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產品責任保險與企業風險管理

Product Liability Insurance and Enterprise Risk Management

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摘 要

本文目的在於探討產品責任保險與企業風險管理之關係，並經由下列四個構面進行分析：(1) 可行之風險管理工具；(2) 公司理財；(3) 公司本身特質；(4) 企業經營效率。本文之實證研究結果除支持 Ehrilich 與 Becker (1972) 之傳統理論—認為保險可與其他風險管理工具互為補充品；並且亦支持近日 Culp (2001) 之主張—認為風險管理工具不僅具有傳統上控制風險之功能，同時亦可促進企業提高經營效率。此外，本文研究發現企業對於產品責任之風險管理可以穩定其股票報酬率之波動，但是並未能提高其公司價值。

【關鍵字】企業風險管理、產品責任風險、保險需求

Abstract

The purpose of this paper is to study the relationship between product liability insurance and enterprise risk management. The analyses include four constructs: (1) alternative risk management tools, (2) corporate finance, (3) firm features, and (4) business operation efficiency. The empirical results support Ehrilich and Becker (1972) that insurance and other risk control programs can be complements and support Culp (2001) that risk management can play the role of efficiency enhancer in addition to the role of classical risk controller. Additionally, this study finds that risk management for product liability may stabilize the volatility of stock returns but does not increase the firm value.

【Keywords】enterprise risk management, product liability risk, insurance demand

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1. Introduction

Developments in economy and technology have made products more innovated and complicated. Consumers may encounter higher potential risk of injury from new products when they enjoy the utility of product innovation. Because of the consumerism in modern society, firms are required by law to provide protection to consumers in case of product injury. In Taiwan product liability insurance became compulsory for the food industry in 2008. Therefore, firms must pay more attention to managing product liability risk, including product quality control, safety program, and compensation for damages. The legal system and regulations for product liability have significant influence on the production cost. Viscusi and Moore (1993) suggest that a huge expected liability cost can discourage the incentives for product innovation. The impacts of product injury on a firm include not only the monetary payment of damages but also the impairment of goodwill and business image. Therefore, almost all businesses employ some types of risk management for product liability risk, including pre-event loss preventions and post-event loss financing such as insurance and emergency funds. These risk management tools are costly and firms need to consider their benefits and costs. There are several factors involved in the decision of risk management, such as the features of the firm, the cost of the selected tools, the manager's risk attitude, the stakeholders' concerns, etc.

In addition to protection for the consumers, risk management of product liability can facilitate the efficiency of business operations since it is a part of enterprise risk management (ERM).[1] Slywotzky and Drzik (2005) indicate four types of risk for an enterprise, hazard risk, financial risk, operational risk, and strategic risk. Product liability risk must be treated as a core (strategic) risk as well as a noncore (hazard) risk for a firm because it is related to the firm's market competition, although liability risk is traditionally regarded as an exogenous and noncore risk for a firm. Therefore, the loss control decision for product liability should be based on the view of enterprise-wide risk management instead of an independent hazard risk. According to the concept of business competitive strategy indicated by Fiegenbaum and Thomas (2004), the risk appetite of a firm interacts with the corporate strategies and performance. Culp (2001) also suggests that a well designed risk

[1] According to COSO (2004), ERM is a process…… , applied in a strategy setting ……, to provide reasonable assurance regarding the achievement of entity objective. However, there are other definitions of ERM appeared in the past few years since it is a new concept and no specific definition accepted by everyone yet (Hampton, 2009). In summary, ERM is regarded as a holistic approach aligning strategy, processes, people, technology, and knowledge to manage uncertainties as the enterprise creates value.

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management program can serve as an efficiency enhancer as well as a classical risk controller. Therefore, the product liability risk should not be managed independently of other business strategies.

The purpose of this paper is to study the enterprise risk management of product liability risk through a two-fold analysis. This paper first analyzes the determinants of demand for product liability insurance, which is one of the most popular risk management tools for product liability risk. This analysis shows the considerations related to the risk management decision. Second, it studies the impact of product liability risk management on the firm value and stability, which are the objectives of business policies. The analyses of product liability insurance and management strategy include four constructs: (1) alternative risk management tools, (2) corporate finance, (3) features of the firm, and (4) business operation efficiency.

Most previous empirical studies, for example, Hoyt and Khang (2000) and Regan and Hur (2007), analyze the corporate demand for insurance based on aggregate product-liability insurance data instead of a specific insurance line. The exception is the study by Beatty, Gron, and Jorgensen (2005) which conducts empirical analysis on product liability insurance. However, they focus the analyses only on the financial aspect and managerial compensation incentives. According to observations in practice, we believe that the determinants for product liability insurance are not limited to financial reasons or managerial incentives. Business operations such as marketing are also important for the insurance decision. Many manufactured products are exported to other countries and subjected to different product liability regulations. The underlying motivations for firms to purchase product liability insurance could be more than financial incentives. In addition to the practical business reasons, in theory the alternative risk management tools themselves may affect the demand for insurance, as suggested by Ehrilich and Becker (1972) and Courbage (2001).

According to Culp (2001) and Harrington and Niehaus (2003), the objective of risk management is to reduce the probability of financial distress for the firm and maximize the firm value. Previous literature has contributed to the study of the impact of risk management through hedging on the firm value (MacKay & Moeller, 2007). However, it is unknown empirically whether risk management on nonfinancial risk contributes to the firm value. In practice, firms manage product liability risk through insurance and/or other tools such as loss prevention and self-insurance. The effects of using these tools have not yet been extensively examined. This paper attempts to discuss the influence of risk management

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strategies for product liability on the firm value and its fluctuations.

The empirical study of this paper is based on the data from the questionnaire as well as the published financial statements of the publicly traded companies in Taiwan. The following section presents the literature review to understand the issues of corporate demand for product liability insurance and its impact on the firm value, and then the testing hypotheses are developed. The sample data and research methodology are described in section 3. Section 4 presents the empirical results and discusses the implications. The conclusion is provided in the final section.

2. Literature Review and Hypotheses Development

Product liability for a firm results from manufacturing or distributing defective products which cause bodily injury or property damage to customers or third parties. The direct losses from product liability usually include the payment for damages and legal costs. In some cases product liability might indirectly impair the goodwill and public image of the firm and result in the reduction of future sales. Firms take insurance or other risk control tools to resolve product liability quickly to minimize the indirect impact on the goodwill, in addition to the direct payment for damages. The previous literature has analyzed the demand for insurance from several aspects, including the cost of risk management methods, financial distress, the manager's incentives, etc. Therefore, in this paper the analyses of product liability insurance and risk management strategy include four constructs: (1) alternative risk management tools, (2) corporate finance, (3) features of the firm, and (4) business operation efficiency.

Ehrilich and Becker (1972) pioneer the theoretical discussion of the relationship between alternative risk management tools, market insurance, self-insurance, and self-protection. Because risk management is costly, it is impossible for the firm to employ all the methods. Ehrilich and Becker (1972) suggest that market insurance and self-insurance are substitutes but market insurance and loss protection can be complements. Courbage (2001), with consideration of background risk and information asymmetry, finds the results consistent with Ehrilich and Becker (1972). Dionne and Eeckhoudt (1984) suggest that the risk-averse will prefer low risk activities and the increase in risk aversion will increase self-insurance but not loss prevention. Based on these studies, the following testing hypotheses regarding alternative risk management tools are developed.

H1a. The firm's demand for product liability insurance is positively related to its loss prevention program.

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H1b. The firm's demand for product liability insurance is negatively related to its self-insurance program.

From the viewpoint of corporate finance, a firm without sufficient funds for emergencies may rely on insurance to supply the risk capitals (Culp, 2001). Beatty et al. (2005) consider the insurance demand to be related to the firm's risk capacity. They suggest that a firm with low risk capacity will demand more insurance and the risk capacity can be a function of firm size, funding cost, liquidity, etc. Fatemi and Luft (2002) remind that the fluctuations of net cash flow might increase the probability of financial distress and suggest that risk management can help to protect the shareholders' value. The studies by Mayers and Smith (1982) and Regan and Hur (2007) indicate that small firms may have higher insurance demand. Probably the firm size implies both human and economic capitals for risk management service and funding.

Additionally, the firm might incur litigation costs after financial distress because of the claim for injury. The firm will encounter a higher probability of bankruptcy when its liquidity is low. In such a case the insurance proceeds can provide the firm with quick funds and reduce the reliance on external financing. Hoyt and Khang (2000) find that the firms with higher potential cost of financial distress have more incentives to buy insurance. In summary, the testing hypotheses regarding the relationship between corporate demand for insurance and its financial construct are listed as follows.

H2a. The firm with better risk capacity will demand less product liability insurance.

H2b. The firm with lower liquidity will demand more product liability insurance.

The construct of firm features emphasizes two aspects: the product exposure and the agency problem of managers.[2] The potential liability risk is of course related to the loss exposure of the product itself. The loss severity and frequency of product liability depend on type of product, sales volume, and sales area. For example, a firm with larger sales volume or sales area in North America may demand more insurance. Smith (1986) and Regan and Hur (2007) indicate that other stakeholders such as customers and distributors are also concerned with risk management because their interests might be affected by the firm. According to product liability law in the U.S., distributors are liable for the injury caused by products sold through their stores. Therefore, firms exporting products to North America sometimes purchase insurance at the request of the importers. The testing hypotheses for the

[2] Although firm size is usually a variable for the firm feature, it is already included in the finance construct and thus omitted here.

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insurance demand due to the loss exposure of product are presented in the following.

H3a. The demand for product liability insurance is positively related to the sales volume.

H3b. The firm which exports products to North America will demand more product liability insurance.

The agency problem is another important consideration for corporate risk management. Culp (2001) suggests that risk management can increase the firm value when there is agency conflict between managers and shareholders which may result in underinvestment or overinvestment problems. Mayers and Smith (1987) show that the underinvestment problem can be controlled through the purchase of insurance. MacMinn (1987) and Garven and MacMinn (1993) explain how insurance can improve the underinvestment problems which usually happen in firms with higher leverage ratio. Therefore, firms with higher leverage will demand more insurance. On the other hand, high leverage may cause the overinvestment problem because of the shareholders' moral hazard to transfer potential financial distress costs to debtholders. Garven and MacMinn (1993) suggest that insurance can help to reduce this moral hazard.

Furthermore, the manager's job security and compensation are connected to the business operation. Zou and Adams (2006) suggest that managerial risk-aversion and incentive-alignment can be the factors affecting corporate insurance demand. Saunders, Strock, and Travlos (1990) indicate that the manager will prefer risky investment when his shareholding increases and becomes close to shareholders' interests. On the other hand, Smith and Stulz (1985) and Tufano (1996) suggest that the manager's risk aversion has an impact on the risk management decision and he may try to diversify risk. Based on the previous literature, the impact of the agency problem on corporate insurance demand in fact is inconclusive. Therefore, the testing hypotheses for the agency problem are as follows.

H3c. The firm with higher leverage ratio will demand more product liability insurance.

H3d. The manager's shareholding has a positive or negative impact on the demand for product liability insurance.

Finally, the construct of business efficiency is investigated for its impact on insurance demand. According to Culp (2001), the function of risk management is not only as a risk controller but also an efficiency enhancer. The firm can integrate its risk management program with other business operations to improve its efficiency. For example, product liability insurance can serve as a marketing tactic to attract consumers because of more protection. A quick settlement for product injuries through insurance payments may limit the impairment of the firm's public image. Viscusi and Moore (1993) suggest that the expected

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liability cost has a negative impact on the product innovation. The firms might be reluctant to innovate on products because of the fear of huge liability cost for injury. If insurance helps to reduce the expected liability cost, it can contribute to product innovation and potential market competition and profitability. On the other hand, insurance premiums will increase the production cost and price, and this increase is a disadvantage for market competition. The overall motivation of the firm in buying insurance to enhance business efficiency is unknown yet. This paper will test the motivation for enhancing business operations through insurance by the following hypotheses.

H4a. The firm will increase the demand for product liability insurance because of its contribution to business operations.

H4b. The firm will reduce the demand for product liability insurance because of its increase in production cost.

The second phase of this study is to test the relationship between product liability risk management and firm value. Modigliani and Miller (1958) argue that in a perfect capital market the management for unsystematic risk will not increase the firm value because the benefit from risk management is offset by its cost. The shareholders can diversify the unsystematic risk through the stock market and will not change their expectation on the stock prices. On the other hand, Culp (2001) suggests that risk management can serve as efficiency enhancer in addition to risk controller. That is, risk management can stabilize the fluctuations of business operations and increase the firm value. Fatemi and Luft (2002) explain that risk management can increase the firm value if there are information asymmetry and transaction costs in implementing risk management strategies. In summary, it is arguable whether risk management can increase firm value. The empirical evidence on this issue is still limited. To investigate the impact of risk management on firm value, this paper develops the following hypotheses.

H5a. The firm value is positively related to the firm's product liability risk management programs.

H5b. The fluctuations of firm value are negatively related to the firm's product liability risk management programs.

3. Sample and Model

3.1 Data and Sample

The data of risk management programs for product liability are not available from the annual reports or any public data base in Taiwan. Therefore, this paper applies a survey to

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ask firms the information about their product liability risk management plans. The questionnaire used for the survey appears in appendix 1. The survey provides data for the firm's product liability loss experience, sales area, purchase of insurance for year 2007, other risk management programs such as safety control and self-insurance (product-recall) funds, the motivations for buying insurance, and comments about the impact of product liability insurance on operation efficiency. The 5-point Likert scale is used for the questions related to the risk management decision. A higher score in a question indicates greater agreement with the statement. For example, the score for "strongly agree" is 5 and the score for "strongly disagree" is 1.

The survey is issued to 440 publicly traded companies listed on the Taiwan Stock Exchange in year 2007.[3] The effective response rate is 20.45%, and 90 companies from various industries responded as shown in appendix 1. Among them there are 56 companies with product liability insurance and 34 without insurance. In addition to the survey data, we retrieve for these 90 firms available public data such as financial statements and stock returns from Market Observation Post System (MOPS) and Taiwan Economic Journal (TEJ). These public data provide the information on profitability, sales, assets, capitals, directors' and managers' shareholdings, and other features of the firms for years 2006 and 2007. The financial data of year 2006 are applied to study the determinants of insurance demand because the insurance is purchased at the beginning of year 2007. The financial conditions at the end of year 2006 will influence the insurance decision. The financial data of year 2007 are applied to study the effect of product risk management on the firm value because the impact of insurance is supposed to show after the purchase. The descriptive statistics of the sample data are listed in table 1.

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[3] With consideration of the limited popularity of risk management, the companies are selected first based on the top 500 listed in Commonwealth magazine. Then the non-public companies are deleted due to unavailability of financial data. Furthermore, the financial institutions are excluded since they usually do not purchase product liability insurance.

Table 1 The descriptive statistics of the sample

Variable	N	Mean	Std Dev	Minimum	Maximum
Insurance amount (NTmillion)	77	212	1124	0	9852
Insurance purchase (yes/no)	90	0.622	0.488	0	1
Loss prevention	89	4.427	1.065	0	5
Self-insurance	89	0.270	0.446	0	1
Beta	90	0.811	0.675	-0.017	5.779
Current ratio	90	2.114	1.375	0.160	8.163
ln (assets NT1000)	90	15.684	1.235	13.295	20.133
ln (sales NT1000)	90	15.374	1.398	12.539	19.959
Leverage ratio	90	0.366	0.152	0.067	0.970
Share %	90	24.6	15.8	4.4	79.1
Tobin's q	89	1.861	1.289	0.509	8.986
Volatility%	89	6.267	9.645	0.283	69.431
Sales growth	90	0.071	0.250	-0.562	1.081
ROA	90	0.061	0.094	-0.248	0.363

Note: Due to the missing data for some firms' responses and market values of stocks, the sample sizes may vary for different variables.

3.2 The Model and Proxies for Explanatory Variables

This paper considers the enterprise risk management for product liability risk as related to four constructs of the firm: (1) substitution of alternative risk management tools (T), (2) corporate finance (C), (3) the features of the firm (F), and (4) business operation efficiency (B). Therefore, the testing model for insurance demand (I) of firm i can be presented by the following equation.

$$I_i = f_i(T_i, C_i, F_i, B_i) + \varepsilon_i \quad (1)$$

In the empirical analysis, the dependent variable (insurance demand, I) is represented by the firm's insurance decision. The proxies for insurance demand include (1) dummy variable (1/0) for purchasing/not purchasing product liability insurance and (2) natural logarithm of product liability insurance amount. The independent variables are the factors related to each construct. Logistic regression is applied when the dependent variable is 1/0 dummy. The OLS and Tobit regression analyses are applied when insurance amount is used for the insurance demand. Tobit regression model is to consider the possible effect of

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censored data because the insurance amount is latent for those firms without insurance coverage.

The proxy for alternative risk management tools (T) is the answer for risk control programs. The number of loss prevention programs is the sum of scores on questions 26-30 of the survey in appendix 1. In each question the score is 1 for the firm with that program, and 0 otherwise. The firm with more programs will get a higher score. For example, the score is 5 if the firm has all five loss prevention programs. The proxy for the self-insurance program is the answer for question 31 about the funding for product recall, yes=1 and no=0. When the firm has funding for recalls as soon as the product defects are found, the product liability claims probably can be reduced.

The variables for the financial construct (C) include firm size (natural logarithm of asset), beta, and current ratio. As indicated above, asset size is an important factor for the firm's risk capacity. Besides, the firm with higher beta usually incurs higher external financing cost because of higher systematic risk and this implies lower capacity for assuming risks. The current ratio indicates the liquidity and the potential cost of financial distress. The lower the current ratio and liquidity, the higher the probability of the financial distress is.

The features of the firm (F) include its sales volume, sales area, and agency problem. The sales volume is measured by the natural logarithm of sales. Sales volume is the measurement for potential product liability risk because a firm with more sales may imply higher liability risk. However, because the sale size is highly correlated to the firm's asset size,[4] these two variables will not be included in the same testing model to avoid multicollinearity. The sales area usually indicates the legal system for product liability. A dummy variable D=1 is used for the firm with sales area in North America and D=0 otherwise, because the U.S. and Canada importers usually require more protections for product liability. Agency conflict is another feature specific for each firm and is represented by the shareholding percentage of insiders (directors and top management) and leverage ratio.

The factors for business operations efficiency include regulation, stability, marketing, production, and cost. The proxy for regulation is the score on question 11 about whether the insurance demand is under the regulatory force. A higher score implies that insurance is not for business operation purposes but is unwillingly carried according to legal requirement. The proxy for stability factor is the factor score extracted from questions 12-16 by way of

[4] The correlation coefficient between asset size and sales volume is 0.91.

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exploratory factor analysis (EFA). These questions are regarding the firm's motivation for purchasing insurance to stabilize business interruption risk. Two proxies for marketing aspect are used. The first one, distributor factor, is the score on question 10 whether the purchase of insurance is due to the request of distributors. Another proxy is the factor score extracted from questions 17-19 based on exploratory factor analysis. It is called marketing factor because questions 17-19 are related to the motivation of insurance for marketing purposes. The production factor is the factor score extracted from questions 20-23 where the respondent considers that insurance will affect product quality and innovation and promote sales volumes. The effect on insurance demand is positive if insurance encourages incentive of care but is negative if insurance causes moral hazard in the duty of care. The cost factor is the factor score extracted from questions 24-25 where insurance is considered as an extra production cost. The definitions and proxies of variables and expected effect on insurance demand are summarized in table 2.

Table 2 Definition of variables and the expected effect on product liability insurance demand

Construct	Variables	Expected effect	Description of data
Product liability Insurance demand	insurance-yes/no		dummy variable = 1/0
	insurance amount		ln (insurance amount)
Alternative of RM tools (H1)	loss prevention	+	total score on questions 26-30
	self-insurance	-	score on question 31
Corporate finance (H2)	Asset size	-	ln (total assets in 2006)
	Beta	+	average of beta in 2006
	current ratio	-	current assets/current liab. 2006
Features of the firm (H3)	sales volume	+	ln (sales in 2006)
	sales area	+	dummy variable =1/0 for sales area in North America or not.
	leverage ratio	+	liabilities/assets in 2006
	Insiders shareholding %	+/-	shares % owned by the directors and top management in 2006
Business operation efficiency (H4)	regulatory force	-	Likert point on question 11
	stability factor	+	factor score extracted from questions 12-16
	distributor request	+	Likert point on question 10
	marketing factor	+	factor score extracted from questions 17-19
	production factor	+/-	factor score extracted from questions 20-23
	cost factor	-	factor score extracted from questions 24-25

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In the second phrase regarding the impact of product liability insurance and risk management programs on the firm value, the OLS regression is applied for the test. The testing model is presented by the following equation.

$$V_i = f_i (I_i , LP_i , SI_i , K_i) + \varepsilon_i \quad (2)$$

The dependent variable related to firm value V in equation (2) for testing hypothesis H5a is measured by Tobin's q as a proxy. Based on Black, Jang, and Kim (2006), the fomula for calculating Tobin's q is equal to the market value of assets over the book value of assets, where the market value of assests is the book value of assets plus market value of equity minus book value of equity.[5] The dependent variable for testing hypothesis H5b regarding the fluctuation of firm value is measured by the volatility of stock returns. The explanatory variables are the risk mangement tools including insurance (I), loss prevention programs (LP), self-insurance plan (SI), and other control variables for the firm such as sales growth and financial information (K). According to the previous literature for firm value such as Black et al. (2006), the asset size has negative impact on Tobin's q, while beta, current ratio, sales growth rate, and ROA have positive effects on firm value. The impact of insiders' shareholding is indeterminate. The definition and proxies of variables and the expected effects are summarized in table 3.

[5] Although Tobin's q is defined as the ratio of the market value of assets to the replacement cost of assets, it cannot be measured directly from the information reported on the firm's financial statements. There are various measuring formulas for Tobin's q in the previous literature. With consideration of data availability, this paper adopts the proxy based on Black et al. (2006).

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Table 3 Definition of variables and the expected effects on the firm values

Variables	Variables	Expected effect [1]		Description of data
Dependent variable	Tobin's q	H5a		market value of assets / book value of assets in 2007
	stock volatility	H5b		stock volatility of the firm in 2007
Explanatory variables-risk management tools	loss prevention	+	-	total score of question 26-30
	Self-insurance	+	-	score of question 31
	product liability insurance	+	-	(1) 1/0 for yes/no insurance (2) ln (insurance amount)
Explanatory variables-control variables	asset size	-	-	ln (assets in 2007)
	beta	+	+	average of beta in 2007
	current ratio	+	+	current assets / current liabilities 2007
	sales growth rate	+	+	sales growth rate in 2007
	returns on asset	+	+	ROA of the firm in 2007
	Insiders shareholding %	+/-	+/-	shares % owned by the directors and top management in 2007

Note: The expected signs in the first line are for hypothesis H5a, and those in the second line are for hypothesis H5b.

4. Empirical Results

The factor loadings used to calculate the factor scores for the business operation efficiency are listed in table 4. The loading coefficients are very close within each factor, thus implying that there is a common factor affecting the answers of those questions. These factors can explain about 60-70% variance among the answers.

Table 4 The factor loadings for the four aspects of business operations

	Stability	Marketing	Production	Cost
Question no.	Q12	Q17	Q20	Q24
(factor loading)	(0.709)	(0.791)	(0.736)	(0.877)
Question no.	Q13	Q18	Q21	Q25
(factor loading)	(0.856)	(0.855)	(0.803)	(0.877)
Question no.	Q14	Q19	Q22	
(factor loading)	(0.703)	(0.893)	(0.814)	
Question no.	Q15		Q23	
(factor loading)	(0.800)		(0.841)	
Question no.	Q16			
(factor loading)	(0.770)			
Cumulative % of total variance Explained	59.28%	71.79%	63.93%	76.97%
sample size N	90	90	90	90

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Based on these factors and other information from financial statements, the empirical results for the determinants of product liability insurance purchase decision are presented in table 5. The regression analyses show that the alternative risk management programs are positively related to the purchase of insurance, no matter in which models. Firms with more loss prevention tools or with self-insurance funds will purchase insurance. This result supports the Ehrilich and Becker (1972) argument that loss prevention and market insurance may be complements but contradicts their argument that market insurance and self-insurance are substitutes. This finding suggests that once a firm is more concerned with product liability risk, it will employ more risk management programs regardless whether they are for loss prevention or loss reduction. That is, the risk culture of the firm probably is the critical reason for risk management, instead of wealth indicated in the economics. The regression analysis based on insurance amount, as shown in table 6, also indicates that the insurance demand has a significantly positive relationship with other risk management alternatives.

In the finance construct, the empirical analysis shows that the asset size is the primary determinant for insurance demand. Firms with more assets will purchase more insurance, which does not support the hypothesis of risk capacity. Probably in practice a big firm usually has more sales and more modern management strategies and thus will pay more attention to risk management. Additionally, it is more possible for a big firm to be a lawsuit target because of its capability to pay the damages. This result is consistent with the finding of Shu (2000) on litigation risk. Another proxy for risk capacity, beta, shows no significant relationship with insurance demand. The effect of liquidity on the insurance is ambiguous. The current ratio shows little impact on the yes/no purchase decision in most models of table 5, but it may have some positive relationship with the insurance amount as shown in table 6 which is inconsistent with the prediction. In summary, the empirical finding implies that the finance construct is a complement to the insurance demand, instead of a substitute. Firms with more assets or liquidity will support or afford the risk management program, which implies that demand for insurance is not just for financing losses.

The regression analysis on the construct of firm's feature shows that the sales volume and sales area are important factors for insurance demand. It is not surprising that the sales volume will provoke the demand for insurance since the potential product liability risk is related to the products sold. The liability risk is higher when the products are sold to North America because the legal system in that area usually provides more protections to the consumers. The empirical results confirm that the demand for insurance is significantly higher for firms with products exported to North America. On the other hand, the agency

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conflict seems not directly related to the insurance demand. Neither the purchase decision nor the coverage amount shows a significant relationship with the leverage ratio or the insiders' shareholding. These results suggest that product liability insurance demand is relevant to market reasons more than the agency problem.

From the viewpoint of business operation efficiency, the marketing aspect is the most important concern in the demand for insurance as shown in tables 5 and 6. Both the distributor's request and the marketing promotion affect the demand for insurance positively. The firms purchase insurance to facilitate the marketing of products. Next, in the regulatory aspect the results show that the firms are willing to purchase insurance for some business purposes. The insurance demand is not due to the regulatory force. The stability factor is not significantly related to the insurance demand, which implies that the function of insurance for controlling unexpected business interruption and liability loss is not a major concern. Probably most firms in Taiwan have not yet experienced huge loss claims for product liability and thus do not purchase insurance primarily for the concern of indemnities. The production and cost factors are not important aspects for insurance, either. The empirical results in table 5 show that the insurance purchase decision is not significantly related to product innovation or quality control. It implies that insurance is primarily used for marketing purposes but not yet as a tool to encourage product innovation or quality. Besides, the insurance premium is still low in Taiwan and thus it does not affect significantly the production cost or price. The results in table 6 show that the insurance amount is negatively related to the production factors, which suggests that firms with more insurance do not agree on the care incentive of insurance. The firms still consider that insurance may cause moral hazard in the duty of care. Another potential reason probably is that the insurer is unwilling to cover innovated products.

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Table 5 The determinants of product liability insurance demand, Y=yes/no

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Intercept	-2.431	-7.893	-13.960	-15.217	-12.075
	(0.034)**	(0.052)**	(0.010)**	(0.013)**	(0.013)**
Loss prevention	0.580	0.582	0.795	0.837	0.764
	(0.021)**	(0.026)**	(0.009)**	(0.019)**	(0.025)**
Self-insurance	1.630	1.574	2.172	1.917	1.938
	(0.016)**	(0.024)**	(0.005)**	(0.020)**	(0.019)**
ln (assets)		0.366	0.545	0.608	
		(0.142)	(0.068)*	(0.062)*	
Beta		-0.722	-0.870	-1.098	-0.918
		(0.224)	(0.223)	(0.213)	(0.267)
Current ratio		0.151	0.636	0.527	0.418
		(0.452)	(0.059)*	(0.189)	(0.235)
ln (sales)					0.465
					(0.081)*
Sales area			3.174	2.419	2.324
			(0.003)**	(0.029)**	(0.032)**
Leverage ratio			2.034	1.945	1.273
			(0.471)	(0.555)	(0.684)
Insiders' shareholding %			0.389	0.005	-0.833
			(0.843)	(0.998)	(0.711)
Regulatory force				-0.942	-0.925
				(0.018)**	(0.019)**
Stability factor				0.153	0.116
				(0.726)	(0.793)
Distributor				0.979	0.999
				(0.023)**	(0.022)**
Marketing factor				0.737	0.842
				(0.075)*	(0.046)**
Production factor				-0.406	-0.443
				(0.360)	(0.322)
Cost factor				-0.165	-0.159
				(0.642)	(0.654)
Logistic R^2	0.226	0.275	0.447	0.577	0.571
Sample size N	88	88	88	88	88

Notes: Regression coefficients with the probability of significance in the parentheses.
The sample size is 88 due to 2 missing data for loss prevention and self-insurance.
* significance level α= 0.1, **significance level α= 0.05.

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Table 6 The determinants of product liability insurance demand, Y=ln (ins. amount)

	Model (1)	Model (2)	Model (3)	Model (4)
Intercept	-46.648	-34.56	-98.761	-73.549
	(0.003)**	(0.007)**	(0.001)**	(0.001)**
Loss prevention	2.938	2.820	7.218	6.858
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Self-insurance	4.028	4.247	5.719	5.963
	(0.065)*	(0.055)*	(0.073)*	(0.068)*
ln (assets)	2.046		3.670	
	(0.010)**		(0.006)**	
Beta	-1.321	-1.314	-4.190	-3.503
	(0.268)	(0.280)	(0.197)	(0.231)
Current ratio	2.329	1.743	3.375	2.457
	(0.043)**	(0.121)	(0.056)*	(0.159)
ln (sales)		1.478		2.371
		(0.028)**		(0.029)**
Sales area	7.548	7.317	11.980	11.518
	(0.003)**	(0.004)**	(0.001)**	(0.002)**
Leverage ratio	10.287	7.660	15.064	12.148
	(0.207)	(0.358)	(0.215)	(0.332)
Insiders' shareholding %	2.632	0.068	0.515	-3.763
	(0.635)	(0.990)	(0.958)	(0.706)
Regulatory force	-3.480	-3.180	-6.137	-5.455
	(0.002)**	(0.004)**	(0.001)**	(0.002)**
Stability factor	0.261	0.193	0.736	0.524
	(0.827)	(0.874)	(0.708)	(0.795)
Distributor	3.172	3.078	5.415	5.135
	(0.008)**	(0.010)**	(0.003)**	(0.006)**
Marketing factor	2.960	3.143	4.720	5.029
	(0.007)**	(0.005)**	(0.005)**	(0.004)**
Production factor	-2.291	-2.318	-3.856	-3.751
	(0.089)*	(0.090)*	(0.069)*	(0.083)*
Cost factor	-0.468	-0.415	-1.441	-1.384
	(0.630)	(0.674)	(0.361)	(0.389)
adj- R^2	0.432	0.416		
Log likelihood			-172.370	-173.948
Sample size N	76	76	76	76

Notes: Models (1) and (2) are OLS regression. Models (3) and (4) are Tobit regression.
The sample size is 76 because only 77 firms respond insurance amount and one of these firms has missing data on self-insurance.
* significance level α= 0.1, **significance level α= 0.05.

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The empirical analyses regarding the impact of risk management on the firm values are shown in table 7. The results suggest that self-insurance funds are negatively related to Tobin's q and the volatility, but loss prevention or insurance do not significantly affect the firm values. However, firms with self-insurance funds imply greater concern with risk management, according to the findings in tables 5 and 6 that risk management programs are complements. Therefore, the empirical finding may still suggest that there is a certain relationship between the firm values and risk management programs. The negative impact of self-insurance funds on Tobin's q and stock return volatility suggests that the firms with risk management probably operate in a more stable manner so that the market value of equity does not increase much and the stock returns fluctuate less. These results are consistent with H5b but inconsistent with H5a. That is, risk management programs do not increase the investors' expectation on the future values of firms but they do stabilize the fluctuations of stock returns. The traditional financial ratios such as assets, beta, sales growths, and ROA remain the dominant factors for firm value and stock return volatility.

A possible reason for this negative relationship between self-insurance and Tobin's q is due to the firm size. The findings in tables 5 and 6 suggest that larger firms will purchase more insurance probably because of greater concern about risk management or because of greater potential liability risk with large sales volume. Since the measurement of Tobin's q is negatively related to the book value of assets[6], it is not surprising that the firms with self-insurance funds have lower Tobin's q. In fact, the regression analyses in table 7 also show that Tobin's q and volatility are significantly and negatively related to the firm size.

To examine the possible effect of the collieaerity or endogeneity between product liability insurance and other risk management programs such as loss prevention and self-insurance, we also conduct correlation analysis among these alternative risk management tools. The Pearson correlation coefficients all are less than 0.38 which imply that the collinearity issue does not cause serious problems in the regression analysis. Additionally, we conduct regression analyses using insurance, loss prevention, and self-insurance individually with other firm characteristic variables as shown in table 8. The results are similar to those in table 7 that Tobin's q and volatility only significantly related to self-insurance.

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[6] In this paper Tobin's q = market value of assets / book value of assets = (book value of assets + market value of equity – book value of equity) / book value of assets = 1+ (market value of equity – book value of equity) / book value of assets.

Table 7 The effect of risk management program on the firm values

	Model (1) Y=Tobin's q	Model (1) Y=Volatility	Model (2) Y=Tobin's q	Model (2) Y=Volatility
Intercept	2.973	13.080	3.893	23.759
	(0.093)*	(0.348)	(0.051)**	(0.120)
Loss prevention	0.123	1.273	0.115	1.480
	(0.244)	(0.139)	(0.329)	(0.116)
Self-insurance	-0.634	-5.204	-0.462	-4.025
	(0.011)**	(0.009)**	(0.106)*	(0.070)*
Insurance (y/n)	-0.239	-0.641		
	(0.316)	(0.733)		
ln (ins. amount)			-0.013	-0.071
			(0.359)	(0.513)
ln (assets)	-0.176	-1.717	-0.233	-2.379
	(0.097)*	(0.047)**	(0.051)**	(0.011)**
Beta	0.755	12.441	0.915	13.382
	(0.034)**	(0.001)**	(0.016)**	(0.001)**
Current ratio	0.148	1.507	0.053	0.479
	(0.063)*	(0.019)**	(0.594)	(0.533)
Sales growth	1.517	9.537	2.140	14.499
	(0.002)**	(0.018)**	(0.001)**	(0.002)**
ROA	6.761	36.032	7.021	40.851
	(0.000)**	(0.001)**	(0.000)**	(0.000)**
Insiders' shareholding %	-0.059	0.023	-0.107	-1.341
	(0.933)	(0.997)	(0.890)	(0.819)
adj- R^2	0.473	0.401	0.512	0.462
Sample size N	87	87	75	75

Notes: Regression coefficients with the probability of significance in the parentheses. Sample sizes vary among models due to missing data in dependent variables, loss prevention, self-insurance, and insurance amount.

* significance level α= 0.1, **significance level α= 0.05

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Table 8 The effect of risk management program on the firm values (alt. models)

	Model (1a) Y=Tobin's q	Model (1b) Y=Tobin's	Model (1c) Y=Volatility	Model (1d) Y=Volatility
Intercept	3.861	3.104	23.610	13.396
	(0.020)**	(0.079)*	(0.074)*	(0.333)
Loss prevention		0.090		1.184
		(0.367)		(0.146)
Self-insurance		-0.696		-5.373
		(0.004)**		(0.005)**
Insurance (y/n)	-0.338		-1.193	
	(0.129)		(0.501)	
ln (assets)	-0.199	-0.182	-1.982	-1.729
	(0.059)*	(0.087)*	(0.023)**	(0.044)**
Beta	0.717	0.724	11.548	12.330
	(0.047)**	(0.041)**	(0.003)**	(0.001)**
Current ratio	0.123	0.142	1.091	1.491
	(0.064)*	(0.074)*	(0.043)**	(0.019)**
Sales growth	1.493	1.592	10.367	9.734
	(0.002)**	(0.001)**	(0.01)**	(0.014)**
ROA	6.727	6.600	36.686	35.599
	(<.001)**	(<.001)**	(0.0004)**	(<.001)**
Insiders' shareholding %	-0.102	-0.005	-0.847	0.210
	(0.886)	(0.994)	(0.881)	(0.969)
adj- R^2	0.4319	0.4732	0.344	0.407
Sample size N	89	87	89	87

Notes: Regression coefficients with the probability of significance in the parentheses. Sample sizes vary among models due to missing data in dependent variables, loss prevention, self-insurance, and insurance amount.

* significance level α= 0.1, **significance level α= 0.05

5. Conclusion

This paper studies enterprise risk management of product liability risk and is different from most of the previous literature related to risk management that focused on the financial risks and hedging. The analyses of product liability risk and management strategy include four constructs: (1) alternative risk management tools, (2) corporate finance, (3) firm features, and (4) business operation efficiency. The empirical findings are consistent with the hypotheses and suggest that risk management is a corporate strategy that considers several

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aspects of business operations. Firms purchase insurance not only for loss financing but also for marketing or other business purposes. Firms with more loss prevention tools or with self-insurance funds will purchase insurance probably because their risk culture pays more attention to risk management in general. That is, the alternative tools are supplements instead of substitutes. Besides, the empirical analysis finds that firms with more assets will purchase more insurance. These results suggest that the demand for insurance increases, rather than decreases, with the insured's wealth. This finding implies that the function of insurance is not only for indemnity payments but also probably for other background risks. As indicated by Fei and Schlesinger (2008), there may be greater precautionary demand for insurance when there is relatively large background risk.

Some important background risks for a firm probably come from public image and marketing channels. A news report of product injury usually severely impairs the reputation of a firm and affects the sales of that product or even other products produced by the same firm. The regression analyses on the constructs of firm's features and business operations all show that marketing is a critical factor for purchasing insurance. The sales area and the request from distributors are important determinants for insurance demand. The primary motivation for the firms to purchase product liability insurance is to provide protections for the consumers and use it as a promotion for the product. The agency problem from managers and directors seems not to be an important determinant for product liability insurance demand. These findings suggest that the role of risk management in a firm is not only that of classical loss controller but also that of business efficiency enhancer. However, this paper does not find that insurance has the function of encouraging product innovation or quality control. Initially it was expected that firms with insurance protection could devote more resources in product innovation and that premium rates would provide incentives for loss control. The empirical findings unfortunately indicate that insurance underwriting restricts innovation of new products and insurance coverage reduces the incentives of quality control.

In addition, this paper attempts to analyze the impact of risk management on the firm value since the literature increasingly suggests that risk management is interactive with business operations and strategic management. The empirical results show that risk management may have a certain contribution in stabilizing the fluctuations of stock returns even though its effect is not as strong as that of other financial factors. The firm value and volatility of stock returns are primarily affected by the firm size, sales growth, and returns on assets (ROA) as suggested in the finance literature. They are somewhat influenced by

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risk management programs. The self-insurance funds have an impact on the investors' expectation about firm value, while the effects of product liability insurance and loss prevention are insignificant. Probably the costs of insurance premiums and loss prevention are regularly embedded in the production cost, but self-insurance funds are characterized by uncertainty regarding their cash needs in the future. Consequently the investors' expectation of the future value of the firm is not related to insurance or loss prevention programs. However, this paper is just an initial effort to study risk management from the viewpoint of enterprise-wide business strategies which include marketing, production, and regulation, in addition to risk financing. Other reasons why a firm implements risk management programs can be investigated in future studies.

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Appendix 1.

I. Questionnaire issued to the public companies.

Part I. Product Liability Insurance Coverage of Your Company

1. What kind of industry does your company belong to?
   ☐ food ☐ electronics & computer ☐ electric engineering ☐ electric appliances
   ☐ textile ☐ plastics ☐ rubber ☐ automobile ☐ drug & cosmetics ☐ bio-technology
   ☐ trading and department store ☐ others

2. Does your company purchase product liability insurance?
   ☐ Yes ☐ No

3. Did your company have any claims for product injury during the past five years?
   ☐ Yes (continue to questions 4 and 5) ☐ No

4. How many times did your company incur claims for product injury during the past five years?
   ☐ one ☐ two ☐ three ☐ four ☐ five+

5. What was the total amount of indemnities incurred by your company for product injury during the past five years?
   Total amount $_____NT /US (fill in the number and select the unit)

6. What are the insurance amount and insurance premiums for year 2007?
   Insurance amount / per accident $_____ NT /US
   Total insurance amount $_____ NT/US, Deductible $ _____ NT/US
   Expected sales $ _____ NT /US, Insurance premiums $ _____ NT/US

7. What is/are the insured sales area (s)?
   ☐ domestic ☐ foreign (mainly ☐ North America ☐ Others)
   ☐ both domestic and foreign

8. What type of business does your company do?

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☐ Type A (producing, manufacturing, assembling, importing)
☐ Type B (wholesale, distributing, retail)

9. How many years has your company been insured?
☐ 1 year ☐ 2-4 years ☐ 5-7 years ☐ 8-9 years ☐ 10+ years

Part II. Motivation for Purchase of Product Liability Insurance

Please select your opinion for the following statements: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree.

	1	2	3	4	5
10. To meet the distributor's request.	☐	☐	☐	☐	☐
11. To meet the regulation of compulsory insurance.	☐	☐	☐	☐	☐
12. It is a necessary tool for risk control.	☐	☐	☐	☐	☐
13. It is effective to share the cost of indemnity.	☐	☐	☐	☐	☐
14. It transfers the liability risk of Consumer Protection Law.	☐	☐	☐	☐	☐
15. The insurers can assist the settlement of claims.	☐	☐	☐	☐	☐
16. It helps to stabilize the business operation.	☐	☐	☐	☐	☐
17. It provides protection for the consumers.	☐	☐	☐	☐	☐
18. It can serve as an advertisement to promote sales.	☐	☐	☐	☐	☐
19. It can improve the public image of the firm.	☐	☐	☐	☐	☐
20. It helps to increase the sales volumes.	☐	☐	☐	☐	☐
21. It increases the motivation for product innovation.	☐	☐	☐	☐	☐
22. It can reduce the liability risk of new products.	☐	☐	☐	☐	☐
23. It enhances the firm's care on product quality control.	☐	☐	☐	☐	☐
24. It will highly increase the cost of goods sold.	☐	☐	☐	☐	☐
25. The premiums will raise product price and reduce sales.	☐	☐	☐	☐	☐

Part III. The Risk Management Programs Currently Implemented in Your Company

26. Do you provide appropriate directions of care and warnings for the product?
☐ Yes. ☐ No.

27. Do you provide appropriate instructions of use/operations for the product?

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☐ Yes. ☐ No.

28. Does your product pass the inspection standards and/or obtain quality certificates such as CNS, UL, CE, etc. ?

☐ Yes. ☐ No.

29. Does your company perform product safety inspection on a regular basis?

☐ Yes. ☐ No.

30. Does your company have other loss prevention programs in addition to insurance (such as quality control, safe packing design, warranty period, etc.) ?

☐ Yes. ☐ No.

31. Does your company have budget or funding plans for product recalls?

☐ Yes. ☐ No.

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II. The summary of the descriptive statistics of the questionnaire responses.

Table A1 The descriptive statistics of the questionaire responses

Variable	N	Mean	Std. dev.	Minimum	Maximum
Industry	90	1104.83	3.975	1101.00	1112.00
Insurance (yes/no)	90	0.622	0.488	0	1
Loss Claim (yes/no)	82	0.195	0.399	0	1
Loss Claim Frequency	77	0.519	1.456	0	5
Loss Claim amount	75	4997935.33	26812451.38	0	164210000
Insurance amount per accident.	74	57335459.46	101834868	0	492630000
Insurance amount (aggregate)	77	212155925	1124673901	0	9852600000
Deductible	72	834714.90	4051004.47	0	32842000.00
Sales revenue	70	22632418829	109359321534	0	755366000000
Insurance Premiums	67	5229119.53	30740121.00	0	250000000
Sales area	90	2.778	1.225	1	4
Company type	90	0.956	0.207	0	1
Insurance years	88	2.136	1.943	0	5
q10	90	3.811	0.820	2	5
q11	90	3.067	0.946	1	5
q12	90	4.078	0.691	2	5
q13	90	4.011	0.742	2	5
q14	90	3.767	0.735	1	5
q15	90	3.833	0.768	2	5
q16	90	3.700	0.841	2	5
q17	90	4.033	0.678	2	5
q18	90	3.344	0.901	1	5
q19	90	3.733	0.845	2	5
q20	90	3.200	0.737	2	5
q21	90	2.856	0.815	1	5
q22	90	3.700	0.799	2	5
q23	90	3.544	0.876	2	5
q24	90	3.100	0.808	1	5
q25	90	2.767	0.750	1	5
q26	90	0.844	0.364	0	1

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q27	90	0.811	0.394	0	1
q28	90	0.878	0.329	0	1
q29	90	0.911	0.286	0	1
q30	89	0.989	0.106	0	1
q31	89	0.270	0.446	0	1

Note: Because of missing data, the sample size of some variables may be less than 90.

III. The distribution of industries of the sample firms.

Table A2 The distribution of industries of the sample companies

Industry	No. of surveys issued	No. of responded surveys	Response rate%
Food	20	8	40.00%
Electronics	299	40	13.38%
Electric engineering	19	6	31.58%
Electric appliances	10	5	50.00%
Textile	10	0	0.00%
Plastics	6	1	16.67%
Rubber	6	4	66.67%
Automobile	15	5	33.33%
Pharmacy	5	2	40.00%
Biotech & medical	16	5	31.25%
International trading	10	1	10.00%
Others	24	13	54.17%
Total	440	90	20.45%

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Biographical Notes

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