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# Switching Cost, Competition, and Pricing in the Property/Casualty Insurance Market for Large Commercial Accounts

Lisa L. Posey\*

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**Abstract:** With large commercial accounts, a small number of insurers negotiate directly with clients on an individual basis and prices are set individually. This paper applies a game theoretic bargaining model to analyze a risk manager's choice of insurer in a multi-period setting, along with insurers' pricing decisions. Insurers set prices and the risk manager chooses an insurer in each of three periods. There exist switching costs for policyholders which are incurred at the time a switch is made to a different insurer. Other switching costs are revealed over time with a certain probability as the client observes the claims management practices of the insurer in the event of a large claim. The conclusions are that, in equilibrium, it will be optimal for an insurer trying to attract business away from a competitor to price the coverage below cost in the second period with the expectation that it can price above cost in the third period. If the client switches, they will pay a price below marginal cost in the second period, but above marginal cost in the third. If the client remains with the original insurer, they are likely to pay above marginal cost in both periods, but certainly in the third period. Switching from one insurer to another may occur in either period if the original insurer does not provide a highly valuable service during the claims management process and the expectation is that the competitor will be sufficiently better to overcome the initial switching costs. [*Keywords:* Commercial insurance, pricing, switching.]

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## INTRODUCTION

Commercial property/casualty (P/C) insurance is known to experience periodic "hard" and "soft" markets where prices rise and fall, respectively. Much attention has been given to the possible sources of hard markets, including capacity constraints and asymmetric information (see,

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\*Lisa Posey is Associate Professor of Business Administration in the Smeal College of Business at Penn State University.

for example, (Cummins and Danzon, 1991; Doherty and Posey, 1997; Gron, 1994; Winter, 1994). Aside from the cyclical nature of these markets, other characteristics of commercial property/casualty markets—and their impact on pricing—have been less explored. Industry observers and participants often note that during certain periods, intense price competition appears to lead to price offers by competitors which are below the cost of providing coverage. The incumbent insurer often is unable or unwilling to match such offers by competitors during the renewal/bargaining process. Corporate clients generally have a handful of quotes, but do not necessarily switch to the lowest-priced insurer even if quality appears to be comparable *ex ante*. Switching costs lead clients to remain with incumbents unless the price difference is significant enough or the client is unhappy with the services provided by the incumbent. Therefore, there is differentiated pricing, unlike the simple competitive market with a unique equilibrium price for similar policyholders.

This paper analyzes a particular segment of the property/casualty insurance market: large corporate accounts, which only a small number of insurers have the capacity to insure. In this market, the premium is often heavily negotiated at the level of the individual account, and there is usually competition between a small number of insurers for the business. In addition, corporate policyholders incur costs of switching from one insurer to another for a number of reasons. Some of these switching costs originate at the beginning of the relationship between the insurer and the policyholder and remain throughout. Included in this group are the costs of transferring data to the insurer's proprietary system for recording and tracking the policyholder's loss and claim experience. Also included are the costs of learning the insurer's procedures for routine claim adjustment. On the other hand, some information that may affect the policyholder's calculation of the costs and benefits of switching insurers may be learned over time or only with a probability of less than one. For example, a large liability claim may or may not occur in any given period of coverage, but when the first such claim does occur, the policyholder will determine how satisfied he is with the insurer's services during the resolution of the claim. A policyholder who has been happy with the handling of routine claims in the past may find that his perceived cost of switching insurers in the future is either increased or decreased, depending on how the level of satisfaction with large claim management compared with prior expectations.

These characteristics of the property/casualty market for large corporate accounts raise the question of how the competitive environment and the existence of switching costs affect insurers' pricing of these insurance contracts and corporations' decisions about when to switch insurers. That

is the focus of this paper. A game theoretic model is developed to capture the stylized characteristics of the market, and the resulting equilibrium strategies of the insurers and a representative corporate risk manager are derived.

In traditional two-period models of markets with a fixed switching cost, the cost develops after consumers have chosen firms in period 1 and is incurred by a consumer if he switches firms in period 2 (e.g., Klemperer, 1987a, 1987b, 1995; Basu and Bell, 1991; Padilla, 1992)<sup>1</sup>. In these models, each of two firms attempts to increase market share in the first period, which in turn determines the number of consumers in the second period from which excess profits may be extracted through switching costs. Each firm must charge all consumers the same price in a given period, and price determines market share. Typically, the prices charged in the final period are greater than the prices that would occur if no switching costs were present. The prices in the first period depend on the assumptions of the model. In addition, no switching occurs in these models—consumers remain with the same firm through both periods.

The current model of P/C insurance for large corporate accounts is a three-period model in which two insurers engage in Bertrand (price) competition for the business of a single large corporate account, since competition occurs at the level of the account.<sup>2</sup> Fixed switching costs (like those assumed in traditional models of switching costs) occur during the first period of the contractual relationship between policyholder and insurer and remain (e.g., the cost of transferring data and learning routine claim adjustment procedures). In addition, as a result of having experience with an insurer over time, the client develops information that has an impact on the cost of switching (e.g., information about the difference between the value of large claim management by the current insurer and that expected from the competing insurer). Since policyholders have idiosyncratic differences and different claims experiences over a given time period, the equilibrium strategies of the game would be identical for two *ex ante* identical policyholders facing the same two insurers, but the market outcome—the resulting prices and switching strategies—may be different *ex post*, depending on what is revealed.<sup>3</sup>

The results of the model indicate that, in equilibrium, switching may occur in either period 2 or period 3. Prices in the final period will be greater than or equal to marginal cost. In the second period, the insurer that did not obtain the business in the first period will price below marginal cost and may be able to induce the risk manager to switch. In this case, the market price for the period will be below marginal cost. If switching does not occur in the second period, the price may be either below, above, or equal to marginal cost depending on the parameter conditions. In either

period, the motivation for switching insurers is a large claim experience where the client's valuation of the handling of the claim is below what is expected from the competing insurer by a significant enough margin to overcome the fixed switching costs.

## THE MODEL

Assume that the risk manager of a large publicly held firm is in the market for a property and/or liability insurance policy. The risk manager intends to buy insurance in each of three periods. Two insurers,  $A$  and  $B$ , are competing for the account. Assume that the shareholders of the risk manager's corporation can diversify away the risk underlying the policy by holding a diversified portfolio of assets, so the objective is to maximize the value of the firm, and risk aversion of the shareholders is not an issue. To provide a motive for the purchase of insurance (rather than self-insurance), assume the risk manager knows that either of the insurers can handle large claims with greater expertise than the firm itself can.

Table 1 provides a list of the variables used in the model and their definitions. Let  $c$  be the expected marginal cost to each of the two insurers of providing the insurance, including the handling of expected claims, both large and routine. If a large claim occurs, the additional value above  $c$  that the risk manager's firm obtains from having insurer  $i$ ,  $i = A, B$ , handle the claim, rather than the firm itself, is  $v_i$ . The risk manager does not know *ex ante* the firm's valuation for either insurer, and these valuations are idiosyncratic to the firm itself, depending on the in-house capabilities of handling a large claim and the negotiating style of the people who would be involved, as well as their other characteristics and responsibilities. The distribution of the idiosyncratic valuations of the group of similar potential policyholders (large firms with similar characteristics in the market) is:  $v_i = \bar{v}$  with probability  $\lambda$  and  $v_i = \underline{v}$  with probability  $1 - \lambda$ ,  $\bar{v} > \underline{v} > 0$ . The risk manager (along with the other potential policyholders) knows this distribution and, *ex ante*, knows no additional information about where its valuations for each insurer lie in this distribution. So the two insurers are perceived as having equal expected quality by the market, with an average valuation for potential policyholders equal to  $E[v] = \bar{v}\lambda + \underline{v}(1 - \lambda)$ .

Once a firm chooses an insurer, the true value of  $v_i$  is learned by all parties if a large claim does occur. Otherwise, no additional information is obtained. The probability of a large claim in any given period is  $\theta$ . Therefore, if the firm purchases insurance from an insurer that has never handled a large claim for them before, then during that period either (1) the firm experiences a large claim and a high valuation,  $\bar{v}$ , is revealed (this occurs

**Table 1.** Variable Definitions

Variable	Definition
$c$	Expected marginal cost to insurers of providing coverage.
$v_i$	Additional value above $c$ that the risk manager's firm obtains by having insurer $i$ ( $i = A, B$ ) handle a large claim. $v_i$ has two possible values, $\underline{v}$ and $\bar{v}$ .
$\lambda$	Probability that $v_i = \bar{v}$ .
$\theta$	Probability of a large claim in any given period.
$s$	Fixed cost of switching insurers in any given period.
$P_i^n$	Price offered to the risk manager by insurer $i$ in period $n$ , $n = 2, 3$ .
$P_i^{n:?}$	Price offered at each individual node, 2:1 through 2:3 and 3:1 through 3:14.
$v_i^n$	information that has been revealed by the beginning of period $n$ about the risk manager's valuation of the large claim handling of insurer $i$ .
$v_i^{n:?}$	information revealed by the time of arrival at each individual node, 2:1 through 2:3 and 3:1 through 3:14.

with probability  $\theta \lambda$ ), or (2) the firm experiences a large claim and a low valuation,  $\underline{v}$ , is revealed (this occurs with probability  $\theta(1 - \lambda)$ ), or (3) the firm does not experience a large claim and no information is revealed (this occurs with probability  $1 - \theta$ ).

In each of the three periods, the two insurers,  $A$  and  $B$ , engage in Bertrand (price) competition to provide the desired coverage.<sup>4</sup> The equilibrium is a subgame perfect Nash equilibrium.<sup>5</sup> As noted, both insurers have a marginal cost of providing the coverage equal to  $c$ . A game tree depicting a portion of the model is presented in Figure 1. The uppermost node on this tree represents the point in the game where the risk manager has already made the first-period decision and chosen insurer  $A$ ; nature is about to determine whether a large claim will occur in the first period, and if so, what the valuation will be. Note that if insurer  $B$  is chosen, then a symmetric game tree represents the other half of the game, which looks identical except the roles of  $A$  and  $B$  are switched. Also note that in the first period, only the expected valuation of each insurer is known, and these expected values are identical. Therefore, the insurers are identical at this point and compete on the basis of price, and if, as expected, they choose

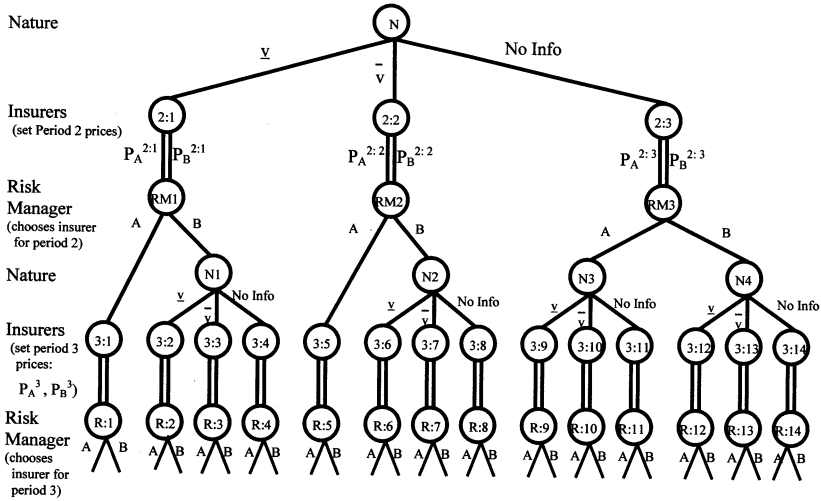


Fig. 1. Business with insurer A at beginning of period 2.

the same price, the business is randomly assigned to one of the two insurers (with a probability of  $\frac{1}{2}$  of going to either). It is assumed that the parameters are such that the firm chooses to insure rather than self-insure in the first period. It then follows that the firm will continue to insure in the subsequent periods.

Nodes 2:1, 2:2, and 2:3 represent the three possible subgames that will be faced at the beginning of period 2. At these nodes the two insurers choose their price offers. At node 2:1 all parties know that the risk manager's firm has a low idiosyncratic valuation of the large claim handling of insurer A; at node 2:2 it has a high valuation, and at node 2:3 no large claim occurred and no further information has been revealed. At all three nodes only the expected valuation for insurer B is known. At nodes RM1, RM2, and RM3, the risk manager chooses either insurer A or insurer B, given the price offers and the information. If the risk manager chooses to switch from one insurer to another at any of these nodes, or to self-insure, a fixed switching cost of  $s$  is incurred at that point. If an insurer is chosen that has not handled a large claim for the risk manager's firm yet, then nature moves again (at nodes N1, N2, N3, or N4) and may reveal the valuation of large-claim handling for that insurer. The fourteen nodes 3:1 through 3:14 represent the beginning of period 3 for all the possible information paths that may have unfolded. Here the insurers make their third-period price offers, and at the nodes below, R:1 through R:14, the risk manager chooses which

insurer to use for the third and final period. As in period 2, if the risk manager decides to switch insurers, a fixed switching cost of  $s$  is incurred.

Some final notation will aid in the characterization of the equilibrium strategies and prices. Let  $P_i^n$  represent the price offered to the risk manager by insurer  $i$  in period  $n$ ,  $n = 2, 3$ . This will be further refined as  $P_i^{n:q}$ ,  $q = 1, 2, 3$  to denote the price offered at each individual node, **2:1** through **2:3** and **3:1** through **3:14**. Let  $v_i^n$  represent the information that has been revealed by the beginning of period  $n$  about the risk manager's valuation of the large-claim handling of insurer  $i$ . This too will be further refined as  $v_i^{n:q}$  to denote the information revealed by the time of arrival at each individual node, **2:1** through **2:3** and **3:1** through **3:14**. For example, at node **2:1**,  $v_A^{2:1} = \underline{v}$  and  $v_B^{2:1} = E[v]$ , and at node **3:1**,  $v_A^{3:1} = \underline{v}$  and  $v_B^{3:1} = E[v]$ , while at node **3:3**,  $v_A^{3:3} = \underline{v}$  and  $v_B^{3:3} = \bar{v}$ .

## EQUILIBRIUM

### Period 3

The game is solved by backward induction. The final choices of the game are the risk manager's at the final nodes of the fourteen subgames for period 3. If the risk manager is already with insurer  $i$  from period 2, then at each of the nodes, **R:1** through **R:14**, the expected payoff from remaining with insurer  $i$  is

$$Payoff_i^3 = c + \theta v_i^3 - P_i^3$$

and the expected payoff from switching to insurer  $j$ ,  $i \neq j$ , is

$$Payoff_j^3 = c + \theta v_j^3 - P_j^3 - s,$$

where  $\theta$  is the probability that a large claim will occur during the period, and this is multiplied by the additional value that the risk manager's firm places on the handling of the claim, given the information about each insurer. The risk manager will choose the insurer whose price will give the greatest expected payoff. It is assumed that if the risk manager is indifferent

between the two insurers, the firm remains with the insurer from the prior period and does not switch. Moving up to nodes 3:1 through 3:14, the insurers must make price offers, competing with one another for the business. Competition will drive the price for insurer  $j$ , the insurer without the business in the second period, down to the zero profit level of  $P_j^3 = c$ . Insurer  $i$  will set its price at the highest possible level that will retain the client, unless this price cannot earn non-negative profits. The prices that leave the risk manager indifferent between the two insurers solve:

$$Payoff_i^3 = c + \theta v_i^3 - P_i^3 = c + \theta v_j^3 - P_j^3 - s = Payoff_j^3.$$

Setting  $P_j^3 = c$  and solving gives the price for insurer  $i$  required to make the risk manager indifferent as  $c + \theta(v_i^3 - v_j^3) + s$ . But insurer  $i$  cannot charge less than marginal cost in this period without obtaining negative expected profits. So insurer  $i$ 's third-period price will be

$$P_i^3 = \max\left\{c + \theta(v_i^3 - v_j^3) + s, c\right\}.$$

Table 2 provides a list of the third-period price offers for the two insurers by node. The first column lists the node where the insurer sets the price. The second and fourth columns list the formulas for the prices of insurer  $A$  and  $B$ , respectively, at these nodes. For illustrative purposes, two examples of parameter values are given and the insurers' prices for those examples are listed in columns 3 and 5.

**Examples.** The examples differ only with respect to the magnitude of the switching cost,  $s$ . The first number in the square brackets represents the price when  $s = \$5,000$  and the second number in the square brackets represents the price when  $s = \$20,000$ . The other assumptions of the examples are as follows:

- $\theta = .01$
- $c = \$1$  million
- $\underline{v} = \$2$  million
- $\overline{v} = \$4$  million
- $E[v] = \$3$  million.<sup>6</sup>

These assumptions lead to the sample prices listed in columns 3 and 5 of Table 2. These examples will be used later to help illustrate the types of equilibria that may be obtained.



**Table 2.** Period 3 Prices that Leave Risk Manager Indifferent Between Insurers Given That Insurer Without Business in Period 2 Charges Marginal Cost

Node	Price for Insurer A ( $P_A^3$ )	Example $P_A^3$ [ $s = 5K, s = 20K$ ]	Price for Insurer B ( $P_B^3$ )	Example $P_B^3$ [ $s = 5K, s = 20K$ ]
3:1	$Max\{c + \theta(\underline{z} - E[v]) + s, c\}$	[1 m, 1.01 m]	$c$	[1 m, 1 m]
3:2	$c$	[1 m, 1 m]	$c + s$	[1.005 m, 1.02 m]
3:3	$c$	[1 m, 1 m]	$c + \theta(\bar{v} - \underline{z}) + s$	[1.025 m, 1.04 m]
3:4	$c$	[1 m, 1 m]	$c + \theta(E[v] - \underline{z}) + s$	[1.015 m, 1.03 m]
3:5	$c + \theta(\bar{v} - E[v]) + s$	[1.015 m, 1.03 m]	$c$	[1 m, 1 m]
3:6	$c$	[1 m, 1 m]	$Max\{c + \theta(\underline{z} - \bar{v}) + s, c\}$	[1 m, 1 m]
3:7	$c$	[1 m, 1 m]	$c + s$	[1.005 m, 1.02 m]
3:8	$c$	[1 m, 1 m]	$Max\{c + \theta(E[v] - \bar{v}) + s, c\}$	[1 m, 1.01 m]
3:9	$Max\{c + \theta(\underline{z} - E[v]) + s, c\}$	[1.01 m, 1 m]	$c$	[1 m, 1 m]
3:10	$c + \theta(\bar{v} - E[v]) + s$	[1.015 m, 1.03 m]	$c$	[1 m, 1 m]
3:11	$c + s$	[1.005m, 1.02 m]	$c$	[1 m, 1 m]
3:12	$c$	[1 m, 1 m]	$Max\{c + \theta(\underline{z} - E[v]) + s, c\}$	[1 m, 1.01 m]
3:13	$c$	[1 m, 1 m]	$c + \theta(\bar{v} - E[v]) + s$	[1.015 m, 1.03 m]
3:14	$c$	[1 m, 1 m]	$c + s$	[1.005 m, 1.02 m]

If  $P_i^3 = c$ , or equivalently,  $\theta(v_i^3 - v_j^3) + s < 0$ , then insurer  $i$  cannot reduce its price enough to make its policy as attractive as that of insurer  $j$  while still obtaining non-negative profits. The condition  $\theta(v_i^3 - v_j^3) + s < 0$  means the information obtained by the risk manager so far indicates that the value of insurer  $i$ 's large-claim handling is lower than that of insurer  $j$  and that the difference is significant enough (when weighted by the probability of a large claim occurring) to overcome the fixed switching cost  $s$ . In this case, the risk manager will switch to insurer  $j$  and pay

a price equal to the insurer's marginal cost. If, on the other hand,  $P_i^3 = c + \theta(v_i^3 - v_j^3) + s \geq c$ , then insurer  $i$ 's price will be greater than or equal to marginal cost, but  $\theta(v_i^3 - v_j^3) + s \geq 0$  implies that switching is not worth it for the risk manager. The risk manager will stick with insurer  $i$  and pay a price greater than or equal to the insurer's marginal cost. Either way, the payoff for the risk manager's firm for period 3 will be  $\theta v_j^3 - s$ .

Of the fourteen subgames for period 3, all but five are certain to have an equilibrium with no switching and with prices above marginal cost at  $P_i^3 = c + \theta(v_i^3 - v_j^3) + s$ . But the parameter conditions may be such that any, some, or all of the subgames beginning at nodes **3:1**, **3:6**, **3:8**, **3:9**, and **3:12** will have an equilibrium strategy for the risk manager of switching insurers. Note that four of the five involve the situation where the period 2 insurer has a low valuation by the risk manager's firm. The final case has no information for the period 2 firm, but a high valuation for the other firm. Switching from insurer  $i$  to  $j$  will occur in the third period as follows: at nodes **R:1**, **R:9**, and **R:12** if  $\theta(\underline{v} - E[v]) + s < 0$ , at node **R:6** if  $\theta(\underline{v} - \bar{v}) + s < 0$ , and at node **R:8** if  $\theta(E[v] - \bar{v}) + s < 0$ . At this point, it has not yet been discussed which, if any, of these nodes might be reached in equilibrium play. To do so, the equilibrium strategies for the second period must be discussed first.

## Period 2

At nodes **RM1**, **RM2**, and **RM3**, the risk manager chooses an insurer based on the insurer's second-period price offerings and the information available at that time,  $v_A^2$  and  $v_B^2$ . The risk manager's firm was with insurer  $A$  in the first period. Since the choice of insurer at this point in period 2 will affect the payoffs in the third period because of switching costs, the risk manager must compare the expected two-period (periods 2 and 3 combined) payoffs associated with the two insurers.

The expected two-period payoff from remaining with insurer  $A$  in period 2 is

$$Payoff_A^2 = c + \theta v_A^2 - P_A^2 + E[\theta v_B^3 - s] = c + \theta v_A^2 - P_A^2 + \theta v_B^2 - s,$$

where  $E[\theta v_B^3 - s]$  is the expected payoff for period 3 if insurer  $A$  is chosen in period 2. The expected two-period payoff from switching to insurer  $B$

in period two is

$$Payoff_B^2 = c + \theta v_B^2 - P_B^2 + E[\theta v_A^3 - s] - s = c + \theta v_B^2 - P_B^2 + \theta v_A^2 - 2s$$

where  $E[\theta v_A^3 - s]$  is the expected payoff for period 3 if insurer  $B$  is chosen in period 2. The risk manager will choose the insurer with the price that gives the greatest expected two-period payoff.

At nodes **2:1**, **2:2**, and **2:3**, the insurers make their price offers for coverage in period 2. Bertrand competition will reduce the price for insurer  $B$  down to the zero expected profit price for periods 2 and 3 combined. Insurer  $A$  will set its price at the level that will make the risk manager indifferent between the two insurers, given the behavior of insurer  $B$ , if that price will lead to non-negative expected profits. Given insurer  $B$ 's second period price, the price for insurer  $A$  that will make the risk manager indifferent is given by:

$$Payoff_A^2 = c + \theta v_A^2 - P_A^2 + \theta v_B^2 - s = c + \theta v_B^2 - P_B^2 + \theta v_A^2 - 2s = Payoff_B^2 .$$

This gives the following relationship between the second-period prices of insurers  $A$  and  $B$ :

$$P_A^2 = P_B^2 + s .$$

If that price will lead to negative expected profits, insurer  $A$  will need to raise its price to receive zero expected profits and, therefore, will lose the business to insurer  $B$ . The equilibria are derived in the appendix for each of the three subgames for period 2, those starting at nodes **2:1**, **2:2**, and **2:3**, respectively. These equilibria, in the context of the overall game, are qualitatively characterized in the following section.

### Overall Model—Periods 1–3

In the first period, insurers  $A$  and  $B$  are identical from the perspective of the risk manager. The risk manager's firm will incur no switching cost in this period since a relationship has not been formed yet with either insurer and no information other than the expected valuations is known. Therefore, Bertrand competition will lead the two insurers to set the same price, that which gives zero expected profits for the combined three periods of the model. The risk manager will then randomly choose one of the two

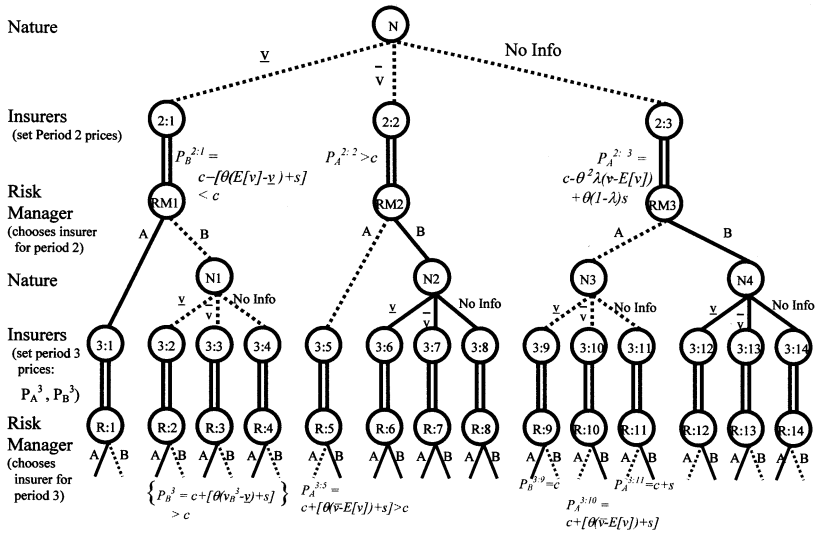


Fig. 2.  $\theta(\underline{v} - E[v]) + s < 0$

insurers to purchase coverage from in period 1 (with a probability of  $\frac{1}{2}$  of choosing each insurer).

Without loss of generality, assume insurer A is chosen. Then the model begins at node N at the top of Figure 1. The large-claim experience is then revealed. With probability  $\theta(1 - \lambda)$ , the firm experiences a large claim, a low valuation ( $\underline{v}$ ) is revealed, and node 2:1 is reached. With probability  $\theta\lambda$  the firm experiences a large claim, a high valuation ( $\bar{v}$ ) is revealed, and node 2:2 is reached. With probability  $1 - \theta$ , the firm does not experience a large claim, no information is revealed, and node 2:3 is reached.

The equilibria are depicted in Figures 2 through 4. The dashed lines represent equilibrium play if a particular node is reached, and the prices for periods 2 and 3 are given for the firm that will obtain the business if the node is reached. The equilibria can be summarized as follows. The risk manager will not switch in period 2 if the valuation of insurer A either is revealed to be high or is not revealed in period 1. If a high valuation is revealed so that node 2:2 is reached, the risk manager will stay with insurer A in periods 2 and 3 and will pay a price in each period that is above marginal cost. Insurer B will set its price below marginal cost in period 2 but will be unable to obtain the business. (For a proof of this assertion, as well as other assertions referring to the equilibria, see the Appendix). If node 2:3 is reached, then the risk manager will stay with insurer A in the second period. What happens in the third period if node 2:3 is reached, as

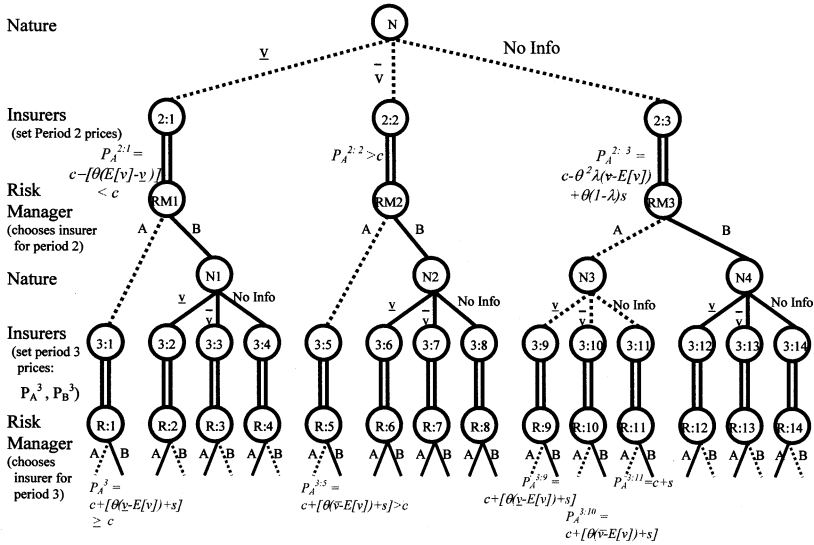


Fig. 3.  $\theta(\underline{v} + E[v]) + s \geq 0$  and  $2\theta(\underline{v} + E[v]) + s \geq 0$

well as what happens if node 2:1 is reached, depends on the sign of  $\theta(\underline{v} - E[v]) + s$ .

The equilibrium for the case where  $\theta(\underline{v} - E[v]) + s < 0$  is depicted in Figure 2. If node 2:3 is reached, the risk manager will stay with insurer A in period 2. In period 3, the risk manager will switch to insurer B if and only if a large claim occurs in period 2 and a low valuation for the claims handling is revealed. On the other hand, if node 2:1 is reached, the risk manager will switch to insurer B in the second period, incur a switching cost,  $s$ , pay a second-period price below marginal cost, and stay with insurer B in the third period, paying a price above marginal cost.

The equilibria for the cases where  $\theta(\underline{v} - E[v]) + s \geq 0$  are depicted in Figures 3 and 4. In this case, the risk manager will stay with insurer A in both periods 2 and 3 if node 2:3 is reached. The price paid will equal marginal cost in the second period and be at least equal to marginal cost in the third. On the other hand, if node 2:1 is reached, insurer B will set its price below marginal cost and the risk manager will stay with insurer A in period 2 if and only if insurer A can set its price low enough to make the risk manager indifferent. Insurer A will do that if it can maintain non-negative profits, which will occur when  $2\theta(\underline{v} - E[v]) + s \geq 0$  as depicted in Figure 3. In that case the risk manager will stay with insurer A in period 2 and period 3. The second-period price will be below marginal cost and the third-period price will be at least as great as marginal cost. If insurer A

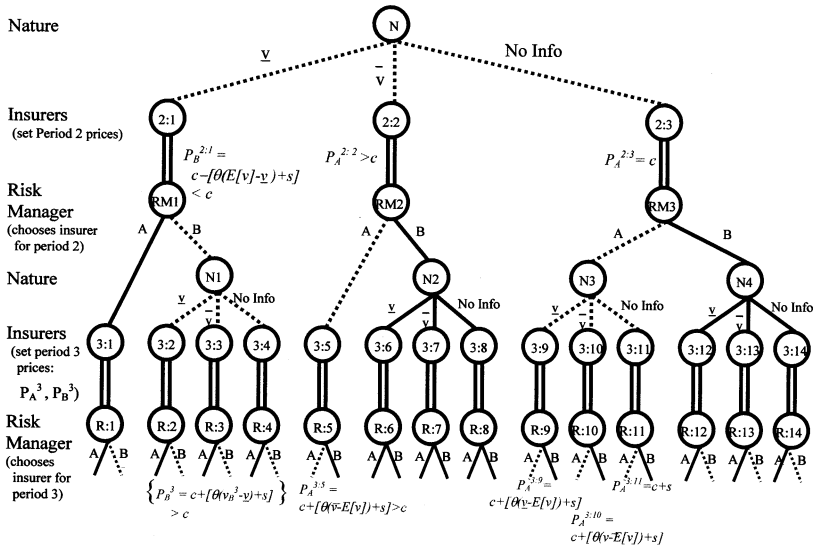


Fig. 4.  $\theta(\underline{v} + E[v]) + s \geq 0$  and  $2\theta(\underline{v} - E[v]) + s < 0$

cannot profitably set its second-period price low enough to make the risk manager indifferent (i.e., when  $2\theta(\underline{v} - E[v]) + s \leq 0$  as depicted in Figure 4), then the risk manager will switch to insurer B in the second period and stay with B in period 3, paying a second-period price below marginal cost and a third-period price above marginal cost.

To illustrate the equilibria, refer back to the examples presented earlier that lead to the period 3 prices listed in Table 2:

- $s = 5,000$  or  $s = 20,000$
- $\theta = .01$
- $c = \$1$  million
- $\underline{v} = \$2$  million
- $\bar{v} = \$4$  million
- $E[v] = \$3$  million.

When  $s = 5,000$ , then  $\theta(\underline{v} - E[v]) + s < 0$  so the parameter conditions for the equilibrium in Figure 2 are satisfied. That means that the risk manager will switch from insurer A to insurer B at the beginning of either period 2 or period 3 if A is revealed to be a low-value insurer in either the first or second period, respectively. This is because switching costs are sufficiently low to warrant the switch. When  $s = 20,000$ , then  $\theta(\underline{v} - E[v]) + s > 0$  and  $2\theta(\underline{v} - E[v]) + s < 0$  and the parameter conditions for the equilibrium in Figure

4 are satisfied. In this case, the risk manager will switch from *A* to *B* at the beginning of the second period if *A* turns out to be low value. But if no information is revealed in the first period and then *A* turns out to be low value in the second period, the risk manager will not switch to *B* for the third period. This is because switching costs are high enough that switching for the last period to obtain marginal cost pricing is not worth it. But switching costs are low enough that in the second period, insurer *A* cannot reduce the price enough to make switching for the remaining two periods unattractive. Finally, if *s* were high enough so that the parameter conditions in Figure 3 were satisfied, then the risk manager would never find switching insurers to be an attractive option in equilibrium.

## CONCLUSION

In this paper, a game theoretic model is developed to analyze certain characteristics of the commercial property/casualty insurance market for large corporate accounts. The results of this model are consistent with what industry observers and participants often note: that during certain periods, intense price competition appears to lead to price offers by competitors that are below the cost of providing coverage. The incumbent insurer often is unable or unwilling to match such offers by competitors during the renewal/bargaining process. Corporate clients generally have a handful of quotes, but do not necessarily switch to the lowest-priced insurer even if quality appears to be comparable *ex ante*. Switching costs lead clients to remain with incumbents unless the price difference is significant enough or the client is unhappy with the services provided by the incumbent. Therefore, there is differentiated pricing, unlike the simple competitive market with a unique equilibrium price for similar policyholders.

Although the model supports pricing both above and below marginal cost, it doesn't predict that prices for all clients will move together in one direction or another as is the case when there is a transition from a soft to a hard market, or vice versa. Pricing below marginal cost to attract customers from other insurers, a practice that appears to have been common during the recent soft market, can be rational economic behavior in some cases. But the revelation that the incumbent insurer's handling of large claims is of low value provides the incentive to incur switching costs and switch to another insurer. This type of revelation is random and is unlikely to happen in a cyclical fashion across clients. Insurers would not price below marginal cost unless they expected to be able to price above marginal cost in future periods. So the model provides an economic justification for two characteristics of insurance pricing—pricing below marginal cost fol-

lowed by pricing above marginal cost—but it does not provide an explicit explanation for the cycles themselves.

The model developed in this paper is a multi-period model (three periods) in which a risk manager must choose between two insurers in each period and the insurers set prices in an environment of Bertrand price competition. Switching costs exist from the onset of a contractual relationship with an insurer. In addition, with a certain probability, a large claim may be incurred by the policyholder that will reveal information about the value to the policyholder of the level of service provided by that period's incumbent insurer. This information will affect the cost-benefit analysis for switching insurers, given the expected (or revealed) value of service for the competitor.

The conclusions of the analysis of the model are that, in equilibrium, it will be optimal for an insurer trying to attract business away from a competitor to price the coverage below cost in the second period with the expectation that it can price above cost in the third period. If the client switches, he will pay a price below marginal cost in the second period, but above marginal cost in the third. If the client remains with the original insurer, he is likely to pay above marginal cost in both periods, but certainly in the third period. Switching from one insurer to another may occur in either period if the original insurer does not provide a highly valuable service during the claims management process and the expectation is that the competitor will be sufficiently better to overcome the initial switching costs.



## APPENDIX

### Subgame beginning at 2:1 (Insurer A found to have low valuation):

The expected two-period profits for insurer  $B$  must first be calculated and set to zero. If insurer  $B$  obtains the business in period 2, it expects to retain it in period 3, since the equilibria for nodes 3:2, 3:3, and 3:4 do not involve switching. Therefore, the two-period expected profits for insurer  $B$  are

$$\pi_B^{2:1} = P_B^{2:1} - c + E[\pi_B^3] = P_B^{2:1} - c + [\theta(E[v] - \varrho) + s] = 0,$$

where  $\pi_B^3$  is insurer  $B$ 's expected profits in period 3. This gives a second-period price for insurer  $B$  of

$$P_B^{2:1} = c + [\theta(E[v] - \varrho) + s]$$

which is below insurer  $B$ 's marginal cost for period 2 coverage. Once the business is obtained by insurer  $B$  in period two, switching costs will allow the insurer to charge a price above its marginal cost in the third period. Therefore, insurer  $B$  is willing to price below marginal cost in the second period to obtain the business and still make zero expected profits overall.

How will insurer  $A$  set its price given the behavior of insurer  $B$ ? The price required to make the risk manager indifferent is

$$P_A^{2:1} = P_B^{2:1} + s = c - [\theta(E[v] - \varrho) + s] = c - \theta(E[v] - \varrho),$$

which is below marginal cost. Insurer  $A$  must determine whether this price will provide non-negative expected profits for periods 2 and 3. These expected profits depend on the sign of the term  $\theta(\varrho - E[v]) + s$  since this sign will determine whether insurer  $A$ , if it gets the business in period 2, expects to retain the business in period 3 or lose it to insurer  $B$  (see Table 2 for node 3:1).

If  $\theta(\varrho - E[v]) + s < 0$ , then the period 3 price required for insurer  $A$  to retain the business in that period is less than marginal cost, so it cannot retain the business while making non-negative third-period profits. Therefore, only second-period profits are considered by insurer  $A$  when calculating expected profits over periods 2 and 3:

$$\pi_A^{2:1} = P_A^{2:1} - c = c - \theta(E[v] - \varrho) - c = -\theta(E[v] - \varrho) < 0.$$

The expected profits are negative and insurer  $A$  cannot set the price required to keep the risk manager from switching to insurer  $B$ . The expected value of large claims management by insurer  $B$  is sufficiently higher than the low valuation revealed during the first-period relationship with insurer  $A$  that it is worth it to incur the switching costs to obtain this additional potential benefit from insurer  $B$  over both periods 2 and 3. The price the risk manager's firm pays for the second-period insurance coverage is  $P_B^{2:1}$ , which is below marginal cost. A switching cost is incurred in the second period, and the expected third-period price paid to insurer  $B$  is  $c + \theta(E[v] - \varrho) + s$ , which is greater than marginal cost.

If  $\theta(\varrho - E[v]) + s \geq 0$ , then insurer  $A$  can price greater than or equal to marginal cost and keep the business in period 3 while making non-negative third-period profits. Therefore, its expected profits for periods 2 and 3 are

$$\begin{aligned} \pi_A^{2:1} &= P_A^{2:1} - c + P_A^{3:1} - c \\ &= [c - \theta(E[v] - \varrho)] - c + c + \theta(\varrho - E[v]) + s - c \\ &= 2\theta(\varrho - E[v]) + s. \end{aligned}$$

This may be either positive or negative or zero. If it is negative, insurer  $A$  cannot retain the business in period 2 without making negative expected profits for periods 2 and 3 combined, so the price must be raised. The risk manager will switch to insurer  $B$  and pay a price below marginal cost. If these expected profits are greater than or equal to zero, then insurer  $A$  can set the price at the level required to retain the business in period 2 and can expect to keep the business in period 3. In this case, the switching cost  $s$  is sufficiently high that, even though insurer  $A$  has been revealed to have the lowest valuation for large claims handling, switching is too costly to make it worthwhile to seek the expected improvement in large claims handling from insurer  $B$ .

### **Subgame beginning at 2:2 (Insurer A found to have high valuation):**

At node **2:2**, insurer  $A$  has been revealed to have a high valuation by the risk manager's firm in the first period. In equilibrium, the firm will stick with insurer  $A$  in both periods 2 and 3 and will pay prices above marginal cost in each period. The actual prices to be paid depend on the parameter

conditions. Under all parameter conditions, insurer  $A$ 's second-period price is above marginal cost and insurer  $B$ 's second-period price is below marginal cost. These results can be shown as follows.

Insurer  $B$  must set its price in period 2 to obtain zero expected profits for periods 2 and 3 combined. In determining those profits, the parameter conditions affect whether it will retain the business in period 3 if it does obtain it in period 2. Consider the subgames beginning at nodes **3:6**, **3:7**, and **3:8**. If **3:7** is reached, then insurer  $B$  will retain the business in period 3, but if **3:6** is reached, the business can be retained only if  $\theta(\underline{v} - \bar{v}) + s \geq 0$ , and if **3:8** is reached the business can be retained only if  $\theta(E[v] - \bar{v}) + s \geq 0$ . Therefore, the following three sets of parameter conditions lead to three different period 2 prices for insurer  $B$ , and consequently for insurer  $A$ .

If  $\theta(\underline{v} - \bar{v}) + s \geq 0$  and  $\theta(E[v] - \bar{v}) + s \geq 0$ , then insurer  $B$  will always retain the business in period 3 if it obtains it in period 2 and the period 2 price that gives zero expected profit for periods 2 and 3 combined is derived by:

$$\pi_B^{2:2} = P_B^{2:2} - c + [\theta(E[v] - \bar{v}) + s] = 0, \text{ which gives}$$

$$P_B^{2:2} = c - [\theta(E[v] - \bar{v}) + s].$$

Can insurer  $A$  set its price at  $P_A^{2:2} = P_B^{2:2} + s$  to make the risk manager indifferent, receive positive expected profits for periods 2 and 3 combined, and retain the business? First note that if insurer  $A$  retains the business in period 2 it will retain it in period 3 as well at node **3:5** (see Table 2).

$$P_A^{2:2} = c - [\theta(E[v] - \bar{v})] \text{ and } \pi_A^{2:2} = 2\theta(\bar{v} - E[v]) + s > 0.$$

So expected profits for periods 2 and 3 are positive at the price required to retain the business in period 2. Insurer  $A$  charges a price above marginal cost in period 2 and at least as high as marginal cost in period 3, and does retain the business in both periods.

If  $\theta(\underline{v} - \bar{v}) + s < 0$  and  $\theta(E[v] - \bar{v}) + s \geq 0$ , then insurer  $B$  will retain the business in period 3 if it obtains it in period 2 unless a low valuation is realized and node **3:6** is reached. The period 2 price which gives zero expected profit for periods 2 and 3 combined is derived by:

$$\pi_B^{2:2} = P_B^{2:2} - c + [\theta\lambda s + (1 - \theta)\{\theta(E[v] - \bar{v}) + s\}] = 0, \text{ which gives}$$

$$P_B^{2:2} = c - [\theta\lambda s + (1 - \theta)\{\theta(E[v] - \bar{v}) + s\}],$$

$$P_A^{2:2} = c + [\theta(1 - \lambda)s - (1 - \theta)\theta(E[v] - \bar{v})] \text{ and } \pi_A^{2:2} = [\theta(1 - \lambda) + 1]s + (2 - \theta)\theta(\bar{v} - E[v]) > 0.$$

So insurer  $A$  can set the required second-period price greater than marginal cost and retain the business with positive expected profits.

Finally, if  $\theta(E[v] - \bar{v}) + s < 0$ , then insurer  $B$  will retain the business in period 3 only if a high valuation is realized and node 3:7 is reached. In this case, the period 2 price that gives zero expected profit for periods 2 and 3 combined is derived by:

$$\pi_B^{2:2} = P_B^{2:2} - c + [\theta\lambda s] = 0, \text{ which gives}$$

$$P_B^{2:2} = c - [\theta\lambda s].$$

$$P_A^{2:2} = c + (1 - \theta\lambda)s \text{ and } \pi_A^{2:2} = (1 - \theta\lambda)s + \theta(\bar{v} - E[v]) + s > 0.$$

Under each of these three sets of parameter conditions, insurer  $B$  prices below or at marginal cost, insurer  $A$  prices above marginal cost in both periods 2 and 3, and Insurer  $A$  retains the business in both periods.

### Subgame beginning at 2:3 (No information revealed about Insurer A):

At node 2:3, insurers  $A$  and  $B$  both have the same expected valuation. If insurer  $A$  is chosen in period 2, it will retain the business in period 3 unless a low valuation is realized in period 2 and  $\theta(\underline{v} - E[v]) + s < 0$  (see node 3:9 in Table 2). Alternatively, if insurer  $B$  obtains the business in period 2 it will retain the business in period 3 unless a low valuation is realized in period 2 and  $\theta(\underline{v} - E[v]) + s < 0$  (see node 3:12 in Table 2). So the sign of  $\theta(\underline{v} - E[v]) + s$  will determine the second period prices of both insurers.

If  $\theta(\underline{v} - E[v]) + s \geq 0$ , then no switching occurs in the third period regardless of which insurer has the business. Insurer  $B$ 's period 2 price that obtains zero expected period 2 and 3 profits solves

$$\pi_B^{2:3} = P_B^{2:3} - c + E[\pi_B^3] = P_B^{2:3} - c + [c + s] - c = 0, \text{ which gives}$$

$$P_B^{2:3} = c - s.$$

This in turn leads insurer A to set its price at

$$P_B^{2:3} = c, \text{ which gives } \pi_A^{2:3} = s > 0.$$

So the risk manager stays with insurer A for periods 2 and 3 and pays a second-period price equal to marginal cost and a third-period price greater than or equal to marginal cost.

If  $\theta(\bar{v} - E[v]) + s < 0$ , then the risk manager will switch insurers in period 3, regardless of which insurer is chosen in period 2, if and only if that insurer reveals a low valuation in period 2. Once again, insurer B sets its period 2 price to obtain zero expected profits for periods 2 and 3 and insurer A adds  $s$  to that price and retains the business as long as its expected profits for periods 2 and 3 are non-negative:

$$\pi_B^{2:3} = P_B^{2:3} - c + [\theta\lambda\{\theta(\bar{v} - E[v]) + s\} + (1 - \theta)s] = 0, \text{ which gives}$$

$$P_B^{2:3} = c - [\theta\lambda\{\theta(\bar{v} - E[v]) + s\} + (1 - \theta)s],$$

$$P_A^{2:3} = c - [\theta\lambda\{\theta(\bar{v} - E[v]) + s\} - \theta s] \text{ and } \pi_A^{2:3} = s > 0.$$

In this case, insurer B charges below marginal cost, insurer A charges a price that may be either above, below, or equal to marginal cost and the risk manager stays with insurer A in period 2 and switches to insurer B in period 3 only if a low valuation is realized in period 2.

## ENDNOTES

<sup>1</sup>These models generally assume a transportation cost in the first period, which is the basis for consumers' choice of firm in period 1. More complex models with switching costs have been developed. These include the case where there is real product differentiation in period 2 (Klemperer, 1987b), the case of an infinite horizon game (Beggs and Klemperer, 1989), and the case where new consumers enter the market in the second period (Banerjee and Summers, 1987; Klemperer, 1987c). The latter may result in first-period prices that are higher than if no switching costs were present. One factor that is important in these models is that a single price must be set for all consumers in a given period and various standard oligopoly market structures are assumed so that quantity is affected by the price decision.

<sup>2</sup>Reducing the market to two insurers can be done without loss of generality because, under Bertrand price competition, all that is needed is the existence of a single competitor to obtain the type of equilibrium pricing strategy that would be obtained with multiple competitors.

<sup>3</sup>A major difference between this model and others with fixed switching costs is the characteristic that prices need not be the same for all customers, but instead prices are determined on a client-by-client basis. Therefore, a single market price does not exist for all clients in equilibrium. This will be true regardless of the number of insurers that compete for the client's business.

<sup>4</sup>Although there exist regulations with respect to price setting in commercial markets, these are far less restrictive than in personal lines of property-casualty insurance. Even in workers compensation, which is the most highly regulated commercial line with respect to prices, there is tremendous room for price variations across clients because of the use of credits and debits. This allows underwriters to essentially compete with one another on the basis of price and then to later find the appropriate debits or credits to justify the price. Therefore, price differences across clients are quite common and price regulation essentially will be ignored in this model.

<sup>5</sup>See Gibbons (1997) for a thorough discussion of the Nash equilibrium concept and the use of game theory in applied economics.

<sup>6</sup>This example could represent a liability risk with expected claims under \$1 million but with a small probability (.01) of a loss of, say, \$20 million. If the large claim occurs, the value to the risk manager's firm of having the insurer to defend it and/or negotiate a settlement will be either \$4 million or \$2 million, each with a probability of .5.

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