The Strategic Role of Insurance: The Warranty Case

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Abstract: We consider a model in which risk-neutral firms purchase liability insurance to guarantee their warranty policies. We show that the firms that have no problem in fulfilling their warranty policies have strong incentives to purchase liability insurance. Firms purchase insurance because doing so enhances their competitive powers. This paper complements the literature on corporate demand for insurance by emphasizing the strategic role of insurance. This paper is also related to the literature on the demand for liability insurance under the negligence rule. We show that firms may purchase liability insurance according to their strategic purpose, even though they take due care under the negligence rule. [Key words: Strategy, insurance demand, warranty, adverse selection, negligence rule.] JEL Classification: D43, D82, G22

INTRODUCTION

Risk aversion has been key in explaining insurance demand in the insurance and economics literature since Pratt (1964) and Arrow (1971). A risk-averse individual purchases insurance in order to reduce risk, while a risk-neutral individual has no incentives to purchase insurance. On the other hand, the corporate demand for insurance is not completely explained by risk aversion because firms are considered less risk-averse than individuals. Mayers and Smith (1982) provide rationales for

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I would like to thank the referees and William L. Ferguson (editor) for their helpful comments. The financial support from KAIST is gratefully acknowledged. I would also like to thank Thi Nha Chau for her support.

Journal of Insurance Issues, 2006, **29**, 1, pp. 33–50.

the corporate demand for insurance: risk shifting, real-service efficiency, agency cost reduction, and tax advantage. MacMinn (1987, 1997) emphasizes that insurance can reduce financial distress costs. Mayers and Smith (1987), Schnabel and Roumi (1989), Garven and MacMinn (1993), and MacMinn and Han (1990) also show that insurance can reduce the underinvestment problem. Han (1996) discusses the corporate demand for insurance under diverse managerial compensation schemes. Han (1999) also suggests that firms can purchase insurance when the contribution of insurance to the real option value of future investment opportunity is greater than the costs.

In a different context, Thakor (1982) and Grace and Rebello (1993) demonstrate that firms can purchase insurance to reduce adverse selection costs. Because firms have private information about their cash flows, they have incentives to purchase insurance if such a purchase reveals information regarding the cash flows (Thakor, 1982). Grace and Rebello (1993) investigate cases in which firms that have private information regarding cash flows and insurable losses issue bonds to undertake a positive net present value project. If higher operating revenues are associated with a higher insurance risk, the firm with good news will purchase insurance. A firm with bad news may not mimic the firm with good news if adverse selection costs in the insurance market exceed the benefit of mimicking in the bond issue market.

On the other hand, Ashby and Diacon (1998) and Seog (2006) explicitly focus on the strategic aspects of insurance. Using Cournot duopoly models, they show that two competing firms may find it beneficial to purchase insurance as an equilibrium strategy or as a Pareto improving strategy. Along a similar line of thinking, we suggest additional strategic rationales for insurance demand in this paper.

We consider a model in which firms purchase insurance to signal the fulfillment of warranty when consumers do not know the product/firm qualities.[1] We show that when there is no insolvency risk, firms offer full warranty in equilibrium, since it removes the uncertainty of losses facing consumers. In this case, firms have no strong incentives to purchase insurance. On the other hand, if some firms are exposed to insolvency risk, a warranty, by itself, is not enough to remove the uncertainty of losses. In this case, firms have strong incentives to purchase liability insurance, since it mitigates the insolvency risk faced by consumers.[2] What is interesting is that firms with no insolvency risks also have incentives to purchase insurance, since consumers cannot observe firm qualities. The driving force of insurance demand is strategic consideration. Firms purchase insurance because it will enhance their competitiveness in the product market.[3]

This paper is also related to another strand of literature focusing on the demand for liability insurance under the negligence rules,[4] under which firms are not legally liable for product failure once they take due care. Thus, in principle, firms do not need to purchase liability insurance. The existence of liability insurance under the negligence rule can be explained by uncertainty in court decisions or uncertainty in the due-care level (see Sarath, 1991; Crocker and Doherty, 1994). This paper suggests another rationale: Firms may purchase liability insurance because of its strategic role in the product market.

The remainder of the paper is composed as follows. The model is outlined in Section II. In the following two sections (Sections III and IV), we investigate the strategic role of insurance under no insolvency risk and under insolvency risk. In Section V, we discuss how our results can explain the demand for liability insurance under the negligence rule. In Section VI, we study a variation of our model by considering first-party insurance and frequency risk. Section VII outlines empirical implications. Section VIII concludes.

MODEL DESCRIPTION

The model developed in Grossman (1981) provides the framework for our analysis.[5] Each consumer who has initial wealth of W_0 purchases one unit of the product from firms. Benefit from the consumption of the product depends on the states of nature and the product quality. There are two states of nature: a good state ("no loss" state) and a bad state ("loss" state). The good state can occur with probability α and the bad state can occur with probability $1 - \alpha$. The state of nature is independent across products. There are also two types of product quality: good quality and bad quality. In the good state, both types of products give a consumer the (monetary) benefit of b. In the bad state, product failure incurs a loss, s. Loss size depends on the product quality: $s = H$ for good quality and $s = L$ for quality product where $H < L$. Therefore, the net benefit from each quality product in the bad state becomes $b - H$ and $b - L$, respectively. Consumers do not observe the product quality at the time of purchase.

Firms are also classified into good-quality firms and bad-quality firms according to the qualities of their products. No firm produces both types of products. A bad-quality firm will be called an *L*-firm and a good-quality firm will be called an *H*-firm hereafter. We assume that each firm produces only one product and that the production cost is normalized to zero.[6] The potential number of firms is larger than demand. In order to highlight our

point, we assume that firms are risk neutral and that there are no tax and real service benefits, nor agency conflicts within a firm.

Each firm has two strategic tools: price and warranty. Given other firms' strategies, each firm offers price and warranty in order to maximize its expected profit. With the warranty, the firm is obliged to cover some of the losses incurred to consumers. For the purpose of this paper, it is convenient to express warranty in terms of the net loss, the loss *not* covered by the firm in the bad state.[7] Note that our expression for warranty is somewhat different from the conventional approach in which warranty is defined via indemnification by the firm. Defining warranty in terms of indemnification, however, is not appropriate in this paper, since consumers face uncertain levels of losses. Even if consumers receive the same indemnification, their net losses will be different. As a result, competition will induce firms to remove the uncertainty by announcing the net loss, not the indemnification.[8] Let us denote G for the net loss announced. When the indemnification in the bad state is denoted by g, $G = s - g$.

We will consider two different cases depending on whether firms can become insolvent. In one case, we assume that firms are always solvent so that the warranty obligations are always fulfilled (see Section III). In the other case, we allow firms to become insolvent, which is our main concern. In case of insolvency, firms may not fulfill their warranty obligations as they arise (see Section IV).

WARRANTY AND DEMAND FOR INSURANCE UNDER NO INSOLVENCY RISK

Throughout this section, we assume that the asset values of firms are high enough to fulfill their warranty obligations from out-of-pocket. Now, let us consider a consumer who purchases a product with price p and the net loss G. The consumer's expected utility, $U(.)$, can be denoted as follows:

$$U(p,G) = \alpha u(W - p) + (1 - \alpha)u(W - p - G) \tag{1}$$

where $W = W_0 + b$ and $u(.)$ is the von Neuman- Morgenstern utility. We also define $W_1 = W - p$ and $W_2 = W - p - G$: W_1 is the wealth in the good state and W_2 is the wealth in the bad state.

The profit of a firm with quality s that sells a product at price $p = p_s$ with indemnification g is $R_s = \alpha p_s + (1 - \alpha)(p_s - g)$. For $R_s = 0$, $p_s = (1 - \alpha)g$. The slope of the locus of $R_s = 0$ is $-\alpha/(1 - \alpha)$ in (W_1, W_2)-plane as depicted in Figure 1. The wealth pair corresponding to $g = 0$ with $p_s = 0$ is denoted as contracts I_s for $s = H, L$ in Figure 1. In equilibrium, firms maximize

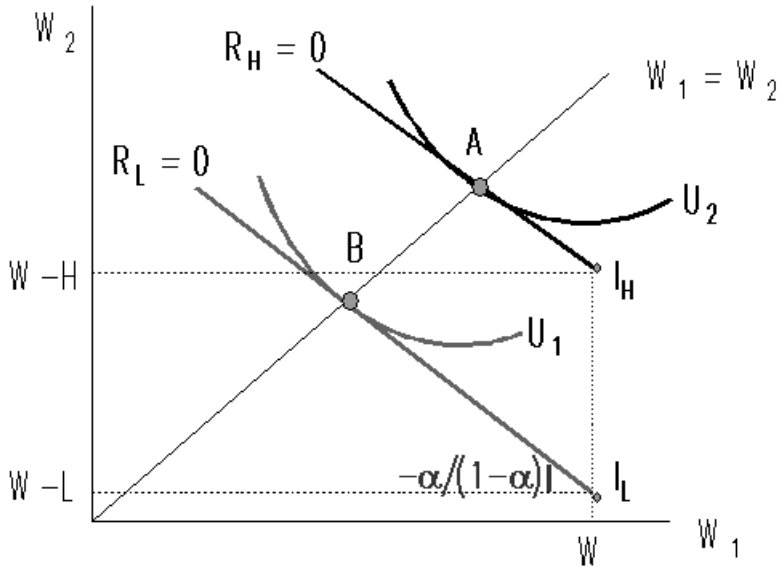

Fig. 1. Equilibrium under no insolvency risk.

expected profits and consumers maximize their expected utilities given their information on others; no firms or consumers want to change their behaviors.

Case of Information Symmetry

Let us begin with the base case in which there exist only H-firms.[9] Competition among H-firms will induce $R_H = 0$. On the locus of $R_H = 0$, they will offer contract A in Figure 1 because it gives consumers the highest utility. It is easy to see that contract A in Figure 1 is in the equilibrium.

In equilibrium contract A, $W_1 = W_2$—that is, $W - p = W - p - H - g$. We have $g = H$ or $G = 0$. A full warranty is offered in contract A. $R_H = 0$ and $p = (1 - \alpha)H$. H-firms have incentives to offer full warranties. No risk is left to consumers: consumer's wealth is $W - (1 - \alpha)H$ in both states.

Case of Information Asymmetry

Now let us change the assumption above and consider the more interesting case in which the supply from H-firms is lower than demand, but the total potential supply exceeds the demand. Thus, there is a positive demand for L-firms' products. L-firms cannot make a positive profit

because of competition. On the locus of $R_L = 0$, L-firms will offer contract B in Figure 1, since it gives consumers the highest utility.

On the other hand, H-firms will also offer B. To see why, note that they can sell their products as long as their offers give consumers a utility higher than U_1. Since firms are profit maximizers, they will offer the most lucrative contract, while keeping a utility above or equal to U_1. Such a contract is exactly B.

As a result, contract B is offered in the equilibrium. Competition and profit maximization induce firms to offer full warranties even under information asymmetry. At contract B, $R_L = 0$ and $W_1 = W_2$. L-firms make zero profits and provide full warranties. We have $G = 0$ (thus, $g = L$) for L-firms and $p = (1 - \alpha)L$. H-firms make positive profits: $R_H = \alpha(1 - \alpha)L + (1 - \alpha)[(1 - \alpha)L - H] = (1 - \alpha)(L - H) > 0$. The H-firms also provide full warranties; $G = 0$ (thus, $g = H$) for H-firms. The consumer's wealth is $W - (1 - \alpha)L$ in both states. This result is basically the same as Grossman (1981) except that we consider severity risks, while Grossman considers frequency risks.

Finally, let us check the effect of warranty on the demand for liability insurance. For this, suppose that liability insurance is available for the warranty obligation. Now, firms have two alternative methods of financing the warranty obligation: liability insurance, *ex ante*, or out-of-pocket, *ex post*. Obviously, as far as the insurance is actuarially fair, the risk-neutral firms are indifferent between the two alternative financing methods. As a result, firms do not have strong incentives to purchase insurance. If the insurance premium is actuarially unfair, firms will never purchase insurance at all. Lemma 1 summarizes the main results of this section.

Lemma 1: Case of No Insolvency Risk

(i) [Grossman, 1981] If there are only H-firms, then H-firms announce full warranties of the product quality. H-firms make zero profits.

(ii) [Grossman, 1981] If the supply from H-firms is lower than the demand, both types of firms announce full warranties of the product quality. L-firms make zero profits and H-firms make positive profits.

(iii) Firms have no strong incentives to purchase actuarially fair liability insurance, since they are indifferent regardless of whether they purchase insurance.

WARRANTY AND DEMAND FOR INSURANCE UNDER INSOLVENCY RISK

Now, we assume that some firms may become insolvent, so that they cannot fulfill their warranty obligations. There are many reasons why consumers may doubt the firms' fulfillment of warranties. The firms may

close their business units, may be acquired by other firms, or may experience financial or managerial difficulties. Sometimes, the frustrating process causes consumers to incur costs (including time cost) to receive the warranty service. Let us define "default" as any situation in which firms fail to fulfill their warranty obligations. Our task is to investigate the effect of the possible default on the firms' strategies and demand for insurance.

Case of Information Symmetry

As in the previous section, first suppose that there are only H-firms in the market. To take into account the default, we assume that the asset value of a firm at the end of the period can be B^+ (with probability $1 - \beta$) or B^- (with probability β), where $B^- < H < B^+$. When the asset value is B^-, an H-firm with the promised indemnification above B^- will default. In the case of default, the consumer will get B^- in the bad state. Thus, when a firm offers a full warranty, the consumer's expected utility becomes

$$U(p', G = 0; RA) = \alpha u(W - p') + (1-\alpha)[\beta u(W - p' - H + B^-) + (1-\beta)u(W - p')]$$

$$= (\alpha + (1 - \alpha)(1-\beta))u(W - p') + (1 - \alpha)\beta u(W - p' - H + B^-),$$

where $p' = (1-\alpha)[\beta B^- + (1 - \beta)H]$, reflecting the risk of default, and RA implies random asset values. This contract is depicted as point A' in Figure 2, where $W - p' - H + C$ is the certainty equivalent, defined by $u(W - p' - H + C) = \beta u(W - p' - H + B^-) + (1 - \beta)u(W - p')$. Note that point A is the contract in equilibrium under no insolvency risk (see Figure 1). Note that $U(p', G = 0; RA) < U_2$ since consumers are risk averse.

Generally, however, point A' is not an equilibrium contract since announcing full warranty is not an optimal strategy. By solving the constrained optimization problem, we can show that when liability insurance is not available, the optimal announcement of net loss is $H - r^0$ such that $B^- \leq r^0 < H$ and the equilibrium price, p'', is $(1 - \alpha)[\beta B^- + (1 - \beta)r^0]$. The result that $r^0 < H$ is easily obtained by differentiating the expected utility at $r^0 = H$: $dU/dr^0 \mid_{r0 = H} = -(1 - \alpha)^2(1 - \beta)\beta[u'(W - p'' - H + B^-) - u'(W - p'')] < 0$. Note that the indemnification of r^0 can be fulfilled only when the asset value is B^+. The expected profit will be zero and the consumer's expected utility will be $U(p'', H - r^0; RA) = \alpha u(W - p'') + (1 - \alpha)[\beta u(W - p'' - H + B^-) + (1 - \beta)u(W - p'' - H + r^0)]$. This contract is depicted as A'' in Figure 2 where $W - p'' - H + C'$ is the certainty equivalent, defined by $u(W - p'' - H + C') = \beta u(W - p'' - H + B^-) + (1 - \beta)u(W - p'' - H + r^0)$. The outcome of partial warranty is reminiscent of Doherty and Schlesinger (1990), in which a partial insurance coverage is optimal when the insurers can become insol-

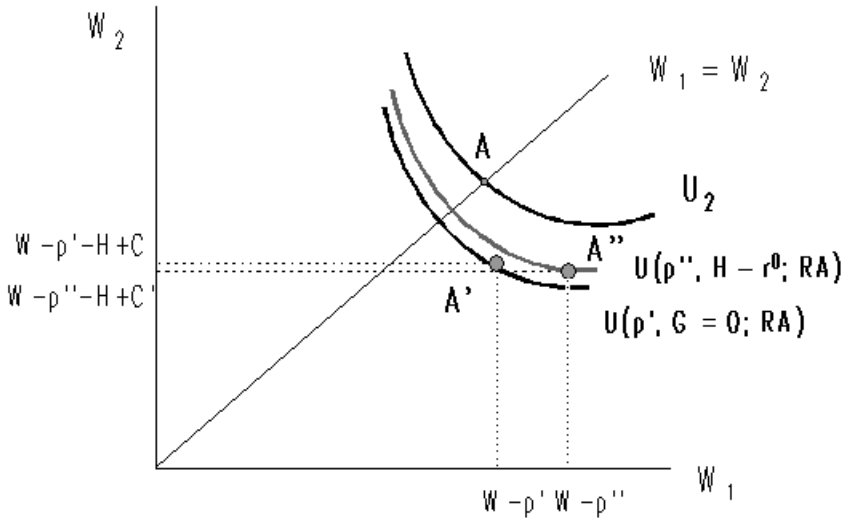

Fig. 2. Partial warranty under insolvency risk when insurance is not available.

vent. By mapping warranty and firm to insurance and insurer, it becomes obvious that we rediscover the same results as in Doherty and Schlesinger.

Now suppose that firms can purchase actuarially fair liability insurance for the warranty. For expository purposes, we assume that insurance firms will never default and consumers can observe whether or not a firm purchases insurance.[10,11] We also assume that if firms purchase insurance, they will fulfill the warranty first through insurance and then through their assets.

We will show that, in equilibrium, firms purchase insurance in order to signal to consumers that any insured loss will be fully covered by the insurance even in the bad state. First, it is easy to show that the solution r^0 to the constrained optimization problem above is not an optimal strategy when the insurance market is available. Consider the following strategy: Offering the price p''' and a full warranty such that $u(W - p''') = U(p'', H - r^0; RA)$, where $W - p'''$ is the certainty equivalent of the lottery $[W - p''$ with prob. α, $W - p'' - H + B^-$ with prob. $(1 - \alpha)\beta$, $W - p'' - H + r^0$ with prob. $(1 - \alpha)(1 - \beta)]$. The full warranty becomes trustworthy if the firm purchases the full liability insurance for the warranty. The expected profit must be positive since consumers are risk averse. Indeed, the expected profit becomes $p''' - (1 - \alpha)H = p''' - [p'' + (1 - \alpha)H - (1 - \alpha)(\beta B^- + (1 - \beta)r^0)] > 0$ since $W - p''' < \alpha(W - p'') + (1 - \alpha)\beta(W - p'' - H + B^-) + (1 - \alpha)(1 - \beta)(W - p'' - H + r^0)$ for a risk-averse consumer.

Eventually, competition will reduce the price to $(1 - \alpha)H$, so that the profit of the H-firm becomes zero. As a result, in equilibrium, consumers retrieve contract A. The consumer's utility becomes $u(W - (1 - \alpha)H)$. H-firms purchase the insurance, offer price $(1 - \alpha)H$ and earn zero profits. We summarize the results in the following lemma.

Lemma 2: Case of Insolvency Risk

Suppose that there are only H-firms. In equilibrium, firms purchase the actuarially fair liability insurance and announce full warranties of the product quality.[12]

Case of Information Asymmetry

Now, suppose that total demand exceeds the supply from H-firms. For simplicity, assume that only L-firms can default. More formally, the asset value of a firm at the end of the period can be A^+ (with probability $1 - \beta$) or A^- (with probability β) where $H < A^- < L < A^+$.[13] With asset value A^-, an L-firm will default if the loss occurs. Since H is smaller than A^-, an H-firm will never default.

By applying to L-firms the logic in the previous subsection, we obtain similar results. First, we can show that when there is no insurance market, an L-firm will offer $p = (1 - \alpha)[\beta A^- + (1 - \beta)r^*]$ for $A^- \leq r^* < L$, so that the expected profit $R_L = \alpha p + (1 - \alpha)[\beta(p - A^-) + (1 - \beta)(p - r^*)] = 0$. Next, if the insurance market exists, L-firms will increase profits by purchasing insurance and offering full warranties. Competition among L-firms will eventually induce L-firms to purchase full insurance. Consumers enjoy the full warranties, since any loss is fully covered by the insurance.

What is interesting is that H-firms have to purchase the liability insurance even if they will never default. As long as financing the warranty obligation is concerned, H-firms do not have to purchase insurance. However, consumers cannot tell H-firms from L-firms, *ex ante*. When an H-firm does not purchase insurance, L-firms may have incentives to mimic the H-firm, or consumers will not purchase from the H-firm if they conjecture that the firm is possibly type L (see the proof of Proposition 1). Thus, a best strategy of the H-firm is to purchase insurance that guarantees the fulfillment of warranty obligation. As a result, both types of firms purchase insurance and offer full warranties.

The purchase of insurance by H-firms highlights the strategic role of insurance. H-firms are risk neutral and have no financial problem in fulfilling the full warranties. Therefore, H-firms do not have to purchase insurance in the usual circumstances considered in the insurance literature. The purchase of insurance is, however, strategically important, since the

insurance company can play a role of signaling the fulfillment of the warranty under information asymmetry.

In summary, equilibrium is characterized as follows[14]: The price is $(1 - \alpha)L$. The profit of the L-firm is $R_L = (1 - \alpha)L - (1 - \alpha)L = 0$. The profit of the H-firm is $R_H = (1 - \alpha)L - (1 - \alpha)H = (1 - \alpha)(L - H) > 0$. The consumer's expected utility is $u(W - (1 - \alpha)L)$. We summarize the results in the following proposition.

Proposition 1: Case of Insolvency Risk

Suppose that the supply from H-firms is lower than demand.

(i) In equilibrium, all firms purchase actuarially fair liability insurance and announce full warranties of the product quality. Especially, H-firms purchase liability insurance even if they will never default.[15]

(ii) L-firms make zero profits and H-firms make positive profits.

[proof] See the text above. It remains to be shown that both types of firms purchase insurance in equilibrium. Suppose that a firm does not purchase insurance and announces it will provide full warranty. There can be different conjectures by consumers on the firm's type. First, suppose that consumers think the firm is type L with positive probability. In this case, consumers will not purchase from the firm since their losses may not be fully covered in the bad state. Secondly, if consumers conjecture that the firm is type H, then they are willing to purchase from the firm. In this case, however, L-firms have incentives to follow this strategy, so that the conjecture is not compatible with equilibrium. As a result, firms should purchase insurance in equilibrium. It is obvious that the insurance coverage in equilibrium should be high enough to remove the insolvency risk facing consumers. With such insurance coverage, offering full warranty is optimal for both types of firms. The equilibrium is unique up to the insurance coverage. QED.

LIABILITY RULE AND DEMAND FOR INSURANCE

Our results are also related to the literature of liability insurance under the negligence rule. In principle, if firms take due care under the negligence rule, they do not need liability insurance since they are not legally liable for any losses. Therefore, the reason why liability insurance exists under the negligence rule is not so obvious. The literature has provided several rationales for the existence of liability insurance under the negligence rule. One rationale is uncertainty of court decisions. Firms may purchase liability insurance because the courts might not observe the firm's care level or might make a mistake in handing out a judgment. Another possible reason

is risk-type uncertainty. If firms do not know their own risk types, they do not know their standard of due care. Therefore, firms may still purchase liability insurance. (For more details, see Sarath, 1991; Crocker and Doherty, 1994).

Our results add additional rationale for the existence of liability insurance under the negligence rule. From the previous sections, we know that firms voluntarily offer the full warranty and purchase liability insurance. They do so whether or not they are legally liable for the losses. Therefore, even if firms take due care under the negligence rule, they will still purchase liability insurance on the basis of strategic concerns to attract consumers.[16] The next proposition summarizes this observation.

Proposition 2: Demand for Liability Insurance under the Negligence Rule

Suppose that the negligence rule applies. When insolvency is possible, firms may purchase liability insurance even if they take due care.

FIRST-PARTY INSURANCE AND FREQUENCY RISK

First Party Insurance

Let us focus on the case in which insolvency is possible. Now, we assume that first-party insurance for consumers is available as well as liability insurance for firms. Consumers can purchase actuarially fair first-party insurance even if they do not receive full warranties from firms.[17] We show that there is indeterminacy of contracts offered by firms, while consumers are fully protected from losses.

First, consider the case in which there are only H-firms. Recall that firms make zero profits and offer contracts fully protecting consumers from losses when first-party insurance is not available. Once first-party insurance is available, consumers are indifferent to contracts on the zero profit line of firms, since they can move to full-protection status by purchasing first-party insurance for the remaining risks. Thus, the contracts offered by firms are not uniquely determined, even though consumers are fully protected from any losses.

Second, the indeterminacy of contracts is still applied to the case in which there are both types of firms. L-firms offer any contract on the zero profit line and consumers purchase first-party insurance for the remaining loss. For H-firms, recall that they make a profit of $(1 - \alpha)(L - H)$ and offer full warranties when first-party insurance is not available. Note also that $(1 - \alpha)(L - H)$-profit line of H-firms is no different from the zero-profit line

of L-firms, since their slopes are the same. This implies that L-firms have no incentives to mimic H-firms if H-firms offer contracts on $(1-\alpha)(L-H)$-profit line of H-firms. Consumers are indifferent among contracts on $(1-\alpha)(L-H)$-profit line of H-firms, since they can move to full-protection status by purchasing first-party insurance for the remaining loss. As a result, we obtain the indeterminacy of contracts for both types of firms.

Frequency Risk

We show that the main results still hold even if we consider frequency risk instead of severity risk. Suppose that both types of firms exist.[18] Let us assume that the probability of no loss is α_H and α_L for H-firms and L-firms, respectively, where $\alpha_H > \alpha_L$. Note that the slope of the iso-profit line of H-firms is steeper than that of L-firms under frequency risk. Now, H-firms can default with lower probability than L-firms.[19] First, suppose there exists no first-party insurance. Under frequency risk, L-firms offer contract A in Figure 3 with full warranty and purchase insurance, because of competition. H-firms also offer contract A with full warranty and purchase insurance. By a similar logic as in Proposition 1, H-firms should purchase insurance even if they are not exposed to insolvency risk, because if not, L-firms may mimic them or consumers may not purchase from them. As a result, both types of firms purchase insurance.

A more interesting case for strategic insurance demand is obtained when first-party insurance exists. Under frequency risk, the indeterminacy of contracts still applies to L-firms. L-firms may offer any contracts, say B in Figure 3, on the zero-profit line and consumers purchase first-party insurance for the remaining risk, $A-B$. However, H-firms have to offer the full warranty (A in Figure 3), since any contract (C for example) different from the full protection on the same iso-profit line will be mimicked by L-firms. This is an interesting finding. H-firms that have lower default possibility have to purchase liability insurance, while L-firms that have higher default possibility do not have to purchase liability insurance. This result contrasts with the indeterminacy of contract offered by H-firms under severity risk. The assumption of frequency risk provides a strong case for the strategic purchase of insurance. Finally, note that, as in the case of severity risk, firms may purchase liability insurance under the negligence rule, since the results hold regardless of legal liability rules.

Corollary 1

(1) First-party insurance: When first-party insurance is available, the contracts offered by both types of firms are indeterminate, while consumers are fully protected by purchasing first-party insurance for the remaining loss.

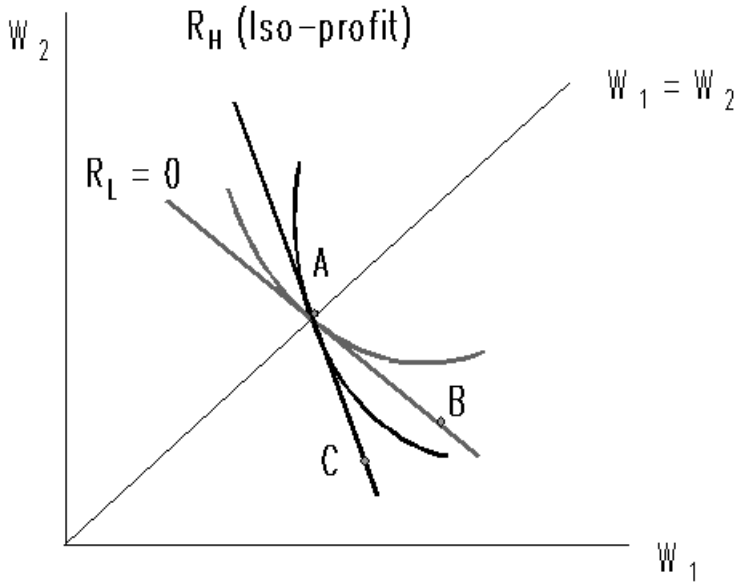

Fig. 3. Equilibrium under frequency risk.

(2) Under frequency risk: (i) When first-party insurance is not available, both types of firms offer full warranty and purchase insurance. (ii) When first-party insurance is available, the contracts offered by L-firms are indeterminate, while H-firms offer contracts with full warranty and purchase insurance. (iii) Consumers are fully protected. (iv) Firms may purchase liability insurance even if they take due care under the negligence rule.

EMPIRICAL IMPLICATIONS

Let us first discuss the empirical implications of cases in which first-party insurance is not available. Purchasing insurance can play a strategic role when the warranty is not committed. Therefore, it can be inferred that the greater the uncertainties faced by consumers about a firm, the higher incentives the firm has for purchasing insurance. Consumers are faced with greater uncertainty about new firms than about incumbent firms, since they have less information about the new firms. By similar reasons, consumers are faced with greater uncertainty about firms in a new industry than about those in an old industry. Thus, new firms or firms in new industries have higher incentives to purchase insurance.

When a firm's reputation regarding fulfillment of warranty is considered, a firm with a bad reputation has higher incentives to purchase insurance than a firm with a good reputation.[20] Firms that are expected to face the possibility of financial or managerial difficulties have higher incentives to purchase insurance, since such difficulties will increase uncertainty about the warranty. For example, firms with high debt ratios have high incentives to purchase insurance. Smaller firms will have higher incentives to purchase insurance than larger firms, as long as smaller firms are considered riskier. Similarly, aggressive and fast-growing (in terms of sales and investments) firms have higher incentives to purchase insurance, since their investments increase uncertainty.

However, there is a caveat: If first-party insurance is available, the empirical implications mentioned above do not necessarily hold. Because of indeterminacy of equilibrium, we cannot predict the extent of insurance purchasing by firms. One implication of the results is that firm's demand for liability insurance is a substitute for the consumer's demand for first-party insurance. On the other hand, if first-party insurance is available *and* frequency risk is considered, good firms have high incentives to purchase insurance, while the purchase of insurance by bad firms is indeterminate. Thus, we can predict that new but good firms and good firms in a new industry will have high incentives to purchase insurance.

CONCLUSION

Insurance literature explains individual and corporate demand for insurance in terms of risk aversion, risk shifting between stakeholders, real-service efficiency, agency cost reduction, tax advantage, financial distress costs, and adverse selection. This paper emphasizes another rationale: the strategic role of insurance. We consider a model in which firms purchase insurance to signal the fulfillment of warranty when consumers do not know the product's or firm's qualities. When there is no insolvency risk, firms offer full warranty in equilibrium, since it removes the uncertainty of losses faced by consumers. In this case, firms have no strong incentives to purchase insurance. On the other hand, if some firms are exposed to insolvency risk, a warranty, by itself, is not enough to remove the uncertainty of losses. In this case, firms have strong incentives to purchase liability insurance, since it mitigates the insolvency risk faced by consumers. What is interesting is that firms with no insolvency risks also have incentives to purchase insurance since consumers cannot observe firm qualities. The driving force of insurance demand is strategic consideration.

Firms purchase insurance, since it will enhance the competitiveness in the product market.

This paper is also related to another strand of literature focusing on the demand for liability insurance under the negligence rules. Under those rules, firms are not legally liable for product failure once they take due care. Thus, in principle, firms do not need to purchase liability insurance. However, firms still have incentives to purchase liability insurance in our model, since purchasing insurance plays a strategic role.

Finally, let us briefly mention some related topics for future research. While we have considered the strategic relation between competition and insurance, there may be other strategic aspects affecting insurance demand. For example, the strategic interaction between the financial side (such as capital structure) and insurance may be an interesting topic. Since the financial side is related to competition, it will be related to the demand for insurance (see Brander and Lewis, 1986). In addition, the purchase or non-purchase of insurance may have some real option values (Han, 1999). The demand for insurance will vary according to its effects on the option values. Another related topic is the endogenous existence of first-party insurance and liability insurance. We have assumed that the markets are exogenously given. However, the two markets may compete with each other. If they are substitutes, as in this paper, then the more efficient market will survive. The relative efficiency will depend on the relative transaction costs and information costs of the two markets.

NOTES

[1] We assume that consumers can observe whether or not firms purchase insurance. This assumption is justified since firms will advertise their purchase of insurance and their insurers in order to attract more consumers when insurance is purchased for strategic purposes, as considered in this paper.

[2] As a result, this paper provides a formal model, under adverse selection, of the well-recognized conjecture that firms with lower liquidation/default risk are valued higher by consumers (see Chapter 2 of Doherty, 1985, and Titman, 1984).

[3] It is interesting to see that insurance has been used as an effective strategic tool in real life. For example, a *Boston Globe* article (2003) reports "[T]he popularity of insurance far outpaced its useful applications: In the 18th century, one enterprising patent-medicine salesman offered 'Dr. White's Venereal Insurance,' a questionable cure for the pox that latched onto the trendiness of insurance as a marketing ploy." In another example, the Alarm Association of Florida (1999) states " [E]veryone wants to know, 'Who is going to pay my bills?' Advertising that you are insured for different types of claims can attract business and can work whether you advertise in the Yellow Pages or the local newspaper."

[4] More precisely, we are considering "the rule of simple negligence."

[5] The model is a variation of the model investigated in Grossman (1981). We consider the case in which quality difference is the severity difference, while Grossman (1981) considers the case in which quality difference implies the frequency (probability of loss occurrence) difference.

By considering the severity difference, we can easily compare the indifference curves without bothering to change the shapes of the curves. It is also easy to check that the implication of the results is not changed under the two definitions of quality difference. We consider frequency risk later.

[6] This assumption is only for technical simplicity.

[7] This type of warranty can easily be found in real life. Instead of announcing indemnification, firms announce the cost imposed on consumers. For example, consumers often have to pay costs for stocking or delivery when the purchase price is refunded. In our expression, the cost is the net loss that is not covered by the firm.

[8] Our expression is consistent with the usual approach of adverse selection literature in which firms care about the wealth levels of consumers (see, for example, Rothschild and Stiglitz, 1976).

[9] Alternatively, we may assume that the supply from H-firms is higher than demand, so that only H-firms can survive in the market.

[10] The assumption of no default by insurance firms is much stronger than needed. In fact, we only need that the correlation between the default of insurance firms and the default of the firm is less than one, so that the firm's purchase of insurance can reduce the consumer's risk.

[11] We implicitly assume that consumers cannot obtain information on product qualities directly from insurance firms, possibly because clients information is confidential. In fact, consumers have no incentives to obtain the information in equilibrium since they are fully protected. We also assume for the time being that consumers cannot purchase first-party insurance. We will consider first-party insurance in a later section.

[12] The equilibrium is unique up to the insurance coverage. As long as the insurance coverage is high enough to fulfill the warranty obligation, then the outcome is the same.

[13] Clearly, assuming that the asset value is A^- or A^+ for both types of firms regardless of insurance purchase is only for technical convenience. Main implications of the results will not be changed even if we consider more precisely the effect of insurance purchase on the asset values.

[14] As in Lemma 2, the equilibrium is unique up to the insurance coverage. As long as insurance coverage is high enough to fulfill the warranty obligation, then the outcome is the same.

[15] Note that our setting is somewhat different from the usual signaling game in that L-firms are competitive while H-firms have limited monopolistic power.

[16] We do not consider the detailed issues in optimal due-care level and firm's choice of care levels, since our results hold for any care level given. For such issues, see Shavell (1982). Our main point is that firms may still purchase liability insurance even if they are not legally liable for the losses.

[17] We implicitly assume that insurance firms can observe the product qualities. Whether or not consumers can observe the qualities after purchasing products does not affect the results.

[18] When only one type of firms exists, the difference between frequency risk and severity risk disappears.

[19] H-firms may have zero probability of default.

[20] Note that if a firm is already known to be a good firm, then the firm does not have to purchase insurance at all.

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