們擔心了。最後要將論文獻給一路與我攜手共進的摯愛，欣穎，我（們）終於取得博士學位了！

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中文摘要

本論文分為兩部分，第一篇研究利用 Halek and Eisenhauer (2001)之研究中所提出利用壽險資料推導出 Arrow-Pratt 風險趨避之縮減式，並以台灣家庭收支調查資料為樣本，實證估計家計單位的風險趨避係數（包括絕對風險趨避係數及相對風險趨避係數），估計結果與 Halek and Eisenhauer (2001)之估計類似，相對風險趨避係數分配為右偏，多數集中在 0 至 4 之間。研究進一步探討背景風險是否為影響風險趨避程度高低之因素，背景風險定義為獨立於其他風險之不可投保風險，所得風險是最常用來代理背景風險的變數，本研究以所得變異係數來代表家計單位無法透過保險或其他避險方法來控制的背景風險，迴歸模型並加入了其他解釋變數包括家庭所得及資產等財富變數、戶長及家庭特性等社會變數及其他地理變數。主要實證結果顯示所得風險愈高其風險趨避程度亦愈高，表示樣本家計單位偏好符合 Pratt and Zeckhauser (1987)之適當風險趨避(proper risk aversion)， Kimball (1993)之標準風險趨避(standard risk aversion)，和 Gollier and Pratt (1996)之風險脆弱性(risk vulnerability)等理論之充分條件及必要條件。

第二篇研究主要探討家計單位保險（包括人壽醫療險及產物保險）之購買決策、消費比例及支出金額是否受到背景風險（以所得變異係數及標準差及減薪廠商比例等所得風險變數作為代理變數)之影響，並實證估計各種保險之所得彈性。利用不同之迴歸模型（包括 Logistic、Tobit 及 OLS 等方法）並控制相關解釋變數包括財富變數及其他社會及地理變數後，實證結果顯示所得風險會正向影響家計單位的保險需求，面對愈高所得風險的家庭會有較高機率購買保險以及傾向購買較多保險，此結果與 Guiso and Jappelli (1998)和 Koeniger (2004)分別針對責任險及汽車險所做之實證分析結果相同，亦與 Eeckhoudt and Kimball (1992)和 Schlesinger (1999)推導出之理論模型一致，家計單位偏好符合 Pratt and Zeckhauser (1987)、Kimball (1993)和 Gollier and Pratt (1996)之條件。研究並估計保險之所得彈性，實證結果顯示所得彈性為正，表示保險購買支出會隨著所得提高而增加，代表保險屬於正常財，此結論與其他相關保險實證研究結果一致。

關鍵字：風險趨避，背景風險，所得風險，保險需求，所得彈性

Degree of Risk Aversion and Demand for Insurance of Households in the Presence of Background Risk

Abstract

Essay 1 of this study uses life insurance expenditure data of Survey of Family Income and Expenditure (SFIE) in Taiwan to estimate the Arrow-Pratt risk aversion coefficient of households empirically by using the reduced form equation derived by Halek and Eisenhauer (2001). This study provides empirical evidence on the nature of the relationship between the risk aversion and background risk which is not under the control of the agent, and that is independent of endogenous risks. Using the coefficient variation of household income as the proxy for background risk, after controlling other factors including household income and wealth, the characteristics of the head of household and other demographic variables, the results suggest that households which are more likely to face higher income risk exhibit a greater coefficient of risk aversion. This finding is consistent with consumer preferences being characterized by proper risk aversion (Pratt and Zeckhauser, 1987), standard risk aversion (Kimball, 1993) and risk vulnerability (Gollier and Pratt, 1996) which are the necessary and sufficient conditions of the optimal risk-taking behavior in the presence of background risk.

Essay 2 of this study investigates how background risk affects households' insurance purchasing decision, expenditure share and amounts of insurance by using data of Survey of Family Income and Expenditure (SFIE) in Taiwan. Using the income risk as the proxy for background risk and controlling other wealth and demographic factors, the findings suggest that insurance expenditure is positively affected by uninsurable background risk. This results suggest that consumer with more income risk is more risk averse and leads a higher demand of insurance. This finding is similar to the empirical results of Guiso and Jappelli (1998) and Koeniger (2004) and is consistent with the theory models derived by Eeckhoudt and Kimball (1992) and Schlesinger (1999). This finding is also consistent with consumer preferences being characterized by proper risk aversion, standard risk aversion and risk vulnerability. This study also finds that the coefficient income elasticity of insurance is positive that means people tend to increase insurance expenditure with respect to an increase in income. This result is consistent with most empirical studies of insurance demand that suggest that a consumer's income change has positive effect on the consumer's demand for insurance and suggest that insurance is a normal good.

Keywords: Risk aversion; Background risk; Income risk; Demand for insurance; Income elasticity.

Essay I. The Relationship between Degree of Risk Aversion and Background Risk

1. Introduction

Individuals' preferences influence a wide variety of risk-taking behavior. The concept of risk aversion is important in understanding individual behavior as well as many other theoretical issues in finance and economics. There are many theoretical studies[1] based on whether relative risk aversion is greater than, less than, or equal to unity or whether the proportion of risky assets held increases, decreases, or remains constant as wealth increases. Empirical support for this issue can be found in the study of Friend and Blume (1975)[2]. Other researchers have focused on gender differences in risk aversion, such as Levin et al. (1988), who found that women are more risk averse, and Riley and Chow (1992), who found risk aversion to be lower among males and whites compared to females and nonwhites, respectively. Riley and Chow (1992) also found risk aversion to decrease with wealth, education, and age (until age 65, at which time risk aversion increases). Zuckerman (1994) found empirical support for risk aversion using a psychological questionnaire, with results indicating that there are significant differences according to age, gender, nationality, race, socioeconomic status, birth order, and marital status. Barsky et al. (1997) calculated the upper and lower bounds on RRA (relative risk aversion) and found differences in risk aversion according to age, gender, race, religion, nationality, and smoking and drinking behaviors. Jianakoplos and Bernasek (1998) examined household holdings of risky assets to determine whether there are gender differences in financial risk-taking using sample data from the U.S. and found that women are more risk averse in financial decision-making than men. To explore risk aversion, Halek and

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[1] For example, Phelps (1962), Levhari and Srinivasan (1969), Hahn (1970), Sandmo (1970), Stiglitz (1970), Rothschild and Stiglitz (1971), and Mirman (1971), Lucas (1972), Maitel (1973), Azariadis (1978), Grossman (1981), Eaton (1981) and Newbery and Stiglitz (1982).

[2] Among others, Farber (1978), Morin and Suarez (1983), Mehra and Prescott (1985), Bellante and Saba (1986), Siegel and Hoban (1982, 1991), Mankiw and Zeldes (1991), Choi and Menezes (1992), P°alsson (1996), Blake (1996), Kocherlakota (1996), Campbell (1996), Safra, Z. and U. Segal (1998), Brav et al. (2002), Szpiro (1983, 1986), Kaplow (2005) and Chetty (2006).

Eisenhauer (1999, 2001) derived a reduced form equation and used life insurance data to estimate the coefficient of risk aversion and examined the relationship between relative risk aversion and demographic groups based on age, gender, education, nationality, race, marital and parental status, religion, health and behavioral indicators, and employment status, income, and wealth.

In real life, people make choices under risk and uncertainty almost in the background of other risks. Many theoretical studies have contributed sufficient and/or necessary conditions for the risk-taking behaviors of individuals after an increase in background risk in the past several decades. The usual definition of risk aversion developed by Arrow (1965, 1971) and Pratt (1964) is based on the assumption that initial wealth is nonrandom. Pratt (1964) also showed that the decreasing absolute risk aversion (DARA) of an individual's von Neumann-Morgenstern utility function yields this natural result, and Levy (1994) has provided evidence that DARA is indeed strongly supported experimentally. Using the results of Ross (1981) and Kihlstrom, Romer, and Williams (1981), the estimation of risk aversion can be easily generalized to the case of introducing background risk. Pratt and Zeckhauser (1987), Kimball (1993), and Gollier and Pratt (1996) derived several sufficient and/or necessary conditions that guarantee that adding a background risk makes individuals become more risk averse. Gollier (2000, 2001) summarized and extended this field of literature. Pratt and Zeckhauser (1987) showed that a necessary condition for properness is that absolute risk aversion is decreasing in wealth. Another necessary condition for properness is the so-called "local properness" condition. Kimball (1993) has shown that standard risk aversion is sufficient for proper risk aversion, where standard risk aversion means that both absolute risk aversion and absolute prudence are decreasing in wealth. Gollier and Pratt (1996) introduced the weakest necessary and sufficient condition (risk vulnerability) on preferences, which guarantees that adding an unfair background risk to wealth makes risk-averse individuals behave in a more risk-averse way with respect to another independent risk. They also showed that risk vulnerability includes proper and standard risk aversion as particular cases. Gollier and Scarmure (1994) and Elmendorf and Kimball (2000) provided sufficient conditions for an increase background risk (labor income risk) to generate more risk aversion. Eeckhoudt, Gollier, and Schlesinger (1996) provided the necessary and sufficient condition for determining when any first degree stochastic dominance (FSD) or second degree stochastic dominance (SSD) changing in background risk would cause the decision maker to behave more risk averse toward the insurable risk. On the other hand, Quiggin (2003) used non-expected utility preferences analysis and showed that aversion to one risk will be reduced by the presence of an independent background risk. He suggested that if the risk is high in any case, people will not be affected by the other small independent background risk. He also showed that the premium for a given risk is always diminished by the presence of independent background risk if preferences followed constant risk aversion, the opposite of the result found for expected utility with standard preferences. Guiso et al. (2002) found that risk aversion is a predictor of income risk by controlling for demographic variables; they also show that the more risk-averse select themselves into occupations with low-income risk. The authors also found that the risk-averse tend to self-select in jobs with low probability of low-income realizations.

Although the literature provides many insightful findings theoretically, there are few articles studied the relationship between background risk and risk aversion empirically. Guiso and Paiella (2008) used a survey of Bank of Italy which has a section designed to elicit attitudes toward risk. Participants are offered a hypothetical security and are asked to report the maximum price that they would be willing to pay for it. They assumed some specific forms (ex. exponential utility) for the utility function to measure the index of risk aversion and found that risk aversion is a decreasing function of the endowment and provide empirical evidence that individuals who are more likely to face income uncertainty exhibit a higher degree of absolute risk aversion. Lusk and Coble (2008) found individuals were slightly more risk averse with an unfair or mean-preserving background risk than when no background risk was present by analyzing individuals' choices over a series of lotteries in a laboratory setting in the presence and absence of independent background risks.

The current paper addresses in two parts: (1) measuring the Arrow-Pratt risk aversion coefficient by using data of insurance markets which are particularly useful to estimate the degree of risk aversion of economics agents, since risk and risk aversion play the driving role for the exchanges in those markets (Gollier, 2001), and (2) conducting an empirical test of the relationship of household risk aversion and income risk. This article uses the life insurance expenditure data of the Survey of Family Income and Expenditure (SFIE) in Taiwan to estimate the risk aversion coefficient for each of households. Using the reduced form equation derived by Halek and Eisenhauer (2001), the Arrow-Pratt coefficient of absolute risk aversion and coefficient of relative risk aversion are measured without imposing assumptions of the utility function form. In the second part of this work, using the coefficient of Arrow-Pratt risk aversion, the relationship of household risk aversion and income risk, which is taken as a proxy for background risk, is explored after controlling for other factors, including household income and wealth, the characteristics of the head of the household and other demographic variables. The empirical results show that households facing normally uninsurable high income risk will become more risk averse, but among households with higher wealth, the impact of income risk will decline. This result is consistent with consumer preferences being characterized by proper risk aversion, standard risk aversion and risk vulnerability which are the necessary and sufficient conditions of the optimal risk-taking behavior in the presence of background risk.

The current paper is organized as follows. Section 2 describes the theoretical models of Arrow-Pratt risk aversion and the conditions which guarantee that adding a background risk makes risk-averse individuals behave in a more risk-averse way. The description of the data and the empirical evidence are given in section 3. Section 4 outlines the conclusions.

2. Theory models

The methods used to estimate the Arrow-Pratt risk aversion coefficient and the conditions which guarantee that adding a background risk makes risk-averse individuals behave in a more risk-averse way will be described in this section.

2.1 Arrow-Pratt Risk Aversion Coefficient

A household's concave von Neumann-Morgenstern utility function is given by $U(w)$ such that $U''(w) < 0 < U'(w)$, where U stands for the utility function and w stands for the individual's wealth. Denoting the absolute risk aversion (ARA) measure by R_A(w) and the relative risk aversion (RRA) measure by R_R(w), Arrow (1965, 1971) and Pratt (1964) defined these two measures as

$$R_A(w) = -{U''(w)}/{U'(w)} \tag{1}$$

and

$$R_R(w) = {-w \times U''(w)}/{U'(w)}, \tag{2}$$

Pratt demonstrated that RRA is proportional to the insurance premium one is willing to pay to avoid a given risk. Arrow showed that this measure is directly related to one's insistence on favorable odds when putting some fraction of wealth at risk. Using the reduced form equation derived by Halek and Eisenhauer (2001), assume that the head of the household is the sole wage earner and the only one that has life insurance in the household. Let HC represent the human capital of the head of the household that is calculated by taking the present value of expected future earnings before he or she dies or retires. There is a probability p of the breadwinner's death causing the loss of HC, and a complementary probability of survival $(1-p)$ exists during the period. The author assumes the household's accumulated stock of assets (A), excluding human capital, is not subject to the same risk as HC. The total premium for life insurance of I is available at a premium rate, or cost of coverage c. The premium rate reflects a markup over the probability of loss, so that $c = \lambda p$, where λ is the loading factor ($\lambda = 1$ if the premium is fair) and the life insurance coverage of V for life insurance is I/c. If a death and consequent loss of HC occurs, the household recovers V in life insurance claims.

Average wealth is then calculated as $E(w) = A + (1-p)HC - cV^* + pV^*$, the household chooses the optimal level of life insurance coverage V^* to maximize expected utility, $EU = (1-p)U(A + HC - cV) + pU(A + V - cV)$. Constructing the first-order and then using the second-order Taylor series expansion of the first-order condition around $E(w)$ gives

$$\begin{aligned} &c(1-p)U^{'}(E(w)) + c(1-p)p(HC - V^*)U^{''}(E(w)) = \\ &p(1-c)U^{'}(E(w)) + p(1-c)(1-p)(V^* - HC)U^{''}(E(w)) \end{aligned} \tag{3}$$

or equivalently,

$$(\lambda - 1)U^{'}(E(w)) = -(1-p)(HC - V^*)U^{''}(E(w)). \tag{4}$$

Then we can obtain a reduced form expression for the Pratt-Arrow measure of relative risk aversion and absolute risk aversion,

$$R_R(E(w)) = {-E(w) * U^{''}(E(w))}\Big/{U^{'}(E(w))} = {E(w) * \theta}\Big/{(HC - V^*)} \tag{5}$$

$$R_A(E(w)) = {-U^{''}(E(w))}\Big/{U^{'}(E(w))} = {\theta}\Big/{(HC - V^*)} \tag{6}$$

where $(HC - V^*)$ represents the uninsured portion of potential loss, and

$$\theta = {(\lambda - 1)}\Big/{(1-p)} > 0 \qquad \forall \lambda > 1. \tag{7}$$

2.2 Risk Aversion and Background Risk

Pratt and Zeckhauser (1987) have shown that a necessary condition for properness is that absolute risk aversion is decreasing in wealth. Another necessary condition for properness is the local properness condition. Kimball (1993) showed that standard risk aversion means that both absolute risk aversion and absolute prudence are decreasing in wealth, and this is sufficient for proper risk aversion. Gollier and Pratt (1996) introduced the weakest necessary and sufficient condition (risk vulnerability) on preferences, which guarantees that adding an unfair background risk to wealth makes risk-averse individuals behave in a more risk-averse way with respect to another independent risk. Before knowing the realization of an independent random variable $\tilde{y}_1$, an individual needs to make an exogenous choice about some endogenous risk. They consider the effect of a change in the background risk from $\tilde{y}_1$ to $\tilde{y}_2$ on the optimal risk-taking behavior relative to the endogenous risk. To solve this problem, the derived utility functions v_i as defined by Kihlstrom et al. (1981) and Nachman (1982) are examined

$$v_i(w) = Eu_i(w + \tilde{y}_i). \tag{8}$$

An individual with utility function u_i and background risk $\tilde{y}_i$ behaves as an individual with utility function v_i and no background risk. One would be done if v_2 were uniformly less/more concave than v_1. The initial problem of analyzing a change in the distribution of background risk is thus equivalent to determining whether

$$R_{A2}(w) \geq R_{A2}(w) \qquad with \quad R_{Ai}(w) = -\frac{v_i^{''}(w)}{v_i^{'}(w)} = -\frac{E(u_i^{''}(w + \tilde{y}_i))}{E(u_i^{'}(w + \tilde{y}_i))} \tag{9}$$

for all R_{Ai} denotes the index of absolute risk aversion of the derived utility function v_i[3].

Pratt and Zeckhauser (1987) introduce the properness or proper risk aversion and showed that

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[3] An individual with utility function u_i and background risk $\tilde{y}_i$ behaves as an individual with utility function v_i, we can rewrite the reduced form expression (5) and (6) as $R_R(E(w)) = {-E(w) * v^{''}(E(w))} / {v^{'}(E(w))} = {E(w) * \theta} / {(HC - V^*)}$, and $R_A(E(w)) = {-v^{''}(E(w))} / {v^{'}(E(w))} = \theta / {(HC - V^*)}$ which are measured in this study.

one necessary condition for properness is that absolute risk aversion is decreasing in wealth, and another necessary condition for properness is the local properness condition $R_A''(w) \geq R_A'(w)R_A(w) \quad \forall w$.

Kimball (1993) showed that the necessary and sufficient condition of standard risk aversion means that both absolute risk aversion $-u''(w)\big/u'(w)$ and absolute prudence $-u'''(w)\big/u''(w)$ are decreasing in wealth.

Gollier and Pratt (1996) provided a complex necessary and sufficient condition called risk vulnerability for unambiguous comparative statics. Restricting the analysis to adding a small independent unfair background risk, they show that the weaker condition of DARA and DAP>DARA combined with

$$T_A(w) \equiv -\frac{u''''(w)}{u'''(w)} \geq R_A(w) \quad \forall w \tag{10}$$

is necessary and sufficient. $T_A(w)$ is hereafter called "absolute temperance".

3. Data and Empirical Results

The data used in this study and the empirical results of the relationship between background risk and risk aversion will be described in this section.

3.1 Coefficients of Risk Aversion

The data of this study is from the 2003 Survey of Family Income and Expenditure (SFIE) in Taiwan, conducted by Taiwan Directorate-General of Budget, Accounting and Statistics. The data comprises family status, appliances of the household, the residence's status, family income (further divided into employee compensation, business owner earnings, property income, rent, and current transfer income) and expenditures (further divided into interest, current transfer expenditures, and consumer expenses). The consumer expenses include expenses for food, clothing, rent/utilities, upkeep, medical care, transportation and communication, entertainment and education, and miscellaneous. In particular, households with term life insurance policies are examined. After excluding some data where household expenditures on term life insurance per annum are zero, the head of household is younger than 18 or older than 65 years old, or there is missing data for other variables; the sample consists of 3,269 households.

A mortality rate (p) for each primary respondent was derived by gender and age from The Fourth Round Experience Mortality Table established by The Life Insurance Association of Taiwan. Because of missing data regarding the face value of all term life insurance policies (V), this work uses the ten-year term life insurance premium rate (c) schedules of Cathay Life Insurance Company, which is the largest one of Taiwan, calculating the loading factor $\lambda = c/p$ and life insurance coverage of $V = I/c$. The potential loss to the household (HC) resulting from the breadwinner's death was constructed by separating out the head's contribution to gross household income, extending the net earnings over the reported number of years to retirement. Expected wealth is then calculated by $E(w) = A + (1-p)HC - cV^* + pV^*$, where the household's accumulated stock of assets (A) includes financial and real estate assets. Finally, we can acquire the coefficients of ARA and RRA by using Equations (5), (6), and (7). Figure 1 and Figure 2 show the distributions of the coefficients of relative and absolute risk aversion. As the figures indicate, the distribution is right-skewed and there are some extreme outliers (the results are similar to Hansen and Singleton, 1983, and Halek and Eisenhauer, 2001).

3.2 Regression Results

OLS regression was used to analyze the relationship between risk aversion and background risk and other demographic variables. The potential effects of other factors were also examined,

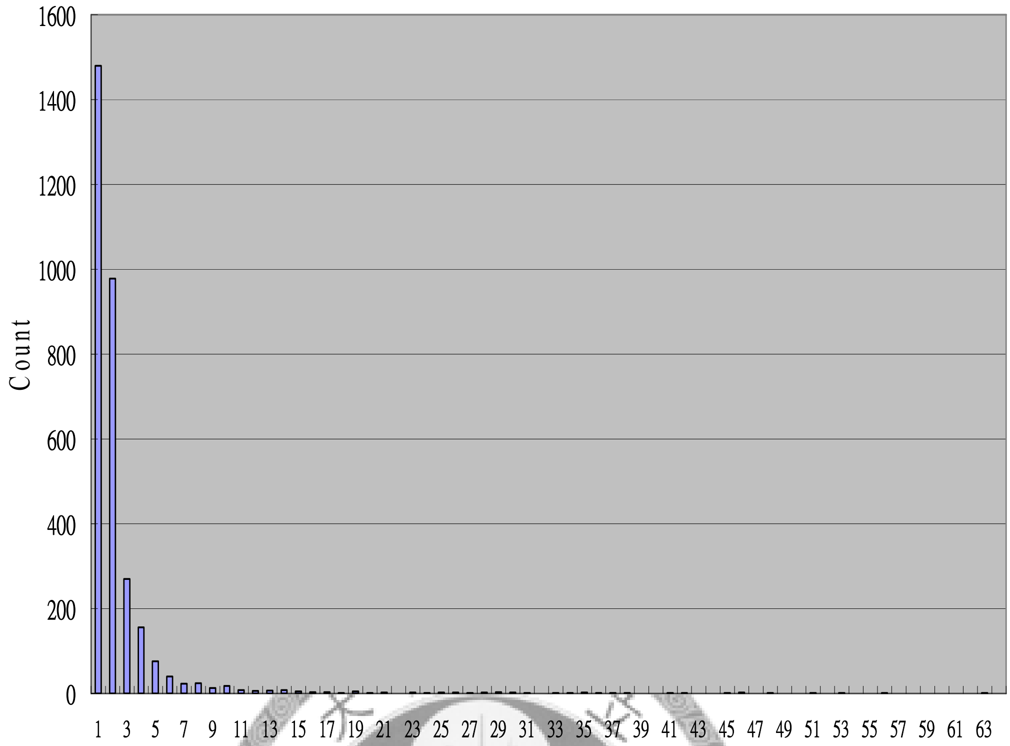

Figure 1 Distribution of coefficients of relative risk aversion

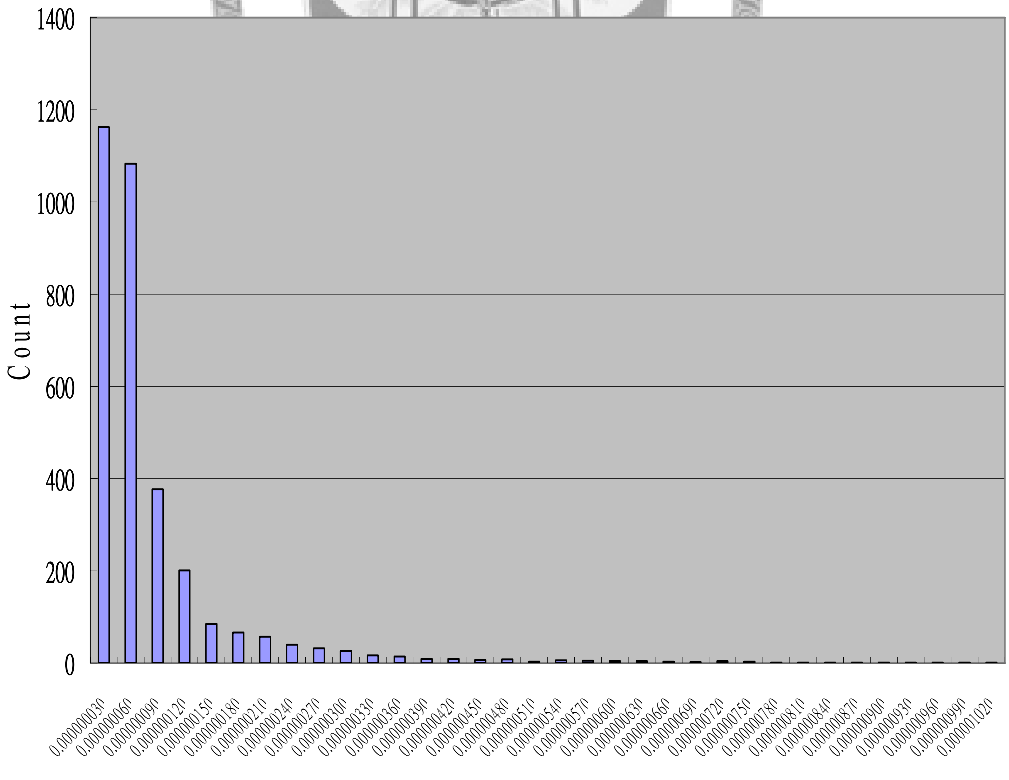

Figure 2 Distribution of coefficients of absolute risk aversion

Table 1. Summary statistics of testing sample (3,269 households)

Variables	Mean	Std Dev
Ln(ARA)	-16.873	1.000
Ln(RRA)	-0.430	0.887
Ln(Household assets)	1.489	1.110
Ln(Household income)	0.251	0.487
Family size	4.081	1.501
No. of children	0.960	1.073
No. of old person	0.206	0.500
Married	0.837	0.370
Male	0.857	0.351
Age	43.730	9.373
Age^2	2000.110	826.322
Education	11.996	3.428
Ln(Alcohol and cigarette expenditure)	-5.376	1.556
Resident in the north	0.635	0.481
Resident in the south	0.144	0.351
Resident in the east	0.011	0.104
Non-government staffs	0.837	0.370
Income risk–CV(by occupation)	0.039	0.036
Income risk–CV(by industry)	0.038	0.012

Note: Household assets, income and alcohol and cigarette are expressed in millions of NT dollars.
Source: Survey of Family Income and Expenditure (SFIE) of Taiwan.

controlling for some demographic and geographical characteristics used in previous studies, such as household wealth, age and the square of age of the household head, marital status, gender, education level of the household head, number of children (under 18 years old), and elder persons (upper 65 years old), family size, resident region dummy (north, center, south or east), and smoking and drinking behavior measured by expenditures on alcohol and cigarettes. The appendix lists the definitions of the variables, and Table 1 presents the sample statistics of the variables.

Background risk is the main concern. Let us first review the treatment of background risk in earlier research and then propose the variables used to investigate background risk. In the past, income risk was used in the empirical literature as a proxy of background risk. The adoption of this method is good in terms of both practicability and significance, and expectations regarding the variability of future income are assumed to be based on past variability. Haurin (1991) developed a measure of variability in future income (the coefficient of variation) based on longitudinal data and found that increased variability of income significantly reduces the probability of home ownership. Haliassos and Bertaut (1995) used three occupation dummies, classifying people into low-risk, high-risk, and managerial occupations, as proxies of income risk in their analysis of why so few households held stocks. Carroll and Samwick (1997) estimated income variance measures by occupation using data from the Panel Study of Income Dynamics (PSID), and Guiso and Jappelli (1998) constructed an income risk proxy using a subjective variance calculated from the "Survey of Households Income and Wealth" conducted by the Bank of Italy. In the survey, each labor income or pension recipient was asked to attribute probability weights to given intervals of inflation and nominal income increases. Assuming a certain value of correlation coefficient between shocks to nominal income and inflation, Guiso and Jappelli (1998) estimated the variance of real income growth as the income risk proxy. Robst et al. (1999) also estimated uncertainty as the coefficient of variation (CV) of income over five years (from 1983 through 1987) to understand whether individuals facing greater uncertainty are less likely to own a home. Heaton and Lucas (2000a) focus on the volatility of entrepreneurs' labor income and find higher correlation with the return on the market portfolio. Koeniger (2004) selected occupation risk dummy variables (including unskilled manual and skilled non-manual) as proxies for income risk in an analysis of automobile insurance in the UK.

The current study uses year 2003 as the testing period. OLS regression is used to show whether households with higher income risk are more (or fewer) risk averse. For the background risk proxy, limited data from the Survey of Family Income and Expenditure (SFIE) in Taiwan are used. Specifically, this research uses three alternative proxies. The first is a dummy variable representing whether the household head is a non-government employee (83.7% of the empirical sample), the second is income risk-CV by occupation and the third is income risk–CV by industry. The corresponding models are Models 1, 2, and 3. The study proposes measuring household income risk by occupation and industry of the household head. For each occupation or industry, the author uses the CV of disposable factor income in each occupation/industry level to proxy the income risk for the corresponding occupation/industry. Thus, the author classifies the sample households into 11 (by occupation) and 10 (by industry) groups with differing income risks measured by CV. To prepare our proxies for income risks, 1993-2002 was selected as the formation period to calculate the average disposable factor income for an occupation or industry, and the coefficient of variation (CV) of each occupation/industry is calculated as the proxy for income risk. Table 2 gives the summary statistics of income risk–CV by occupation and income risk–CV by industry, which, as discussed above, are the coefficient of variation of the household factor incomes deviated from the imputed incomes (mean factor real incomes by occupation or industry from 1993 to 2002).

Table 2 shows that the means of coefficients of relative risk aversion and indexes of income risk by occupations and industries. Higher background risk by occupations include the following: (1) Legislators, Administrators, Business Executives and Managers, (2) Forestry Workers and Fishermen, (3) Agricultural and Animal Husbandry Workers, and (4) Other Occupations. Those with lower background risk include the following: (1) Service Workers and Shop and Market Sales Workers, (2) Plant and Machine Operators and Assemblers, (3) Laborers, and (4) Professionals. By way of industry, groups such as (1) Mining and Quarrying, and (2) Water, Electricity and Gas have higher income risk, while (1) Commerce, (2) Transport, Storage and Communication, and (3) Community, Social and Personal Services have lesser income risk.

Table 3 and Table 4 present the regression results of the models used in this study. Table 3

Table 2. RRA and background risk variables: coefficient of variation (CV) of real income by occupation and industry (1993-2002)

Occupation	Mean	CV	RRA	Industry	Mean	CV	RRA
Legislators, Administrators, Business Executives and Managers	939.5[a]	0.051	1.179	Agriculture, Forestry, Fishing and Animal Husbandry	212.7	0.040	1.681
Professionals	727.5	0.028	1.530	Mining and Quarrying	508.2	0.086	.[b]
Technicians and Associate Professionals	542.2	0.035	1.345	Manufacturing	424.6	0.051	0.944
Clerks	392.3	0.031	0.994	Water, Electricity and Gas	730.7	0.091	1.836
Service Workers and Shop and Market Sales Workers	403.3	0.019	1.115	Construction	4219.9	0.047	1.046
Agricultural, and Animal Husbandry Workers	199.2	0.102	1.799	Commerce	445.7	0.022	1.067
Forestry Workers and Fishermen	359.6	0.087	0.875	Transport, Storage and Communication	525.5	0.031	0.882
Craft and Related Trades Workers	403.8	0.036	0.983	Finance, Insurance, Real Estate and Business Services	571.3	0.043	1.216
Plant and Machine Operators and Assemblers	363.5	0.026	0.809	Community, Social and Personal Services	507.8	0.033	1.401
Laborers	287.8	0.026	0.803	Non-working and Others	172.2	0.050	2.309
Others	216.2	0.227	1.686				

Note: a. The mean of disposable factor real income is expressed in thousands of 1993 NT dollars.
b. The RAR of industry Mining and Quarrying is omitted because no household heads work in this industry.
Source: Survey of Family Income and Expenditure (SFIE) of Taiwan.

shows the regression results of the logarithm of the coefficient of ARA (absolute risk aversion). The three models give qualitatively similar results. In regards to the wealth variables, household income variables in the three models are negative and significant at a 1 percent confidence level, but variables of household asset are not significant. This means that households with higher income are less risk averse. The coefficients of the household head's age and the square of age (included to capture a potentially nonlinear relationship) are significantly negative and positive, respectively, showing that age is convex with ARA. A household head that is 40 years old is the least risk averse. The results are in line with those in previous studies, such as Riley and Chow (1992) and Zuckerman (1994). Household heads who are male tend to have lower ARAs in the current study,

Table 3. Multivariate OLS regression analysis for Ln(ARA)

	Model 1		Model 2		Model 3	
Independent Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	-13.512^{***b}	<.0001	-13.604***	<.0001	-13.586***	<.0001
Ln(Household assets)	-0.005	0.7763	-0.012	0.5081	0.003	0.8927
Ln(Household income)	-0.165***	0.0005	-0.161***	0.0006	-0.152***	0.0011
Family size	-0.032**	0.0387	-0.029*	0.0549	-0.032**	0.0351
No. of children	0.091***	<.0001	0.091***	<.0001	0.094***	<.0001
No. of old person	0.149***	<.0001	0.157***	<.0001	0.158***	<.0001
Married	0.022	0.6947	0.030	0.5992	0.025	0.6612
Male	-0.075	0.1436	-0.085*	0.0954	-0.089*	0.0821
Education	-0.019***	0.0041	-0.019***	0.0034	-0.018***	0.0046
Age	-0.163***	<.0001	-0.162***	<.0001	-0.166***	<.0001
Age^2	0.002***	<.0001	0.002***	<.0001	0.002***	<.0001
Ln(Alcohol and cigarette expenditure)	-0.011	0.3346	-0.010	0.3591	-0.011	0.3405
Resident in the north[a]	-0.235***	<.0001	-0.265***	<.0001	-0.266***	<.0001
Resident in the south	-0.011	0.8348	-0.003	0.9518	-0.002	0.9712
Resident in the east	0.057	0.7223	0.057	0.7231	0.058	0.7193
Non-government staffs	-0.061	0.2309				
Household assets* Non-government staffs	-0.004**	0.0393				
Income risk–CV(by occupation)			1.397***	0.0098		
Household assets* Income risk–CV(by occupation)			-0.0561***	0.0042		
Income risk–CV(by industry)					2.665*	0.0634
Household assets* Income risk–CV(by industry)					-0.1413***	0.0008
Adj R-square	0.1218		0.1205		0.1211	

Note: a: The basic (omitted) resident variables are Resident in the Center.
b: The symbol *** significance at 1%, ** significance at 5%, and * significance at 10%.

Table 4. Multivariate OLS regression analysis for Ln(RRA)

	Model 1		Model 2		Model 3	
Independent Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	2.809***	<.0001	2.712***	<.0001	2.791***	<.0001
Ln(Household assets)	0.226***	<.0001	0.220***	<.0001	0.232***	<.0001
Ln(Household income)	-0.036	0.3923	-0.031	0.4598	-0.021	0.6088
Family size	-0.050***	0.0003	-0.050***	0.0002	-0.052***	0.0001
No. of children	0.112***	<.0001	0.111***	<.0001	0.114***	<.0001
No. of old person	0.156***	<.0001	0.158***	<.0001	0.158***	<.0001
Married	-0.008	0.8810	-0.002	0.9765	-0.005	0.9207
Male	-0.102**	0.0243	-0.113**	0.013	-0.109**	0.0163
Education	-0.002	0.6866	-0.001	0.8463	-0.001	0.8562
Age	-0.169***	<.0001	-0.168***	<.0001	-0.171***	<.0001
Age^2	0.002***	<.0001	0.002***	<.0001	0.002***	<.0001
Ln(Alcohol and cigarette expenditure)	-0.012	0.2535	-0.012	0.2515	-0.012	0.2228
Resident in the north[a]	-0.064	0.1040	-0.060	0.1095	-0.062	0.1009
Resident in the south	0.008	0.8749	0.013	0.7908	0.013	0.7981
Resident in the east	-0.027	0.8507	-0.029	0.8394	-0.030	0.8354
Non-government staffs	-0.030	0.5165				
Household assets* Non-government staffs	-0.004**	0.0175				
Income risk–CV(by occupation)			1.001**	0.0379		
Household assets* Income risk–CV(by occupation)			-0.0526***	0.0026		
Income risk–CV(by industry)					0.159	0.9010
Household assets* Income risk–CV(by industry)					-0.1284***	0.0007
Adj R-square	0.1110		0.1112		0.1119	

Note: a: The basic (omitted) resident variables are Resident in the Center.

b: The symbol *** significance at 1%, ** significance at 5%, and * significance at 10%.

which implies that men are less risk averse than women. Household heads with more years of education have a lower ARA, which is consistent with the results of Levin et al. (1988), and Jianakoplos and Bernasek (1998). The number of elderly persons and number of children in the household have positive effects on ARA, but family size has a negative relationship with ARA. Households in the Northern area are less risk averse than those in the center of the nation, but variables representing residence in the South and East are not significant. The effect of alcohol and cigarette expenditures is negative (smoking and drinking behavior leads to a decline in ARA) but is not significant. The coefficients of income risk in model 2 and model 3 are significantly positive, suggesting that households facing more income uncertainty are more risk averse (the coefficients of income risk is negative but not significant in model 1, that means household heads who are government staffs may be not have lower income risk, this variable does not affect degree of risk aversion). The interaction variables of income risk and household assets are negative, indicating that higher assets lead to a reduction in the level of risk aversion caused by the income risk effect.

Table 4 shows the RRA estimation of the three models. Household asset variables in the three models are all positive, that means household with higher assets is less risk averse. The estimation results of other demographic and geographical variables are similar to the ARA estimates in Table 3. The income risk estimation results of model 2 and model 3 are positively related to RRA, which are similar to the direction of the estimation of the ARA regression. This means that household heads with higher income risk are more risk averse, consistent with recent theories of attitudes toward risk in the presence of background risk. The interaction variables of income risk and household assets are also negative, indicating that the income risk effect declines with an increase in household assets. The main results of the two regressions suggest that households facing higher income risk have higher ARA and RRA. In other words, these households are more risk averse than those with stable income.

4. Conclusions

In the real world, people almost always make choices in the presence of background risks. Risk aversion and decision behavior under background risk is an interesting and important topic. After decades of research, many issues in this topic have been investigated and many illuminating results were derived. A Taiwanese data set, the Survey of Taiwan Family Income and Expenditure from 1993 to 2004, is used to calculate the coefficients of risk aversion in the current study. The reduced form equation derived by Halek and Eisenhauer (2001) is used to measure the Arrow-Pratt coefficient of absolute risk aversion and coefficient of relative risk aversion without imposing the assumptions of the utility function form. Three alternative proxies are constructed for income risk, which is taken as proxies for background risk and studies the relationship of the household's risk aversion and income risk, after controlling for other demographic and geographic factors including household income and assets, the age, sex, marriage, and education of the head of the household, family size, number of children and old persons and household's residential area. Empirical results show that age of the household head has a convex relationship with ARA and RRA. Household heads of about 40 years old have the lowest risk aversion, while those with lower levels of education have higher ARA (education have no impact of RRA), and male household heads are less risk averse than female household heads. The empirical results also show that individuals facing higher income risk are more risk averse, but households with higher wealth have a reduced impact of income risk. This result is consistent with consumer preferences being characterized by the conditions of optimal risk-taking behavior in the presence of background risk (Pratt and Zeckhauser's "proper risk aversion" (1987), Kimball's "standard risk aversion" (1993) and Gollier and Pratt's "risk vulnerability" (1996)).

Essay II. Households′ Demand for Insurance in the Presence of Background Risk

1. Introduction

People often make decisions under uncertain conditions, against the background of other uncontrollable risks in the real world. Over the past several decades, many theoretical papers have contributed knowledge regarding sufficient or necessary conditions that cause individuals' to take less risk after introducing an increased background risk[1]. Pratt and Zeckhauser (1987) introduced properness or proper risk aversion; Kimball (1993) revealed conditions called standard risk aversion (decreasing absolute risk aversion and prudence); and Gollier and Pratt (1996) provided a complex necessary and sufficient condition called risk vulnerability. These conditions guarantee that adding an unfair background risk to wealth makes risk-averse individuals behave in a more risk-averse way. Eeckhoudt, Gollier, and Schlesinger (1996) determined the effect on risk-taking preferences of first-degree stochastic dominant or second-degree stochastic dominant deteriorations in background risk. Following their results, we can find the positive effect of background risk on the insurance demand which also depends on the risk-taking attitude of the individuals. Diamond and Stiglitz (1974) and Fu (1993) suggested that a higher degree of risk aversion will decrease investment in a risky asset. Dionne and Eeckhoudt (1985) showed that an individual with more risk-aversion would invest more in self-insurance activities. Following Diamond and Stiglitz (1974) and Dionne and Eeckhoudt (1985), Tzeng, Wang, and Ho (1999) inferred that individuals with more risk aversion would increase demand for insurance. They provided comparative statics of an increased risk aversion on market insurance and self-insurance simultaneously and found that individuals who were more risk averse would maintain the same expenditure on self-insurance, but demand more market insurance when both market insurance and self insurance were available.

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[1] Among others, Eeckhoudt and Kimball (1992), Kimball (1990, 1993), Gollier and Scarmure (1994), Gollier and Pratt (1996), Eeckhoudt, Gollier and Schlesinger (1996), Gollier and Kimball (1996), Meyer and Meyer (1998), Gollier and Zeckhauser (2002), Gollier and Schlee (2006), Franke, Schlesinger, and Stapleton (2006), Fei and Schlesinger (2008).

The current study aims to provide empirical evidence that the addition of a zero-mean, uninsurable risk increases the demand for insurance. Some research studies have applied empirical data to examine whether individuals with higher income risk (used as the proxy of background risk) buy less risky investments. For example, Duffie and Zariphopoulou (1993) found that an increase in income risk causes households to be less willing to bear investment risk, thus reducing their demand for risky securities. Guiso, Jappeli, and Terlizzese (1996) showed that households with greater income risk bought fewer risky assets. They used a cross-section survey of Italian households to analyze the effect of income risk and borrowing constraints on a household's portfolio and the demand for risky assets. They showed that background risk reduced a household's willingness to bear other controllable risks. They also found that investors with more income risk reduced their overall exposure to risk by investing in lower-risk assets. Elmendorf and Kimball (2000) found that although labor income risk increases overall saving, it tends to lower investment in risky assets. Heaton and Lucas (2000a) found that proprietary income risk influenced portfolio choices. Heaton and Lucas (2000b) provided empirical evidence regarding the role of background risk in household portfolio choices. They found that background risk increases the degree of risk aversion and that households with more background risk will invest more cautiously in financial markets. These results suggest that considerable heterogeneity in exposure to background risk exists, and that households with greater exposure tend to hold a smaller share of stocks in their portfolios. Cocco, Gomes, and Maehout (2005) also showed that income risk will reduce individuals' financial risk. Campbell (2006) defined nonfinancial market risk (such as randomness in real income or poor health on asset allocation) as background risks that cause individuals to be more averse to their investment risks and portfolio choices.

Although the literature provides many insightful findings with both theory and empirical evidence about background risk, to our knowledge few empirical studies have focused on this issue in the context of casualty insurance and car insurance, and no studies have examined household total insurance, life and health insurance and property insurance expenditures. Using a cross-section survey of Italian Bank customers, Guiso and Jappelli (1998) found that households facing greater income risk (self-report index) bought more casualty insurance. Koeniger (2004) provided empirical evidence that households with higher income risk (dummy variables of occupation risk including unskilled manual and skilled non-manual) spent more on automobile insurance in the United Kingdom. The current study uses an objective index of income risk such as variation of household realized income and the probability of receiving a lower wage to address this research question: Does an increase in background risk cause households to purchase more or less insurance?

This study proposes an empirical model and uses a Taiwan dataset to present empirical evidence on the relationship between income risk and demand for insurance. Specifically, this study tests whether households with a higher background risk purchase more (or less) insurance. Following Haurin (1991), Gakidis (1998), Robst, Deitz, and McGoldric (1999) and Vissing-Jorgensen (2002), this study uses the standard deviation and the coefficient variance as proxies for background risk. Individuals with a higher probability of receiving a lower wage from their employer, which has never been used to measure income risk, should face more income uncertainty. This study uses the ratio of lowered wages (how many factories reduce employees' wages per one hundred factories on average) as an index of income risk. The empirical evidence finds that income risk raises the demand for insurance, while income risk combined with household resources has a negative effect on insurance purchases. This means that for relatively poor households, an increase in the income risk increases the probability of purchasing insurance, while the opposite is true for relatively wealthy households. This study's empirical results support the notion that decision makers' preferences are characterized by decreasing absolute prudence and decreasing absolute risk aversion—the well-known "standard risk aversion" condition proposed by Eeckhoudt and Kimball (1992) and Kimball (1993). It also suggests that consumers with more income risk are more risk averse and purchase more market insurance (Schlesinger, 1999). This study also measured the income elasticity of insurance and found it is almost equal to one. This means insurance is a normal good. Households increase or decrease their insurance expenditure in the same proportion that their income increases or decreases. This result is consistent with most empirical studies that suggest that a consumer's income change has positive effect on the consumer's demand for insurance; an increase in income causes an outward shift in the demand curve[2]. For example, Beenstock, Dickinson, and Khajuria (1988) showed the income elasticity of property-liability insurance was equal to 1.34 for 45 countries. Outreville (1990) found the income elasticity of property-liability insurance was larger than unit by testing with a cross-section of 55 developing countries. Truett and Truett (1990) estimated the demand functions of life insurance for the United States and Mexico by using OLS models, they found that the estimated income elasticity of demand for life insurance was also positive (0.77-3.87). Showers and Shotick (1994) calculated the income elasticity of total insurance by using Tobit analysis and found that it was positive (0.3244). Eisenhauer (1997) found income effect of life insurance was also positive, indicating life insurance is a normal, non-Giffen good. Enz (2000) used S-curve model to estimate the income elasticity of both life and non-life insurance, and found the income elasticity of insurance was greater than 1 and would change with real income per capita (the maximum value of the income elasticity of life and non-life insurance were 1.9 and 1.5).

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[2] Theoretical papers such as Mossin (1968), Hoy and Robson (1981), Briys, Dionne, and Eeckhoudt (1988), Meier (1998), Schlesinger (1999) and Hau (2008) found that insurance is an inferior good or may be a Giffen good. Most of ther studies including Beenstock et al. (1988), Outreville (1990), Truett and Truett (1990), Browne and Kim (1993), Showers and Shotick (1994), Eisenhauer (1997), and Enz (2000) found that people tend to increase insurance expenditure with respect to an increase in wealth empirically that support that insurance is a normal good that is different with theory predicts. Ho and Tzeng (2002) derived the Hicksian demand for insurance and show it generates different measurements for income effect with Marsharllian demand which the reason why these studies display is mixed results.

The remainder of the paper is organized as follows. Section 2 details a theoretical model to analyze demand for insurance with background risk. Section 3 proposes an empirical model to estimate a household's insurance purchase with income risk. A description of the data and the empirical evidence are given in section 4. Section 5 outlines this study's conclusions.

2. The Model for Demand for Insurance with Background Risk

Eeckhoudt and Kimball (1992) and Kimball (1993) find that decreasing absolute risk aversion (DARA) plus decreasing absolute prudence (DAP) is a sufficient condition for taking more risk after introducing an independent background risk, if the underlying utility function is increasing and globally concave. If the utility of the individual exhibits decreasing absolute risk aversion and decreasing absolute prudence, introducing an independent background risk makes the individual more risk-averse and at the same time more prudent and then would demand for more insurance.

Following Eeckhoude and Kimball (1992), consider an individual who has initial wealth with an uninsurable risk. Let w incorporate the certainty part of the initial wealth, including the expected level of the uninsurable risk. Thus, without losing any generality, the remaining uncertainty, $\tilde{\varepsilon}$, is a pure risk (has a zero mean). $\tilde{\varepsilon}$, being exogenous and non-insurable, is called a "background risk". $\tilde{y}$, is the insuable risk and it's expected value is μ. α, is the coinsurance rate and the loading factor is λ. Assume the individual has an underlying von Neumann-Morgenstern utility function u. Under the expected utility framework, the optimal insurance problem of an individual in the absence of background risk is

$$\underset{\alpha}{Max}\, E\left[u(w-(1-\alpha)\tilde{y}-\alpha\lambda\mu)\right], \tag{1}$$

where E is the expectation operator with the subscript denoting the variable to be taken expectation (in the following the subscript will be omitted when it is obvious). The insurance premium can be expressed as $\lambda\mu\alpha$. If $\lambda=1$ (fair premium), the optimal coinsurance rate α^* is

1, but $\alpha^* < 1$ if $\lambda > 1$.

After introducing an independent background risk $\tilde{\varepsilon}$, the initial wealth w is replaced by $w + \tilde{\varepsilon}$, the optimal insurance problem of an individual in the presence of the background risk is

$$\underset{\alpha}{Max}\, E\left[u(w + \tilde{\varepsilon} - (1-\alpha)\tilde{y} - \alpha\lambda\mu)\right], \tag{2}$$

Let the optimal coinsurance rate solution be denoted α^{**}.

Using the method of Kihlstrom, Romer, and Williams (1981), define another utility function $v(w)$ obtained by integrating out the background risk $\tilde{\varepsilon}$:

$$v(w) = E(u(w) + \tilde{\varepsilon}), \tag{3}$$

then, (2) can be rewritten as

$$\underset{\alpha}{Max}\, E\left[v(w - (1-\alpha)\tilde{y} - \alpha\lambda\mu)\right], \tag{4}$$

the optimal coinsurance rate solution also be the same α^{**}. Let π be the risk premium, ψ is the precautionary premium which established by Kimball (1990, 1993), π and ψ are given by:

$$E\left[u(w + \tilde{\varepsilon})\right] = u(w - \pi(w, \tilde{\varepsilon})) \tag{5}$$

$$E\left[u'(w + \tilde{\varepsilon})\right] = u'(w - \psi(w, \tilde{\varepsilon})) \tag{6}$$

since $E(\tilde{\varepsilon}) = 0$, $\pi(w, \tilde{\varepsilon}) > 0$,

differentiate (5) with w,

$$E\left[(u'(w + \tilde{\varepsilon})\right] = (1 - \frac{\partial \pi}{\partial w}) \cdot u'(w - \pi(w, \tilde{\varepsilon})) = u'(w - \psi(w, \tilde{\varepsilon})) \tag{7}$$

if π is decreasing in w (DARA), $\frac{\partial \pi}{\partial w} < 0$, then $\psi > \pi$. Kimball (1990, 1993) suggests that v is more concave and therefore more risk averse than u if DARA and DAP ($\frac{\partial \psi}{\partial w} < 0$) are both satisfied. From (3),

$$v(w) = E\left[u(w + \tilde{\varepsilon})\right] = u(w - \pi(w, \tilde{\varepsilon})) \tag{8}$$

differentiating (8) with respect to w yields:

$$v'(w) = (1 - \frac{\partial \pi}{\partial w}) \cdot u'(w - \pi(w, \tilde{\varepsilon})) = u'(w - \psi(w, \tilde{\varepsilon})) \tag{9}$$

and

$$v''(w) = (1 - \frac{\partial \psi}{\partial w}) \cdot u''(w - \psi(w, \tilde{\varepsilon})) \tag{10}$$

so that,

$$-\frac{v''(w)}{v'(w)} = (1 - \frac{\partial \psi}{\partial w}) \cdot \left[-\frac{u''(w - \psi(w, \tilde{\varepsilon}))}{u'(w - \psi(w, \tilde{\varepsilon}))} \right] \geq -\frac{u''(w - \psi(w, \tilde{\varepsilon}))}{u'(w - \psi(w, \tilde{\varepsilon}))} \geq -\frac{u''(w)}{u'(w)} \tag{11}$$

Schlesinger (1999) notes that for an insurance premium that is fair, any risk-averse individual will choose an insurance policy with full coverage. If the insurance loading be positive, an increase in the individual's degree of risk aversion at all levels of wealth will lead to an increase in the optimal level of coverage ($\alpha^* < \alpha^{**} < 1$).

Solving (1), yield a first-order condition for the unconstrained objective:

$$\frac{dEu}{d\alpha} = E\left[u'(w - (1 - \alpha)\tilde{y} - \alpha\lambda\mu) \cdot (\tilde{y} - \lambda\mu) \right] \tag{12}$$

the second-order condition for a maximum holds trivially from the assumption that $u'' < 0$. Indeed, $\frac{d^2 Eu}{d\alpha^2} < 0$ everywhere, indicating that any α^* satisfying (12) will be a global maximum.

Evaluating (12) at $\alpha = 1$ shows that

$$\begin{aligned} \left.\frac{dEu}{d\alpha}\right|_{\alpha=1} &= E\left[u'(w - \lambda\mu) \cdot (\tilde{y} - \lambda\mu) \right] = (1 - \lambda)\mu E\left[u'(w - \lambda\mu) \right] + \operatorname{cov}(u'(w - \lambda\mu), \tilde{y}) \\ &= (1 - \lambda)\mu E\left[u'(w - \lambda\mu) \right] + 0 \end{aligned} \tag{13}$$

If $\lambda = 1$, the value of equation (13) will be zero ($\alpha^* = 1$, full coverage), and will be negative ($\alpha^* < 1$, partial coverage) when $\lambda > 1$. The result is usually referred to as Mossin's Theorem. If proportional insurance is available at a fair premium ($\lambda = 1$), full coverage ($\alpha^* = 1$) is optimal. If the price of insurance includes a positive premium loading ($\lambda > 1$), then partial insurance is optimal ($\alpha^* < 1$). Next, we consider an increase in the individual's degree of risk aversion at all levels of wealth. Following Pratt (1964), there exists a concave function g, such that

$$v(w) = g[u(w)] \quad where \quad g' > 0, \quad and \quad g'' < 0 \tag{14}$$

Since $v(w)$ is a risk-averse utility function, we note that $E[v(w-(1-\alpha)\tilde{y}-\alpha\lambda\mu)]$ is concave in α . Let the insurance loading $\lambda > 1$ (with $\alpha^* < 1$), thus, consider the following:

$$\begin{aligned} \left.\frac{dEv}{d\alpha}\right|_{\alpha^*} = \left.\frac{dEg[u]}{d\alpha}\right|_{\alpha^*} &= Eg'[u(w-(1-\alpha^*)\tilde{y}-\alpha^*\lambda\mu)]u'[(w-(1-\alpha^*)\tilde{y}-\alpha^*\lambda\mu)\cdot(\tilde{y}-\lambda\mu)] \\ &> g'[u(w-(1-\alpha)E\tilde{y}-\alpha^*\lambda\mu)]Eu'[(w-(1-\alpha^*)\tilde{y}-\alpha^*\lambda\mu)\cdot(\tilde{y}-\lambda\mu)] = 0 \end{aligned} \tag{15}$$

The last expression equals zero by the first-order condition. The inequality in (15) implies $\alpha^* < \alpha^{**}$ because $E[v(w-(1-\alpha)\tilde{y}-\alpha\lambda\mu)]$ is concave in α .

3. Empirical Models

Some empirical studies have analyzed the income risk effect on investing in risky assets (Guiso, Jappelli, & Terlizzese, 1992, 1996; Haliassos & Bertaut, 1995; Heaton & Lucas, 2000a, b; Guiso et al., 2001); precautionary saving (Hochguertel, 2003); and housing demand and tenure choice (Dynarski & Sheffrin, 1985; Haurin & Gill, 1987; Haurin, 1991; Robst, Deitz, and McGoldrick, 1999; and Diaz-Serrano, 2005a, b). Few empirical research studies, to our knowledge, have analyzed the relationship between income risk and insurance (Guiso & Jappelli, 1998; Koeniger, 2004). This article introduces empirical models and uses a specific Taiwan database (described in Section 4) to test whether background risk increases or reduces a household's total insurance, life and health insurance and property insurance expenditures.

Gollier (2001) indicated that observable characteristics of agents, as wealth, social status, gender, occupation and the like, have an important impact on the attitude toward risk. Assume that an individual's insurance expenditure is determined by preference, wealth, income, household's characteristics and background risk. Because an individual's preference is unobservable, this study has no choice but to ignore this factor. Regarding wealth, this study defines the household resources variable as the proxy of the household's wealth by summing the households' yearly estimated real estate value and financial income according to Koeniger (2004). To account for other potential factors, the author controls for several demographic and geographical characteristics, including head of household's age; square of age; marital status; gender; head of household's years of education; number of children (under 18 years old); family size; residence region dummy (north, center, south, or east); and a dummy of the urbanization level of the residential location (city, town, or country). Finally, note that this study's main concern is background risk. Let us therefore first review some treatments of earlier research and then propose our variables for background risk.

Empirical literature previously used income risk as a proxy of background risk. This adoption is beneficial in view of both practicability and significance. DeSalvo and Eeckhoudt (1982) analyzed the effect of income uncertainty, proxied by the probability of unemployment, on housing consumption and found a negative effect. Dynarski and Sheffrin (1985) divided income into permanent and transitory components and found that transitory income plays an important role in the process of acquiring housing. They showed that renters can overcome down payment constraints when they receive a positive realization of transitory income, finding that the decision to purchase a home for existing renters was strongly influenced by transitory income. Haurin and Gill (1987) assumed that income derived from a female spouse's earnings was relatively unstable, and households used the spouse's earnings ratio be the proxy of income risk. They found that increased uncertainty about future income reduced the demand for owner-occupied housing. Haurin (1991) explicitly measured income uncertainty as the coefficient of income variation across time. He found a negative relationship between income risk and the probability of home ownership. Haliassos and

Bertaut (1995) used three occupation dummies, classifying people into low-risk, high-risk, and managerial occupations, as proxies of income risk to analyze why so few held stocks. Guiso and Jappelli (1998) constructed income risk proxy by a subjective variance, which was calculated from a "Survey of Households Income and Wealth" by the Bank of Italy. In that survey, each labor income or pension recipient was asked to attribute probability weights to given intervals of inflation and nominal income increases. Assuming a certain value of correlation coefficient between shocks to nominal income and inflation, Guiso and Jappelli (1998) estimated the variance of real income growth as the income risk proxy. Robst, Deitz, and McGoldrick (1999) used three measurements, including the coefficient of variation (CV) of income for the prior five years; residual of earnings estimation functions; and residual of individual specific regressions. Their results indicated uncertainty plays an important role in the decision to purchase versus rent, with uncertainty decreasing the probability of owning. Gakidis (1998) and Vissing-Jorgensen (2002) assumed an income process and used the variance of income realizations as proxy for income risk. Koeniger (2004) chose dummy variables of occupation risk (including unskilled manual and skilled non-manual) as proxies for income risk to analyze automobile insurance in the UK.

Specifically, this study classifies income recipients (by household heads) based on their occupation or industry. For a given occupation, the author treats the mean real income in 1992-2005 (our formation period) to be the attributed factor income for the occupation. We then take the deviation (measured by the coefficient of variation or standard deviation) of actual household incomes from the attributed income. Another income risk variable is the ratio of lowering wages (how many factories reduce employees' wages per one hundred factories on average in 2003-2005) by industry as proxy for the unobservable background risk of the household. Data for this variable is taken from Employee Turnover Statistics of Taiwan. Thus, there are three proxies for the background risk: 1) the coefficient of variation (CV) by given occupation; 2) standard deviation

(SD) of real income for a given occupation type; and 3) the ratio of lowering wage by industry (details given later). Specifically, the three alternative proxies are respectively called Income risk–CV by occupation; Income risk–SD by occupation; and the ratio of lowering wage by industry. The corresponding models are named as Model 1, 2, and 3.

Atkinson et al. (1990), Blundell et al. (1993), Blundell et al. (1994), and Banks, Blundell, and Lewbel (1997) used an expenditure share equation to study consumer demand patterns and the allocation of household expenditures. Guiso and Jappeli (1998) suggested that the share of insurance premiums of total wealth should, in fact, be a good proxy of the demand for insurance per unit of risk. Following these studies, the current study also uses insurance expenditure share (insurance expenditures divided by total consumption expenditures) to measure household demand for insurance. Some of the households in our data do not spend any income insurance; thus, the expenditure data is truncated on zero. Tobin (1958) suggested that using a censored regression method such as Tobit model was a suitable method. This study adopts the two-stage method of Sawkins and Dickie (2002) and Rubenstein and Scafidi (2002), which studied lottery participation and expenditures. The first stage of estimation, this article uses Logistic regression to analyze the household's decision of buying insurance or not. The following equation is estimated:

$$\begin{aligned}\text{logit}(P) \equiv \log \frac{\text{Prob}(INS=1)}{1-\text{Prob}(\text{INS}=1)} &= \sum \alpha_i x_i + \beta_0 Householdresource + \beta_1 Income \\ &+ \beta_2\ Incomerisk + \beta_3 Incomerisk \times Householdresource\end{aligned} \tag{16}$$

$$\text{Prob}(INS=1) = \frac{\exp^Z}{1+\exp^Z}, \text{ where} \tag{17}$$

$$\begin{aligned}Z = \sum \alpha_i x_i + \beta_0 Householdresource + \beta_1 Income \\ + \beta_2 Incomerisk + \beta_3 Incomerisk \times Householresource + \varepsilon\end{aligned} \tag{18}$$

where dependent variable Z (INS) is binary (0 for no insurance and 1 for positive expenditure of insurance), x is explanatory variables including age, the square of age, education level, sex and marriage status of a household head, family size, number of children, residential location and urbanization area.

The second stage of estimation, truncated Tobit regression is called for to deal with a limited dependent variable and to estimate how much expenditure share households spend on insurance. The equations to be estimated is:

$$\begin{aligned} INSShare = \sum \alpha_i x_i + \beta_0 Householdresource + \beta_1 Income \\ + \beta_2 Incomerisk + \beta_3 Incomerisk \times Householresource + \varepsilon \end{aligned} \tag{19}$$

which dependent variable INSShare is insurance expenditure share of a household.

OLS regressions are used to estimate how much amounts households which have positive insurance expenditure spend on insurance and to estimate the income elasticity of insurance, the equations are:

$$\begin{aligned} \ln INSExpen = \sum \alpha_i x_i + \beta_0 \ln Householdresource + \beta_1 \ln Income \\ + \beta_2 Incomerisk + \beta_3 Incomerisk \times Householresource + \varepsilon \end{aligned} \tag{20}$$

which dependent variable lnINSExpen is natural logarithm of insurance expenditure of a household and coefficient β_1 of (20) is the income elasticity of insurance.

In these estimation equations, the main Incomerisk variables are expected to have a positive effect ($\beta_2 > 0$), that means households with more income risk buy more insurance and supports that household's preference is characterized by decreasing absolute prudence and decreasing absolute risk aversion proposed by Eeckhoudt and Kimball (1992) and Kimball (1993).

4. Data and Empirical Results

The data and sample used in the empirical research will be described in section 4.1. The estimation results of the relationship between background risk and demand for insurance will be described in section 4.2.

4.1. Data and Sample

The data for this study was taken from the Survey of Family Income and Expenditure (SFIE) in Taiwan, conducted by the Taiwan Directorate-General of Budget, Accounting, and Statistics. The annual survey investigates about 14,000 households per year to capture variations in income and consumption. The data comprises family status; appliances in the household; the residence's status; family incomes (further divided into employee compensation, business owner earnings, property income, rent, and current transfer incomes); and expenditures (further divided into interest, current transfer expenditures, and consumer expenses). The consumer expenses, in turn, include expenses on food, clothing, rent/utilities, upkeep, medical care, transportation/communication, entertainment/ education, and miscellaneous.

This article proposes to measure household income risk based on the occupation and industry of household heads. For each occupation, this study calculates the standard deviation (SD) and coefficient of variation (CV) of real income in occupation, and the ratio of lowering wage by industry level to proxy the income risk for the corresponding occupation/industry. Thus, the author classifies the sample households into eight groups by occupation and 13 groups by industry with differing income risks. To prepare our proxies for income risks, this study chose 1992-2005 as the formation period to calculate the average real income for an occupation, and calculate the standard deviation (SD) and coefficient of variation (CV) of each occupation as the proxy for income risk. Regarding the ratio of lowering wage by industry, the author used Employee Turnover Statistics of Taiwan for the years 2003-2005 and calculated the ratio of lowering wage of factories. Finally, the author chose the year 2006 as the testing period by using Logistic, Tobit, and OLS regressions to show whether households with higher income risk purchase more (or less) insurance.

In our testing sample, the original data consisted of 13,681 households. After excluding some households that were missing values (some industries such as agriculture, forestry, fishing, animal husbandry, education services, public administration, Non-working and others are not presented in data of Employee Turnover Statistics) and outlier data (e.g., the household had no income and no household resources) a sample of 9,351 households remained. Of these, 9,166 households showed positive expenditures on total insurance, 7,828 households showed positive expenditures on life and health insurance, 8,807 households showed positive expenditures on property (automobile and housing) insurance. Table 1 provides sample statistics of the variables used in the regression models for the total testing sample. It also shows the sample statistics (including mean and standard deviation) of the variables for the insurance-purchase subsample (henceforth "the subsample") for households that had a positive expenditure on insurance. The appendix includes variable definitions.

As shown in Table 1, a household's total expenditure on insurance per annum has a mean of 38,883 NT dollars (about US $1,195), the household's average life and health insurance expenditure amount is 33,022 NT dollars (about US $1,015) in the total sample. The household's total expenditure share of insurance (insurance expenditure divided by total consumption) per annum has a mean of 0.045 (the life and health insurance expenditure share is 0.038). This means households on average purchase 45 NT dollars on insurance per one thousand dollars of consumption (the life and health insurance is 38 NT dollars). Table 1 also shows that the average amount and the expenditure share of insurance for the subsample (e.g., positive insurance expenditure) of the total insurance, the life and health insurance and the property insurance.

The household heads of the subsample exhibit certain characteristics. Heads of households in the three subsamples tend to be somewhat younger, and the ratio of married and male are both higher than those in total sample. The average of a household's family size and the number of children in the subsample are also higher than in the total sample. The average number of years of education for household heads is about 11.5 years. In the subsample, both the average household

Table 1. Summary statistics of total sample and subsample (with positive insurance amounts)

	Total sample		Subsample of total insurance		Subsample of life & health insurance		Subsample of property insurance	
Variables	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age	44.111	10.276	43.945	10.082	43.690	9.454	43.892	10.034
Age^2	2051.380	938.338	2032.820	911.592	1998.150	842.236	2027.170	904.864
Male	0.792	0.406	0.798	0.402	0.805	0.396	0.808	0.394
Married	0.723	0.447	0.731	0.444	0.767	0.423	0.742	0.437
Education	11.546	3.231	11.590	3.215	11.827	3.142	11.571	3.209
Family size	3.734	1.495	3.771	1.481	3.937	1.440	3.806	1.475
No. of children	0.850	1.034	0.867	1.038	0.992	1.058	0.875	1.040
Household resources	116.496	168.170	117.253	168.844	125.618	178.190	115.719	154.671
Income	938.001	623.259	949.450	622.728	1007.480	628.572	955.142	615.032
Resident in the north	0.445	0.497	0.441	0.497	0.469	0.499	0.425	0.494
Resident in the south	0.315	0.465	0.317	0.466	0.294	0.456	0.326	0.469
Resident in the east	0.038	0.192	0.038	0.192	0.032	0.176	0.039	0.193
Resident in Cities	0.860	0.347	0.859	0.348	0.871	0.335	0.855	0.352
Resident in Towns	0.129	0.335	0.129	0.335	0.120	0.325	0.133	0.339
Expenditure share on total insurance	0.045	0.044	0.046	0.044				
Expenditure on total insurance	38,886	57,802	39,672	58,113				
Expenditure share on life & health insurance	0.038	0.043			0.045	0.043		
Expenditure on life & health insurance	33,022	55,774			39,446	58,843		
Expenditure share on property insurance							0.008	0.008
Expenditure on property insurance							6,214	8,428
No. of cars and motorcycles							2.508	1.202
Income risk–CV (by occupation)	0.034	0.009	0.034	0.009	0.035	0.009	0.034	0.009
Income risk–SD (by occupation)	17.447	11.905	17.561	11.966	18.261	12.443	17.547	11.925
Income risk–Ratio of lowering wage	2.380	1.027	2.388	1.029	2.412	1.048	2.392	1.026
Sample size	9,351		9,166		7,828		8,807	

Note: Household resources, Income and Expenditure on insurance are expressed in thousand of year 2006 NT dollars.
Source: Survey of Family Income and Expenditure (SFIE) and Employee Turnover Statistics of Taiwan.

Table 2. Background risk variables: standard deviation (SD) of real income, coefficient of variation (CV) of real income and average ratio of lowering wage

Occupation	SD	CV	Industry	Ratio of lowering wage(%)
Legislators, Administrators, Business Executives and Managers	51.191	0.0549	Mining and Quarrying	1.60
Professionals	33.763	0.0471	Manufacturing	3.28
Technicians and Associate Professionals	18.677	0.0346	Water, Electricity and Gas	0.00
Clerks	12.899	0.0331	Construction	2.25
Service Workers and Shop and Market Sales Workers	9.327	0.0232	Trade	1.51
Craft and Related Trades Workers	16.062	0.0401	Accommodation and eating-drinking places	1.10
Plant and Machine Operators and Assemblers	9.899	0.0274	Transport, Storage and Communication	2.69
Laborers	8.293	0.0290	Finance and insurance	5.61
			Real estate and rental and leasing	2.16
			Professional, scientific and technical services	1.64
			Health care and social	2.43
			Cultural, sporting and recreational services	1.42
			Other Services	1.53

Note: The mean and standard deviation of real income is expressed in thousands of year 1993 NT dollars.
Source: Survey of Family Income and Expenditure (SFIE) and Employee Turnover Statistics of Taiwan.

resources and income are larger (excluding the household resources of the subsample of property insurance). Regarding the income risk variables, household heads in the subsamples have higher income risk on SD by occupation and ratio of lowering wage by industry. This means people who have a positive expenditure on insurance may face higher income risk on average than total households, including those who spend positive or nothing on insurance.

Table 2 summarizes the statistics of our background risk variables: the standard deviation and the coefficient of variation of the household real income deviated from its imputed incomes (mean real incomes by occupation from 1992 to 2005). We use three income risk variables: 1) Income risk–SD by occupation; 2) Income risk–CV by occupation; and 3) Ratio of lowering wage by industry, respectively used in Models 1, 2, and 3. Statistics of Income risk by occupation show that the occupations with higher background risk include the following: 1) legislators, administrators, business executives, and managers, and 2) professionals. Those with lower background risk include: 1) service workers and shop and market sales workers; 2) plant and machine operators, and assemblers; and 3) laborers. For Ratio of lowering wage of industry, groups such as 1) finance and insurance; 2) manufacturing; and 3) transport, storage and communication workers have higher income risk. For example, on average, 5.61 factories are lowering employees' wages per one hundred factories. Employees working in 1) water, electricity, and gas; 2) accommodations and food and drink establishments; and 3) cultural, sporting, and recreational services have lower risk.

4.2. Empirical Results

This study estimated three regression methods (Logistic, Tobit, and OLS regression) to analyze the insurance buying decision, insurance expenditure share, and insurance expenditure amount of total insurance and life and health insurance. OLS regression method is also used to analyze the property insurance expenditure of subsample which household would purchase only when they have cars, motorcycles and houses. Table 3 and Table 4 present the results of the Logistic regression of total insurance and life and health insurance. The Logistic estimation measured the probabilities of the decision to buy insurance based on household characteristics and other economic variables. The dependent variable was binary, which means a household either buys or does not buy insurance. Zero (0) was used for no insurance and 1 for a positive expenditure of insurance. Table 3 and Table 4 both show that the coefficients of the three income risk variables is

Table 3. The effect of income risk on the total insurance decision (Logistic estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	-1.9059	0.1445	-1.7133	0.1759	-1.4868	0.2432
Age	0.1041***	0.005	0.1098***	0.003	0.1035***	0.0055
Age^2	-0.0015***	<.0001	-0.0015***	<.0001	-0.0015***	<.0001
Male	0.4218**	0.0171	0.4398**	0.0118	0.4593***	0.0086
Married	0.5276**	0.0139	0.5082**	0.0178	0.5294**	0.0136
Education	0.0235	0.479	0.0118	0.7268	0.0317	0.3319
Family size	0.4894***	<.0001	0.5004***	<.0001	0.4828***	<.0001
No. of children	1.1556***	0.0005	1.1595***	0.0005	1.1557***	0.0005
Household resources	0.0026	0.2931	0.0015	0.2481	0.0015	0.3335
Income	0.0028***	<.0001	0.0026***	<.0001	0.0028***	<.0001
Resident in the North[b]	-1.4434***	<.0001	-1.4483***	<.0001	-1.4359***	<.0001
Resident in the South	0.0843	0.7866	0.0878	0.7778	0.0788	0.800
Resident in the East	0.2334	0.5981	0.2334	0.5979	0.2544	0.5656
Resident in Cities[c]	0.4551	0.4927	0.4542	0.4925	0.4516	0.4939
Resident in Towns	0.4601	0.5055	0.4684	0.497	0.4623	0.5018
Income risk–CV (by occupation)	20.6548	0.1641				
Asset* Income risk–CV	-0.0710	0.2292				
Income risk–SD (by occupation)			0.0359**	0.0376		
Asset* Income risk–SD			-0.00007**	0.0452		
Income risk–Ratio of lowering wage					0.0464	0.6802
Asset* Income risk – Ratio of lowering wage					-0.0006	0.2260

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

Table 4. The effect of income risk on the life & health insurance decision (Logistic estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	-5.3723***	<.0001	-5.1814***	<.0001	-5.079***	<.0001
Age	0.1352***	<.0001	0.1365***	<.0001	0.1367***	<.0001
Age^2	-0.00148***	<.0001	-0.0015***	<.0001	-0.0015***	<.0001
Male	-0.4019***	<.0001	-0.3934***	<.0001	-0.3774***	<.0001
Married	0.1879**	0.0285	0.181**	0.035	0.1946**	0.0231
Education	0.0824***	<.0001	0.0724***	<.0001	0.0867***	<.0001
Family size	0.2006***	<.0001	0.2098***	<.0001	0.1975***	<.0001
No. of children	1.3244***	<.0001	1.3216***	<.0001	1.3224***	<.0001
Household resources	0.00421***	0.0034	0.0034***	<.0001	0.00236**	0.0112
Income	0.00127***	<.0001	0.0012***	<.0001	0.00129***	<.0001
Resident in the North[b]	-0.0464	0.6337	-0.0474	0.6265	-0.0366	0.7066
Resident in the South	-0.5563***	<.0001	-0.5549***	<.0001	-0.5513***	<.0001
Resident in the East	-0.3639**	0.0210	-0.3608**	0.0221	-0.3517**	0.0263
Resident in Cities[c]	0.8909***	0.0005	0.8983***	0.0005	0.8723***	0.0006
Resident in Towns	0.5767**	0.0297	0.5903**	0.0261	0.5588**	0.0348
Income risk–CV (by occupation)	12.2335**	0.0349				
Asset* Income risk–CV	-0.0515	0.1690				
Income risk–SD (by occupation)			0.0212***	0.0002		
Asset* Income risk–SD			-0.00005**	0.0274		
Income risk–Ratio of lowering wage					0.00492	0.9191
Asset* Income risk – Ratio of lowering wage					0.000024	0.9459

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

positive. Note, however, the Income risk variables of Model 1 and Model 3 of Table 3 and the Income risk variable of Model 3 of Table 4 are not significantly different from zero. Further, this is consistent with Guiso and Jappeli's (1998) estimated result of casualty insurance purchasing decision. The coefficients of a household head's age and the square of age (included to capture a potential nonlinear relationship) are significantly positive and negative, respectively, showing age was concave with the probability of insurance expenditure. The age at which an individual shows a maximum probability of total insurance purchasing is calculated at approximately 35-36 years old (it is 45-46 years old on the life and health insurance decision estimate results); those younger than 35 or older than 36 have a lower probability of buying insurance. Households that have more persons or children and household heads that are married or with higher education level tend to have a greater probability of purchasing insurance. Household heads that are male tend to have a lower probability of purchasing life and health insurance but a higher probability of total insurance buying. Related to the wealth variables, both Table 3 and Table 4 show that higher household resources and income induce a higher probability of positive insurance expenditure; note, that household resource variables are not significant in Table 3.

Next, this study used information on the share of expenditures devoted to insurance to determine how expenditure share changes with income risk and other household demographic characteristics. Tobit regression is used to analyze the effect of household characteristics on total insurance and life and health insurance expenditure share. This approach examines the marginal change in demand for insurance, as well as the change in the probability of buying insurance. Table 5 and Table 6 show the results of truncated Tobit estimation of expenditure share of total insurance and life and health insurance. Similar to the Logistic regression results, the coefficients of the three income risk variables is positive (all income risk variables are significant at 95% confidence level) and the interaction term between the income risk and the value of household resources is negative

Table 5. The effect of income risk on the expenditure share of total insurance (Tobit estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	0.00362	0.6633	0.00909	0.2689	0.00638	0.4410
Age	0.00147***	<.0001	0.00149***	<.0001	0.00149***	<.0001
Age^2	-0.00002***	<.0001	-0.00002***	<.0001	-0.00002***	<.0001
Male	-0.00245**	0.0384	-0.00216*	0.0661	-0.00216*	0.0662
Married	0.00929***	<.0001	0.00923***	<.0001	0.00955***	<.0001
Education	0.00059***	0.0007	0.00051***	0.0045	0.00073***	<.0001
Family size	-0.00325***	<.0001	-0.00318***	<.0001	-0.00317***	<.0001
No. of children	-0.00014	0.7991	-0.00019	0.7286	-0.00024	0.6643
Household resources	0.00005***	<.0001	0.00003***	<.0001	-0.0000012	0.8409
Income	0.00002***	<.0001	0.00002***	<.0001	0.00002***	<.0001
Resident in the North[b]	-0.00443***	0.0004	-0.00438***	0.0004	-0.00381***	0.0021
Resident in the South	-0.00868***	<.0001	-0.00858***	<.0001	-0.00848***	<.0001
Resident in the East	-0.00444*	0.0705	-0.00428*	0.0808	-0.00388	0.1145
Resident in Cities[c]	-0.00353	0.3894	-0.00369	0.368	-0.00340	0.4067
Resident in Towns	-0.00276	0.5131	-0.00277	0.5107	-0.00314	0.4572
Income risk–CV (by occupation)	0.25457***	<.0001				
Asset* Income risk–CV	-0.00094***	<.0001				
Income risk–SD (by occupation)			0.00023***	<.0001		
Asset* Income risk–SD			-0.0000007***	<.0001		
Income risk–Ratio of lowering wage					0.00139***	0.0064
Asset* Income risk – Ratio of lowering wage					0.000002	0.1797

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

Table 6. The effect of income risk on the expenditure share of life & health insurance (Tobit estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	-0.04394***	<.0001	-0.03787***	<.0001	-0.04027***	<.0001
Age	0.00238***	<.0001	0.00240***	<.0001	0.00240***	<.0001
Age^2	-0.00003***	<.0001	-0.00003***	<.0001	-0.00003***	<.0001
Male	-0.00575***	<.0001	-0.00545***	<.0001	-0.00544***	<.0001
Married	0.01000***	<.0001	0.00995***	<.0001	0.01030***	<.0001
Education	0.00095***	<.0001	0.00087***	<.0001	0.00111***	<.0001
Family size	-0.00197***	<.0001	-0.00191***	<.0001	-0.00184***	<.0001
No. of children	0.00194***	0.0019	0.00189***	0.0024	0.00179***	0.0039
Household resources	0.00006***	<.0001	0.00003***	<.0001	0.000001	0.8646
Income	0.00002***	<.0001	0.00002***	<.0001	0.00002***	<.0001
Resident in the North^b	0.00001	0.997	0.00006	0.9676	0.00071	0.611
Resident in the South	-0.00883***	<.0001	-0.00873***	<.0001	-0.00860***	<.0001
Resident in the East	-0.00600**	0.0331	-0.00585**	0.0379	-0.00555**	0.0493
Resident in Cities^c	0.00052	0.9126	0.00033	0.9445	0.00070	0.8829
Resident in Towns	-0.00147	0.7639	-0.00150	0.759	-0.00188	0.7018
Income risk–CV (by occupation)	0.27858***	<.0001				
Asset* Income risk–CV	-0.00116***	<.0001				
Income risk–SD (by occupation)			0.00025***	<.0001		
Asset* Income risk–SD			-0.000001***	<.0001		
Income risk–Ratio of lowering wage					0.00133**	0.0200
Asset* Income risk – Ratio of lowering wage					0.000002	0.2472

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

(excluding income risk variables of Model 3 which are both positive but not significant). Income risk raises the insurance expenditure share of households, while income risk interacting with other household resources has a negative effect. This means that the expenditure share of insurance is higher in households with more income risk. It also suggests that for relatively poor households, an increase in income risk increases the expenditure share of insurance more than it does for relatively wealthy households. The results are in line with previous studies such as Koeniger's (2004), which showed that unskilled manual workers (with higher income risk) spent significantly less on motor-vehicle insurance, whereas skilled non-manual workers (with lower income risk) spent significantly more on motor-vehicle insurance than the rest of the population. Heads of household who are married and female tend to have a greater insurance expenditure share. A household head's education level has a positive relationship with share of insurance expenditure. This is consistent with Browne and Kim's (1993) estimation results of life insurance. Family size has a negative relationship with insurance expenditure share. This result is different from the result of Logistic models which show the family size variable has a positive effect. The number of children also has a negative relationship, but the coefficient is not significant (note that, Family size and number of children have a positive relationship with probability of buying insurance). The estimation results of age and the square of age show a maximum total insurance expenditure share is about 37 years old, and it is about 40 years old of the estimate results of life and health insurance. Higher household resources and income induces the more expenditure share of total insurance and life and health insurance. The estimation results of controlling variables are broadly consistent with Showers and Shotick (1994), Guiso and Jappeli (1998), and Koeniger (2004) that also analyzed insurance demand using the Tobit model. The primary results of both regressions suggest that households facing higher income risk have more insurance expenditures or a higher probability that they will choose to buy insurance. These empirical results support that a household's preference is characterized by decreasing absolute prudence and decreasing absolute risk aversion; also referred to as the well-known “standard risk aversion” condition proposed by Eeckhoudt and Kimball (1992) and Kimball (1993).

Table 7, Table 8 and Table 9 report the results of OLS estimations using the subsample withpositive insurance expenditure of total insurance, life and health insurance and property insurance to calculate the income elasticity of insurance and uncover how insurance amounts vary with income risk and other household characteristics. Table 7 shows the estimate results of total insurance of subsample, comparing the estimation results to the data in Table 5, almost all the coefficients of Table 7 have the same direction of the Tobit regression, excluding the variables “Number of children,” “Residents in Cities,” and “Residents in Towns,” which are not significant in the Tobit regression. Similar to Truett and Truett (1990), the coefficients of household head’s age respectively significantly positive, and the age with maximum of total insurance expenditure is about 34 years old. Similar to Table 3 and Table 5, the coefficients of the three income risk variables are positive (the variable “Income risk-Ratio of lowering wage” of Model 3 is not significantly different from zero at 90%). This indicates that households that have positive total insurance expenditures will increase their demand for insurance if they face higher income risk. Table 8 shows the estimate results of life and health insurance of subsample. The coefficients of household head’s age respectively significantly negative that are different from Table 7, and the age with minimum of insurance expenditure is about 58 years old. The three income risk variables are positive (but the variable “Income risk-CV” of Model 1 is not significantly different from zero at 90%). Positive insurance expenditure households with higher income risk buy more life and health insurance. Table 9 shows the estimate results of property insurance of subsample. The coefficients almost have the same direction of the estimate results of total insurance (Table 7) excluding the variable of male. The coefficients of the variable income risk-CV and the variable income risk-SD

Table 7. The effect of income risk on the natural logarithm of total insurance expenditure (OLS estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	1.5582***	<.0001	1.6645***	<.0001	1.5619***	<.0001
Age	0.0200**	0.0251	0.0203**	0.0230	0.0203**	0.0229
Age^2	-0.0003***	0.0013	-0.0003***	0.001	-0.0003***	0.0012
Male	-0.1800***	<.0001	-0.1750***	<.0001	-0.1708***	<.0001
Married	0.2992***	<.0001	0.2972***	<.0001	0.3013***	<.0001
Education	0.0297***	<.0001	0.0279***	<.0001	0.0315***	<.0001
Family size	-0.0284**	0.0104	-0.0266**	0.0169	-0.0309***	0.0051
No. of children	0.0420***	0.0081	0.0409**	0.0101	0.0432***	0.0064
Ln Household resources	0.1694***	<.0001	0.1715***	<.0001	0.1655***	<.0001
Ln Income	1.0163***	<.0001	1.0088***	<.0001	1.0254***	<.0001
Resident in the North[b]	-0.1618***	<.0001	-0.1597***	<.0001	-0.1601***	<.0001
Resident in the South	-0.3911***	<.0001	-0.3889***	<.0001	-0.3898***	<.0001
Resident in the East	-0.2707***	<.0001	-0.2678***	0.0001	-0.2619***	0.0002
Resident in Cities[c]	0.2776**	0.0159	0.2755**	0.0167	0.2713**	0.0185
Resident in Towns	0.2679**	0.0238	0.2678**	0.0238	0.2608**	0.0278
Income risk–CV (by occupation)	3.6748**	0.0174				
Asset* Income risk–CV	-0.0008	0.6737				
Income risk–SD (by occupation)			0.0044***	0.0008		
Asset* Income risk–SD			-0.000003	0.1283		
Income risk–Ratio of lowering wage					0.0171	0.1837
Asset* Income risk – Ratio of lowering wage					0.00002	0.4987
Adj R-square	0.3478		0.3482		0.3476	

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

Table 8. The effect of income risk on the natural logarithm of life & health insurance expenditure (OLS estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	3.137140***	<.0001	3.207340***	<.0001	3.139350***	<.0001
Age	-0.037980***	0.0064	-0.038090***	0.0063	-0.037890***	0.0065
Age^2	0.000326**	0.0382	0.000326**	0.0382	0.000328**	0.0369
Male	-0.148180***	0.002	-0.144570***	0.0024	-0.141260***	0.003
Married	0.121490**	0.0206	0.120060**	0.022	0.123210**	0.0188
Education	0.017100**	0.0122	0.016240**	0.0188	0.017940***	0.0072
Family size	-0.150220***	<.0001	-0.149350***	<.0001	-0.151670***	<.0001
No. of children	-0.041680*	0.0551	-0.041870*	0.0542	-0.040980*	0.0589
Ln Household resources	0.167090***	<.0001	0.169490***	<.0001	0.161020***	<.0001
Ln Income	1.090140***	<.0001	1.086590***	<.0001	1.093130***	<.0001
Resident in the North[b]	-0.132490***	0.0054	-0.130520***	0.0061	-0.130560***	0.0061
Resident in the South	-0.446890***	<.0001	-0.445060***	<.0001	-0.445290***	<.0001
Resident in the East	-0.376620***	0.0002	-0.374220***	0.0003	-0.365780***	0.0004
Resident in Cities[c]	0.088200	0.6267	0.084930	0.6394	0.083820	0.6437
Resident in Towns	0.016680	0.9284	0.015400	0.9339	0.008300	0.9644
Income risk–CV (by occupation)	2.804960	0.1796				
Asset* Income risk–CV	-0.001120	0.6466				
Income risk–SD (by occupation)			0.003080*	0.0748		
Asset* Income risk–SD			-0.000003	0.2193		
Income risk–Ratio of lowering wage					0.030530*	0.078
Asset* Income risk – Ratio of lowering wage					0.000014	0.6629
Adj R-square		0.2111		0.2113		0.2114

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.
b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

Table 9. The effect of income risk on the natural logarithm of property insurance expenditure (OLS estimates)

	Model 1		Model 2		Model 3	
Indep. Variables	Coef.	p-valve	Coef.	p-valve	Coef.	p-valve
Intercept	4.793350***	<.0001	4.960400***	<.0001	4.745180***	<.0001
Age	0.001310	0.8088	0.001810	0.7378	0.001390	0.7991
Age^2	-0.000048	0.4272	-0.000059	0.3282	-0.000046	0.4501
Male	0.060520***	0.0029	0.066730***	0.0009	0.073470***	0.0003
Married	0.162890***	<.0001	0.160750***	<.0001	0.161570***	<.0001
Education	0.019790***	<.0001	0.017120***	<.0001	0.023660***	<.0001
Family size	-0.099820***	<.0001	-0.097310***	<.0001	-0.103550***	<.0001
No. of children	0.099870***	<.0001	0.098180***	<.0001	0.101870***	<.0001
Ln Household resources	0.071640***	<.0001	0.074950***	<.0001	0.077250***	<.0001
Ln Income	0.332950***	<.0001	0.317530***	<.0001	0.358490***	<.0001
Resident in the North[b]	-0.209430***	<.0001	-0.205120***	<.0001	-0.207570***	<.0001
Resident in the South	-0.296550***	<.0001	-0.293880***	<.0001	-0.294940***	<.0001
Resident in the East	-0.113170***	0.0059	-0.110710***	0.0069	-0.109540***	0.0079
Resident in Cities[c]	-0.074550	0.2702	-0.073650	0.275	-0.087000	0.199
Resident in Towns	0.071160	0.3064	0.072930	0.2937	0.061630	0.3768
No. of cars or motorcycles	0.389020***	<.0001	0.391180***	<.0001	0.387390***	<.0001
Income risk–CV (by occupation)	4.276550***	<.0001				
Asset* Income risk–CV	0.005380***	<.0001				
Income risk–SD (by occupation)			0.004960***	<.0001		
Asset* Income risk–SD			0.000006***	0.0004		
Income risk–Ratio of lowering wage					-0.012570	0.1119
Asset* Income risk – Ratio of lowering wage					0.000062***	0.0025
Adj R-square		0.4444		0.4464		0.4418

Note: a: The symbol *** significance at 99%, ** significance at 95%, * significance at 90%.

b, c: The basic (omitted) resident variables are Resident in the Center and Resident in Countries.

are positive (the Income risk variable of Model 3 is negative and not significantly different from zero at 90%). This indicates that households with higher income risk will increase their demand for property insurance.

The coefficients of the variable “Income” show the income elasticity of total insurance, life and health insurance and property insurance. The coefficients of income elasticity of total insurance and life and health insurance are both a little larger than one, the income elasticity of property insurance is also positive but smaller than one[3]. The results mean a household’s income change has a positive effect on the consumer’s demand for insurance. This result is consistent with some empirical studies such as Beenstock et al. (1988), Outreville (1990), Truett and Truett (1990), Cleeton and Zellner (1993), Browne and Kim (1993), Showers and Shotick (1994), Eisenhauer (1997), and Enz (2000) all of which found that people tend to increase insurance expenditures with respect to an increase in wealth. This supports the notion that insurance is a normal good.

5. Conclusion

In real life, people almost always make choices with various background risks. Decision behavior with background risks is both interesting and important. Over the past few decades, a considerable number of studies have been conducted on this topic, and many illuminating results have been derived. Most of these results, both theoretical and empirical, investigate risk-averse agents and household portfolio decisions including risky assets, housing, saving, and casualty and automobile insurance. None, to our knowledge, however, have focused on the issue in the context of household’s total insurance, life and health insurance and property insurance expenditures.

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[3] This study also estimates $\ln INSExpen = \beta_0 + \beta_1 \ln Income + \varepsilon$ by five equal divisions according to income, and the estimations of the coefficient β_1 (income elasticity) of total insurance from lowest to highest income level are equal to 1.0898, 1.7146, 1.6179, 1.3185, and 0.8436. The income elasticity of total sample is equal to 1.2818. This result shows income elasticity of highest and lowest income level households are smaller. The estimation results of income elasticity of life and health insurance and property insurance are similar to the result of total insurance.

Empirical literature previously used income risk as a proxy of background risk. This adoption is beneficial in view of both practicability and significance. The purpose of this study was to discover whether households buy more insurance after empirically introducing an independent background risk.

Using the Survey of Taiwan Family Income and Expenditure and Employee Turnover Statistics, this article constructed three indexes to be proxies of background risk, including the standard deviation (SD) and coefficient of variation (CV) of real income in occupation and the ratio of lowering wage by industry level to measure income risk. To further check the question whether increasing background risk causes households to purchase more or less insurance, the dataset of year 2006 Survey of Taiwan Family Income and Expenditure was used to empirically explore the effect on household insurance expenditure of income risk. This study's results found that households with more income risk purchase more insurance, after controlling other factors, including household resources and income; the age, sex, marriage status, and education of the household head; family size; and residential area by using Logistic, Tobit, and OLS regression models. This finding is similar to the empirical results of Guiso and Jappelli (1998) and Koeniger (2004) that suggest that a household's preference is characterized by decreasing absolute prudence and decreasing absolute risk aversion, otherwise known as the "standard risk aversion" condition proposed by Eeckhoudt and Kimball (1992) and Kimball (1993). This study also found that the coefficient income elasticity of insurance is positive, which means people tend to increase insurance expenditures with respect to an increase in income. This supports the notion that insurance is a normal good. This result is consistent with most empirical studies of insurance demand that suggest that a consumer's income change has positive effect on the consumer's demand for insurance.

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Appendix: Definition of variables

Age: the age of the head of the household.

Married: a dummy with value 1 if the head of the household is married, and 0 otherwise.

Male: a dummy with value 1 if the head of the household is male, and 0 otherwise.

No. of children: number of children under 18 years old.

Family size: number of people of the household.

Education: education years of the head of the household, the original data give ranked classification of education level (elementary, junior high, senior high, community college, and university, graduate). We translate the rank into education years as follows:

= 6 if education level is elementary school or under,

= 9 if education level is junior high school,

= 12 if education level is senior high school,

= 14 if education level is community college school,

= 16 if education level is university,

= 18 if education level is graduate school and above.

Income: yearly factor income of a household, including employee compensation, business owner earnings, property income, rent, and current transfer incomes.

Household resources: rent of real estate and property revenue of a household.

Resident in Cities: a dummy with value 1 if the household lives in a "city."

Resident in Countries: a dummy with value 1 if the household lives in a "country."

Resident in Towns: a dummy with value 1 if the household lives in a "town."

The SFIE classifies residential regions into "cities", "countries" and "towns" by the proportion of occupation industries of the residents: To be a "city," a region must have less than 25% employment proportion in Agriculture, Forestry, Fishing, Animal and Mining and

Quarrying industries, *and* more than 40% in Service industries. To be a "country," the employment proportion must be more than 45% in Agriculture, Forestry, Fishing, Animal and Mining and Quarrying industries. Others are classified as "towns."