MARINE LIABILITY INSURANCE:

AN ANALYSIS OF MUTUALITY VERSUS FIXED PREMIUMS

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Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

in

Economics

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July 25, 2002
Arlington, Virginia

Keywords: Insurance, Liability, Mutal Premiums, Fixed-rate Premiums

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MARINE LIABILITY INSURANCE: AN ANALYSIS OF MUTUALITY vs. FIXED PREMIUMS

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(ABSTRACT)

This paper deals with the pricing differences between a mutual co-operative underwriting system and a fixed-premium underwriting system in providing coverage for marine liability. There has been much debate in recent years within the marine liability underwriting industry over which method fosters more competition, and hence, lower premiums for shipowners who are required to carry such coverage in order to operate. This paper will look at the current mutual marine insurance industry (Protection & Indemnity Associations or P&I Clubs) to compare its pricing both before and after the entry into the market of the fixed-premium underwriters, using data from 1985-2000 that encompasses both a major loss cycle and normal cyclical pricing variations. This analysis will hopefully provide information on whether mutual premium levels for the P&I Clubs differed substantially with the entry of the fixed-price competitors. This is important for the individual shipowners belonging to these mutual underwriting associations, because any variation in premium pricing could mean the potential for either great savings or tremendous losses.

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LIST OF ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COFR	Certificate of Financial Responsibility
CRISTAL	Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution
CVM	Contingent Valuation Methodology
dwt	deadweight tons, the carrying capacity of a ship in long tons
FWPCA	Federal Water Pollution Control Act of 1972
grt	gross registered tons, a ship's internal volume
ILU	Institute of London Underwriters
IMO	International Maritime Organization
ITOPF	Independent Tanker Owners Pollution Federation Ltd.
Lloyd's	Underwriters at Lloyd's of London
NOAA	National Oceanic and Atmospheric Administration
NRDA	Natural Resource Damage Assessment
OPA	Oil Pollution Act of 1990
P&I Club	Protection & Indemnity Club
SDR	Special Drawing Rights
TOVALOP	Tanker Owner Voluntary Agreement Concerning Liability for Oil Pollution
ULCC	Ultra Large Crude Carrier, a tanker over 275,000 dwt
VLCC	Very Large Crude Carrier, a tanker over 160,000 dwt

Introduction

Risk is defined by one leading insurance text (Pritchett, Schmit, Doerpinghaus, and Anthearn, 1996) as "variability in future outcomes" (p.3). Risk-sharing by any underwriter may be defined as "mutual insurance", because insurance companies do not hold any resources other than those of their owners, creditors, and policy-holders, but the differences in how direct the relationship is between policy-holders and owners is where premium pricing variation becomes important.

Potential risks in the world of shipping and shipowning involve losses associated with all aspects of shipping, including both property and liability; e.g., loss of or damages to the vessel, damages to crew and cargo, pollution, and third party liability. Insurance coverage against those risks is often mandated by government and/or financial backers (lienholders and cargo owners) in order for shipowners to operate, yet the value of these potential risks has always exceeded the financial capacity of normal insurance markets. For over one hundred years, a substitute system based on the pooling of risks by the assured shipowners has been successfully used to mitigate losses when they occurred. Recent developments, however, in both the financial and regulatory arenas have raised questions about the effectiveness of the current system; in particular, whether or not it hampers free movement of premiums among coverage providers and whether these premiums adequately reflect risks covered.

Marine pollution insurance, as with other types of marine insurance, is subject to a high level of financial volatility over time, with troughs and peaks related to the level of losses incurred during any one period and to the premium rates received from business placed: key elements which often do not correspond to a profitable or break-even ratio (where premiums exceed or equal claims). This volatility is due primarily to the fact that the number of ships that require insurance normally lie between 30,000 and 35,000[1], but while the premium income available from them in any given year is finite, the amount of claims is not. This causes a significant effect on market capacity, which is the total amount of capital

[1] Len Campbell, outgoing ILU Chairman quoted in his final address to members in February, 1996, London.

available to underwrite future coverage. Thus a profitable year in marine insurance, where premiums exceed claims by a nice margin, tends to attract additional capital adding to market capacity. This causes increased competition the following year to utilize that underwriting capital to seek a positive return for investors. However, this competition to attract new business and utilize the additional capacity leads underwriters to offer reduced premium rates. This situation is known as a "soft" market, where lower premium income brings about lower returns and potential profit for the policy year in question. The next policy year, the reduced earnings lead, in turn, to a decrease in available capital or reduced capacity. Eventually the bottom of the trough is reached when losses mount, requiring a "hardening" of the market where higher premiums must be charged to rebuild financial capacity, beginning the cycle anew.

If the policy year is one involving excessive claims, this can lead to a negative return on capital (claims exceeding premiums by a wide margin). Should this occur, the uneven nature of the industry becomes even more apparent with an exponentially greater reduction in available capital the following year. In extreme cases, the financial viability of an underwriter is compromised. Due to the extreme nature of marine losses, which are either very low or very high, the cycle is inherently more volatile than that which occurs in other areas of insurance, except perhaps property and casualty lines. This fact has been one reason why the number of providers of marine insurance has never been great.

In the past few years, alternative methods of underwriting marine liability risks, mainly fixed-priced insurance, have been making tentative inroads into the market. Although such methods as fixed-priced insurance had been tried in the past, their viability was never long-lived, due to the reasons stated above, and suspicions remain over whether they can succeed in providing coverage for the long-tailed losses often found in marine liability. While some believe that fixed-premium-based methods can provide the financial solvency necessary to cover the uncertain nature and potentially catastrophic levels of exposure found in covering shipping liabilities, others are convinced that they are a short-term result of a "soft" market, where excess capacity seeks easy returns, and, should losses mount, would soon cease writing coverage and exit the market.

The object of this paper is to determine whether or not the entry into the market of the fixed-premium underwriters has artificially reduced the premiums of "required" levels of liability coverage offered by the mutuals compared to levels found in the years before their entry. This analysis is based on the assumption that the premium levels of the mutual P&I Clubs provide accurate and fair pricing of the real risks involved in underwriting potential marine liability, because they are based on over one hundred fifty years of pricing experience and because of the non-profit nature of the Clubs. It should be noted that P&I annual premium earnings went from $2.5 billion in 1993 to $1.8 billion in 1997, most recently standing at $1.4 billion in 2000[2], while losses did not see a corresponding reduction in their figures.

To develop this analysis, the beginning of the paper will provide background on both the mutual and fixed-rate underwriting systems and their structure. The middle section will outline the model, data, and methodology used, while the final section will discuss results of testing the hypothesis on the data with attached regression and testing figures, followed by a conclusion based on these results.

[2] Figures from United Insurance Brokers Limited Protection & Indemnity Review 2001, London.

Chapter 1

Section 1.1

Protection & Indemnity (P&I) Marine Insurance

The marine liability insurance industry has been dominated for over one hundred-fifty years by a system characterized by the mutual sharing of the risks of shipping and shipowning. Based on the principle of having no share-based capital, membership signifies not only being a risk-incurring assured, but also an insurer liable for paying a proportion of all losses incurred by other assured members.

For the majority of vessels trading internationally, over 90% of the world's merchant fleet marine pollution and third-party liability insurance is provided through Protection & Indemnity Associations (known as P&I Clubs), which are wholly-owned mutual insurance cooperatives of shipowners. In the P&I Club structure, members pool their funds to provide coverage for liability[3] in exchange for payment of an initial levy, or advance "call" for premiums, followed by supplementary calls for the remaining premium plus any additional funds needed to cover losses. This funding of losses "post hoc" allows shipowners to spread the cost of their coverage over a period of time, an attractive feature in times of tight profit margins often found in the shipping industry. Supplementary calls for funds are made of members belonging to a Club during a specific policy year. If claims for that year exceed both the initial advance premium calls, calculated supplementary calls, and reserves on hand (the accounting year is not "closed" until all claims have been filed and accounted for), then an additional supplementary call is calculated as a percentage of the original premium amount charged of each member. Call history has ranged from a low of –10% (refund) of the initial advance call to a high of 240%. It should be noted that until the 1996 policy

[3] Although the current oil pollution liability limit for P&I members is $1 billion arising from any one incident (including collisions between vessels), an additional $500 million in reinsurance (insurance for insurers) is available commercially on the London market. Other non-pollution liability was unlimited until recent years.

renewal date, non-pollution marine liability insurance had no liability limit for P&I Club members[4]; i.e., potential supplementary calls for members also had no limit.

The International Group of P&I Clubs currently consists of nineteen members providing coverage for over 90% of the world's blue water (ocean-going) tonnage. It provides a legalized, non-competitive cartel for the pooling of insurance claims, and for the collective purchase of reinsurance (insurance for insurers), the largest reinsurance policy in the world, which covers claims above a predetermined amount.

Coverage for claims is layered and beginning with the 1999 policy year (beginning 20 February[5]), all group members share claims in excess of the first $5 million retained by each club. The upper limit of this pooling agreement or layer stands at $30 million, and claims over that figure would be paid by reinsurers up to $500 million, with the Group retaining a 25% deductible. Above the $500 million layer, non-pollution claims are reinsured 100% in London on the commercial market, up to $2.03 billion. Finally, any catastrophic claim in excess of the upper reinsurance limit reverts back to the Group for payment in proportion to each club's total entered tonnage. This liability would actually be paid in proportion by each member, based upon their respective tonnage, albeit limited to the sum of 2.5% of the combined property. In other words, the limitation of each Club stands at $2.25 billion plus approximately $2 billion, after adding reinsurance and pooling agreements, for a total liability cap of $4.25 billion. There is an exception to these sums for liability for oil pollution, which has a cap of $1 billion per occurrence and requires additional premium payments on a per voyage and gross tonnage basis for each vessel covered.

In 1985, the European Union granted a ten-year approval to the price-fixing mechanism that allowed a Club to charge the same premium rate for one year as was charged by a previous Club for any vessels switching P&I Clubs. This reduced the

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[4] The International Group of P&I Clubs fiercely debated the feasibility of instituting a limit to non-oil pollution claims, almost leading to a break-up of the 150-year old system. A pooling agreement allowing for a $20 billion ceiling to liability exposure for each club member was adopted in 1995, and would cover any catastrophic claims above the group reinsurance contract. This figure has since been revised downward to a maximum ceiling of $4.25 billion.

possibility of exposure to moral hazard[6] from unscrupulous shipowners; for example, switching a vessel that had failed a survey or was in need of expensive updates to another Club when the original Club thus required a higher premium to maintain the vessel's coverage. In 1995, this policy was reviewed and, according to new thinking by EU Maritime Commission members, was determined to be monopolistic pricing which stifled competition to the detriment of the consumers, the shipowners. The International Group protested, claiming that instead this pricing method protected the new Club from the moral hazard of unknown exposures, while protecting the old Club from unfair membership losses due to predatory pricing. A ruling by the EU Maritime Commission was made in 1996, however, that the current pricing method would be allowed to stand for another ten years, on condition that the Clubs remove all administrative costs from premium calculations. These were published separately on their annual reports beginning with the 20 February 1998 policy year, thereby providing a better method of comparison for shipowners in choosing Clubs.

The Club system has always been a closed system with little information available about its operations. The spotlights focused on the Clubs by the EU and other international forums in the past decade, and the influence of the P&I Clubs in reducing ex ante moral hazards of covering sub-standard vessels, however, have also brought increased attention to its financial structuring. In fact, Standard & Poor's (S&P's) only began rating P&I Clubs in 1994. In this new endeavor, they had difficulty in accommodating supplementary calls from members as a measure of solvency, given that this method of reserves is entirely dependent upon the financial health of individual shipowners for which no financial data was provided. Strictly speaking, a Club could be technically considered financially insolvent at any one period in time because of its dependence on future supplementary calls to cover current losses. As a result, initial low ratings were given by S&P's in 1994 to those Clubs with the greatest dependence on supplementary calls, which led to a general tendency to increase

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[5] This was the traditional date upon which the North Sea again became safely navigable through the melting ice floes after winter.

[6] Moral hazard is defined as the risk that an assured may lack the incentive to prevent or contain a loss or has provided misleading information about potential liabilities. An insurer must charge a higher premium if this problem is suspected.

reserves on deposit. The Clubs' free reserves (as opposed to reserves for claims incurred but not yet reported) now stand at an estimated $1.8 billion, up from just $0.5 billion a few years ago. This step, contrary to Club tradition, was taken in order to improve S&P's ratings and attract "quality" members, i.e., those with a lower risk profile. The thought of decreasing both the necessity and quantity of supplementary calls for claims for all shipowners was the driving factor behind this change.

In 1998, the S&P's Report on the P&I Clubs for the first time stated that the influence of member financial viability was a factor in determining the rating of the Clubs. It included a rated sampling of shipowners in order to establish a baseline for each Club, while changing their rating scheme to a lettering system similar to that assigned to other financial institutions (A+, A, etc.). This more transparent rating undoubtedly benefits the stronger Clubs at the expense of the weaker. In fact, the mutuals have recently experienced some significant changes: the purchase of a smaller Club by a larger one, the merger of two of the largest Clubs, the demutualization of one Club (conversion to a fixed-price entity), and the bankruptcy of a marginal Club due to reinsurance disputes, all signs of the increasing volatility in the industry. This instability, combined with the rigidity of the Clubs in insisting on elevated liability limits, added to the increased realization by shipowners that they are ultimately the underwriters for the Clubs' solvency, subsidizing others' losses. The entire market became more open to potential competitors working outside the mutual traditions by offering fixed-premium coverage, an attractive feature for quality shipowners.

Section 1.2

Fixed Premium Marine Insurance

In the marine liability insurance market, fixed-premium underwriters have come and gone over the past several decades, never getting beyond establishing a token presence. Several factors have hampered the existence and growth of these companies: their policies offered only low coverage levels, payment of premiums was required up-front in a lump sum, and they lacked the capacity of furnishing additional customer services such as those offered by the P&I Clubs to their members. The first factor guaranteed that most shipowners' potential liabilities could not be fully covered, while the second caused shipowners operating on tight profit margins to prefer the periodic payments of the P&I Clubs. Finally, the last issue meant that services required in normal ship operations were lacking, such as filing letters of undertaking to avoid an arrest of a ship or having local representatives handle claims in exotic locales. The fixed-price underwriters could not compete with the Clubs over the long term with those shortcomings and either withdrew completely from the market or limited themselves to occupying only a small niche.

Downward trends in claims in the mid-nineties however, combined with an excess of underwriting and reinsurance capacity, led to what is known as a "soft" market. For example, lower premium incomes produced in other lines of underwriting (non-marine) caused traditional underwriters to search for new business lines to provide other sources of income. This encouraged them to attempt a new offering of fixed-premium marine liability coverage to shipowners during a period of low losses. These efforts were mostly backed by large reinsurance and insurance companies such as Underwriters at Lloyd's and Terra Nova of Bermuda. And these large companies, for the first time, permitted upper policy limits that approached or equaled the $1 billion limits found for oil pollution liability, thereby offering a realistic alternative to the Clubs on this essential point. This was especially attractive for shipowners not wishing to be exposed to the larger risks of belonging to a Club. In fact, the 1998 policy year renewals saw some $50 million of premiums being placed with fixed-price offerings, thus representing approximately 5% of the market share

being lost by the Clubs. In that year, eight fixed-premium facilities offered liability coverage to the marine market, with AXA of France entering the market in September 1999 as the last new addition to the group. By the end of December 1999, the fixed premium market had around 7 million gross tons of vessels covered, which, although not a tremendous amount in global terms, still represented a high-water mark in historical terms of competitive strength with the P&I Clubs.

The lack of the threat of supplementary calls was another attractive feature of the fixed-premium underwriters, especially in the recently depressed shipping market, which has so depleted shipowners' coffers. And while not offering the same level of auxiliary service as the P&I Clubs, with rates remaining competitive in the soft market in 2000, they were seen as an attractive alternative to the mutuals. In fact, the combination of declining premium rates seen until September 11, 2001[7] and declining investment income was a major reason their entry into the marine liability insurance market represented a significant threat to the P&I Club structure.

[7] Marine premiums were beginning to tighten before the WTC attacks, based on deteriorating loss levels during the past two years. After Sept 11, rate increases are averaging 25% for the 2002 policy year renewals.

Section 1.3

Literature Review of Insurance Pricing Models

A common approach found in insurance valuation modeling is one where variables measure past performance in order to account for the uncertainty of present and future costs. For example, past liabilities must be measured (usually in present value terms), because they may deplete available surplus if they exceed premiums, thus playing an essential role in determining the amount of insurance capacity, or risk, that an underwriter may assume in the future. Another problem facing underwriters involves the uncertain cash flow received over time from premiums. This also affects surplus amounts and the assumption of future risks, because any catastrophic loss would quickly exceed past premiums received and might necessitate use of current income. In addition, capacity is affected by market risks: varying interest rates received on invested assets and reserves, inflation rates, and exchange rates, all of which influence future risk assumption because they affect premiums, claims, and surpluses held.

Some of these problems were addressed in a 1993 paper by Ronald Chung, Hung-Gay Fung, Gene C. Lai, and Robert C. Witt, entitled "Causal Relationships Between Premiums and Losses, and Causes of the Underwriting Cycles", which dealt with the property-casualty insurance industry and the cyclical nature of underwriting returns. This paper used a vector autoregressive model to test the relations between premiums and losses as well as to test how premiums responded to shocks to selected variables. Premiums were stated to be a function of past premiums, past losses paid, aggregate policyholders surplus, the five-year Treasury bond rate at time t, the conditional variance of losses paid at time t, and the conditional variance of interest rates on treasury bonds at time t. The results of the regression using this model found that insurance premiums indeed responded to shocks to the variables studied, although within the boundaries of the rational expectations theory with an institutional lag hypothesized by Cummins and Outreville that provided a basis for the analysis.

In a 1994 paper, "Adverse Selection in an Insurance Pool", Bruno Biais and Christian Gollier discuss a variation on the Rothschild-Stiglitz equilibrium model for insurance to account for adverse selection. They describe equilibrium in a competitive market (assuming perfect information, free entry and identical risk adverse consumers) as one where insurance contracts earn zero profits. In Rothschild-Stiglitz Lecture Notes, the equation for the supply of insurance contracts is thus written as follows: the probability of loss p is worth $\pi(p, \delta) = - (1-p) - \delta_1 - p\delta_2 = - \delta_1 - p(\delta_2 - \delta_1) = 0$, where δ_1 represents the premiums and δ_2 the losses paid on a claim. In equilibrium, $\pi(p, \delta) = 0$, known as "fair" insurance, is where the available contracts fall along the fair odds line where the slope equals 1-p/p. Adding asymmetric information in the form of both low-risk and high-risk customers, the market adapts by creating either a pooling equilibrium in which both groups buy the same contract, or a separating equilibrium in which different types of coverage are available to each group. As described earlier, we've seen that the P&I marine insurance industry offers a pooling contract with minor differentiations based upon the premiums charged for each class of risk (e.g., vessel type), while the fixed-price underwriters provide a low-cost contract to only one group, the low-risk one with related lower loss profiles. But the basic underlying operating premise remains the same for both, as shown in this paper; i.e., premiums are a direct function of losses.

In another 1994 paper studying earthquake coverage, entitled, "The Effect of Costly Risk Bearing on Insurers' Supply Decisions", Anne Kleffner and Neil Doherty indicated that writing coverage for a catastrophic event increased the variance in insurers' cash flows due to correlated losses and uncertainty regarding the actual loss distribution. In other words, catastrophic coverage policies, such as those covering the risks of earthquakes or hurricanes, which carry a potentially high correlation for underwriters, can be safely written only by taking into account the entire underwriter's portfolio and financial characteristics. More specifically, the ability to underwrite a catastrophic event is directly related to the variance of a firm's marginal costs. The higher the marginal costs, the lower the amount of coverage that can be written. In addition, because of differing abilities in raising external capital after a large loss, which affects profitability in the short term, the quantity of

insurance provided on the market is directly related to the structure of the underwriter in question. Once again, the premise of premiums as a function of past losses is utilized to explain market capacity, and the marine liability insurance industry structure again demonstrates parallels to the results found in the property-casualty sector.

A 1997 paper, entitled "On the Pricing of Intermediate Risks: Theory and Application to Catastrophic Reinsurance", authors Kenneth A. Froot and Paul G.J. O'Connor confirm that prices and quantities for catastrophic reinsurance (underwriters' insurance) are negatively correlated. This phenomenon is also reflected at the lower direct-insurance level where high premiums will reduce the amount of related exposure and vice versa, both of which are often a result of either a spike or dip in past losses with resulting effects on current capacity. Their findings were tested with a quasi-log linear model where the price of reinsurance was a function of quantity demanded, variance of exposure, and internal funds available to the insurer. In short, premiums were found to be a function of market demand (market premiums), losses, and surpluses.

Another consideration in regards to the P&I Clubs' argument that the addition of a fixed-price competitor distorts pricing in the market for marine liability insurance is that of adverse selection. According to the chapter entitled "Converging Markets and Integrated Solutions" in Integrating Corporate Risk Management, by Prakash Shimpi, adverse selection is defined as the incentive of market participants who have special knowledge of risks to select the types of contracts to their advantage and generally to the disadvantage of those offering the contracts. As mentioned earlier, there are two types of equilibria found in the insurance market: the "separating equilibrium", where distinct contracts are chosen by market participants based on different types of information they possess, and the "pooling equilibrium", where a single type of contract is chosen by market participants regardless of any information held. The Clubs state that the pooling structure under which they normally operate is no longer valid due to the entry of the fixed-price competitors who distort the market, and they are forced to work as if in a separating equilibrium structure, while using a common, pooled contract. In other words, the Clubs maintain that, by offering lower premiums to those shipowners with lower risk profiles, the fixed-price competitors are

skimming off" the best clients, leaving them to not only carry the higher-risk shipowners, but at premium levels inadequately set to safely underwrite those risks.

Chapter 2

Section 2.1

Model

In a perfectly competitive market with risk neutral firms and free entry, actuarially fair insurance is defined as that where the premiums collected, PR, equal the indemnities, or claims paid, LP such that PR = LP. This is also defined as "pure premium", although it can be expanded to include allocated claims expenses, and results from a classic profit-maximizing model, where π = PR – LP. More realistically however, gross premiums charged for an insurance policy must take into account not only losses covered, but also the probability of additional claims, administrative and reinsurance costs, and the need for reserves required to maintain solvency levels required by regulators and competitive forces such as Standard & Poor's raters. In addition, other "loading" factors may be added to basic premium levels, such as policyholders' surplus. The future uncertainties affecting current prices are what separate insurance from normal industrial economic models, leading from a notion of perfect equilibrium to one where the degree of probability becomes a central issue, colored by real time and duration of potential risk.

In the marine insurance industry, factors affecting prices such as administrative expenses and reinsurance costs (estimated to be about 20% of premium costs) are generally consistent for both mutuals and fixed-premium facilities. In light of the European Union ruling on mutual pricing requiring the exclusion of administrative costs, and based on the assumption of perfect competition, these are excluded from the model used here. The model incorporates a basic multivariate linear equation, providing us with an idea of how gross premiums[8] have been affected by time *t*, by gross losses paid, surpluses held, and gross tonnage covered each year, with the addition of an error term ε.

Of note is that fixed-premium underwriters deal with a shorter-tail loss potential limited to the one-year lifespan of the policy accounting period, and may recover for

[8] Based on the mutuality of P&I reinsurance (insurance for underwriters), only gross premium and losses paid figures are used. This avoids any possible confusion that might result from attempts to exclude reinsurance costs, recoveries, and deductibles, which are generally uniform for all the Clubs.

excessive claims for losses in period *t* through an increase in premiums in period *t+1*. This contrasts with the P&I Clubs which deal with a three-year lag used in their underwriting accounting system before a policy year is "closed". This delay in closing a policy year allows for the final determination of losses[9], assurance that all potential claims for losses paid have been accounted for (including claims from members for indemnity of payments made up front for losses), and enables the collection of additional premiums, or supplemental calls as needed for the specific period *t*. In addition, in contrast to a fixed-premium insurance program, mutual premiums are also influenced by past premiums, which may vary due to changes in membership and past collection rates, as well as past loss rates, which might vary from period *t-1* to *t-3*[10]. The Clubs' surpluses, which do not include a profit margin and serve to underwrite current, rather than future potential losses, however, are assumed finalized after one year from their accounting standpoint, based on the premise that any shortfalls for any specific policy year would be recovered using supplementary calls from members. It should be noted that surpluses never played a substantial role in premium pricing until 1994, after the initial rating of the Clubs by Standard & Poor's which was lower for those Clubs holding the least amount of surpluses. This caused the Clubs to begin augmenting their surplus reserves in a substantial manner to improve ratings, attracting members, and, especially in recent years, using investment income from surpluses held to offset premiums. In addition, the gross tonnage variable was not lagged over time because it does not vary once a tonnage amount is entered into a Club for coverage during a specific policy year.

Taking the model with premiums, losses paid, and surpluses, based on lagged data to account for the three-year accounting method used by the P&I Clubs, we have the following equation:

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9 Damaged vessels, cargoes, and other losses must be assessed by surveyors, often in distant locales and difficult circumstances, and require time to make a final determination; e.g., a vessel may be initially assessed as repairable but, once arrived in the shipyard, determined to be a total loss.

10 Ibid.

$$PR_t = \beta_0 + \sum_{j=1}^{3} \beta_1 PR_{kt-j} + \sum_{j=1}^{3} \beta_2 LP_{kt-j} + \sum_{j=1}^{3} \beta_3 SR_{kt-j} + \beta_4 GT_{kt} + \varepsilon_{kt}$$

Where

β_0 = constant

β = coefficient

PR = gross premiums

LP = gross losses paid

SR = surplus or reserves on hand

GT = gross tonnage

ε = error term

t = (1,…,3) time period for years lagged

k = (1,…,14) for each of the fourteen P&I Clubs

The assumptions stated in the model above reduce the analysis to existent risk-assessed tangibles. Factors such as client privilege, cross favors, or provisions for other non-tangibles that might influence premium levels for members of P&I Clubs are excluded, although real pricing would take them into account. In addition, systematic risks, such as interest rates, exchange rates, or risks associated with changes in investment prices, are excluded from the model in order to maintain simplicity and better isolate the studied effects of the identified variables on current premiums. In addition, this exclusion was due to the very short period of time (since 1994) in which the P&I Clubs have actively accumulated substantial reserves and initiated investment strategies in order to offset losses and soft markets rather than rely solely on supplementary premium calls to cover shortfalls.

The difference between the mutuals and the fixed-price underwriters lies in the final purpose: the P&I Clubs are tasked with making zero profit by providing shipowners with coverage at cost, while the fixed-price schemes are tasked with making a maximum profit for their shareholders. In fact, the leverage ratio or the ratio of gross losses paid, LP_{t-1}, to surpluses, SR_{t-1}, in the preceding period *t-1*, could be used to determine how much

additional risk; i.e., premiums written, an underwriter may assume in period *t*. Actual adjustments to pricing are made accordingly by the underwriters, albeit working under the competitive constraints of the mutual system, to reduce exposures in subsequent periods to past claims for losses.

The analysis of the P&I Club data to determine if the entry of the fixed-rate underwriters affected the current premium levels that were normally charged by the P&I Clubs should be immediately visible in the signs of the relative coefficients for the different periods. For the overall years 1985-2000, I expect that the coefficients for most of the variables should maintain positive signs; i.e., effects on the dependent variable by changes in the independent variables were not overly affected by the entry of the fixed-rate competitors due to the preponderance of the data relating to a P&I-only market and the relationships remained positive ones. For example, if the amount of gross losses paid (LP) increased, then current premiums must increase to cover them to not adversely affect surpluses beyond an acceptable level; if the amount of surpluses (SR) increased (to a certain point), then current premiums should increase based on the assumption that the build-up is due to some event that requires surpluses on hand to be used (like increased expected losses reported but not yet paid). However, the sign for gross tonnage (GT) may be negative, because if the amount of GT increased, then the marginal costs of any increased potential risk due to a larger tonnage base could be more easily spread among the members and would result in a decrease in current premiums overall. Conversely, if the amount of entered GT declined for a particular policy year, the corresponding amount of current premiums would increase, due to the reduced tonnage base, because the marginal costs of any reduced risk are then spread among fewer members based upon their proportional tonnage entry with the Club. In looking at these assumptions, it is important to recall that the P&I Clubs are member-owned and member-run, so any changes in premiums based on a need to increase surpluses or resulting from an increase in gross tonnage covered must be within the boundaries of what the members, as shipowning businessmen, find acceptable.

For the years 1985-1997, prior to the entry of the fixed-rate competitors, all the variables should maintain positive signs, except gross tonnage, because the relationship of

each remaining variable to current premiums should be a positive one, where increased losses paid would require increased current premiums to cover them, and increased surpluses would signal some upcoming event requiring increased current premiums. Overall, losses paid figures generally increased over the 15-year time period for all the P&I Clubs, which combined with the fact that they were now being rated by Standard & Poor's, caused surpluses needed to be increased as well. Both these factors caused a positive relationship which required an increase in current premiums. Gross tonnage did not vary greatly over the period, so any changes should not be substantial enough to significantly affect current premiums, even given a negative sign of the coefficient.

If there are effects to be immediately observed due to the entry of the fixed-rate competitors on the signs of each variable's coefficient, then they should be for the years 1998-2000 and after having added in the lagged variables. For past premiums (PR_{t-j}), a negative sign is expected, because members may leave the Clubs for the new competitors, causing a decline in that figure which would require an increase in the dependent variable, current premiums. For losses paid (LP), both past and current, a positive sign is expected, because the amount of losses paid for claims would be expected to increase if the lower-risk, risk-adverse clients moved to the fixed-rate competitors, causing a corresponding increase in the amount of current premium necessary to cover them. For current surpluses (SR), a negative sign, because the increase in both losses paid and potential losses would lead to a decline in the amounts held in reserve, also requiring an increase in the dependent variable. And for gross tonnage covered (GT), a negative sign is expected, because the actual loss of clients moving their tonnage to the fixed-rate competitors would require an increase in current premium to compensate for the remaining risks spread among fewer members and a reduced tonnage base.

Section 2.2 Data

Data used included gross premiums, gross losses paid, gross surplus/reserve data and the total gross tonnage covered for each of the fourteen largest P&I Clubs for the period 1985-1999 (and 2000 figures where available) for each policy year. Gross premiums and

gross tonnage figures for the fixed-premium facilities were available for only one policy year, 1998, and therefore could not be used to provide a real comparison over the time period studied. Past loss, premium, and surplus data were also not available for the fixed-premium underwriters and the 2000 policy year figures were not been released.

Section 2.3 Methodology

The data was stacked and regressed as a whole for the entire period 1985-2000 and then pooled and regressed separately for the periods 1985-1997 and 1998-2000. The results were compared for structural changes between the stacked regression results and those from the first and second period. Lags for each of the three years were then added at single year intervals to the premium and losses paid data, and to surpluses. The regressions were re-run for the stacked and separate pooling periods and the results compared to see if structural changes could be verified.

Section 2.4 Testing

To test whether the entrance of the fixed-rate underwriters into the market affected premiums for the P&I Clubs, a Chow F-test for structural change was performed on the results of the initial unlagged regressions, then on each of the lagged regressions for the one to three year periods, with the results compared between the overall stacked data and the separate time period regressions. In addition, the data was tested to determine if autocorrelation was present in the initial regressions using the Durbin-Watson test.

The null hypothesis that this paper wishes to test using the regression equation is as follows:

$$H_o: \beta_0 = \delta_{0,\ldots,} \beta_n = \delta_n$$

where $\beta = (\beta_{0\ldots}\beta_n)$ represents the coefficients for the variables affecting the mutuals' premium levels for the period 1985-1997, before the entry of the fixed-price underwriters

into the market, while $\delta = (\delta_{0...}\delta_n)$ represents these same coefficients for the period 1998-2000, after their entry, assuming $\varepsilon_t \sim (0, \sigma^2)$ under H_o.

If true, the null hypothesis signifies that premium changes for the P&I Clubs retained their basis on usual pricing factors, such as prior years' premiums and claims, leverage rates, tonnage covered, etc.; i.e., the Clubs continued to price coverage as had been done in the past, regardless of the entry of the fixed-rate underwriters into the market. Therefore, increased competition brought by the fixed-rate underwriters did not therefore affect the P&I pricing outside of normal boundaries, and pricing could be said to have been competitive even prior to the entry of the fixed-rate underwriters. However, if the null hypothesis is rejected, then we might assume that the entry of the fixed-rate underwriters into the market did affect normal pricing patterns for the P&I Clubs. Whether or not this suggests that the mutuals were left exposed to a higher-risk, less-diversified pool of shipowners than before cannot be determined from current data and is not the subject of this analysis. Should loss levels for both the mutual underwriters and fixed-rate underwriters become available for the most recent period, one could test this argument. In the interim, however, we will be satisfied to see whether or not the mutuals' pricing methods have been affected by increased competition, and, perhaps, in which direction.

Chapter 3

Results

As seen in the attached Table 1 on page 23, the initial results of the regression run on the stacked data for the entire fifteen year period produced signs for the coefficients that were all positive. The effects on the data of the entry into the market of the fixed-rate competitors were for a very short period and not pronounced enough to affect the signs of each variable's coefficient for the overall period. The losses paid (LPt) coefficient was the most significant in having influence on the dependent variable, in keeping with the pricing standards stated by the P&I Clubs as their raison d'etre. Surpluses (SRt) also had a significant *t* statistic, as was also expected, while gross tonnage showed no real significance at all in the pooled data regression.

There was a marked difference between the two partial time periods for the losses paid (LPt) coefficient, which declined from 0.99 to 0.66, with a reduction in the *t* statistic from 11.70 to 6.81, both of which signify that losses did not carry the same weight on current premium pricing after the entry of the fixed-rate competitors as it had before, although it remained the dominant factor. Coefficient figures for surpluses (SRt) also showed a marked difference between the two time periods, falling from 0.12 to 0.017, with another sizeable reduction in the corresponding *t* statistic from 4.4 to 0.73. The R square figure remained almost identical for both the before and after periods at approximately 80%.

For the 1985-1997 figures, the signs of the coefficients were positive for all the variables except for gross tonnage. The *t* statistic for the gross tonnage coefficient remained non-significant throughout, so its influence on current premium pricing is negligent.

For the 1998-2000 figures, the signs of the coefficients were all positive, although the changes in the regression weights for losses paid (LPt) and surpluses (SRt) were significant and the *t* statistics declined for all variables, which seems to indicate that the overall effects of the fixed-rate competitors did affect current premium pricing for the P&I Clubs during the second period, at least marginally.

The Chow test is distributed F(k, N1+N2-2k) where k is the number of estimated parameters (4 in this regression) and N1 and N2 are the number of observations for each of

the unrestricted regressions. The critical value at 5% significance for F distributions with 4 degrees of freedom in the numerator and 201 in the denominator is 2.37, and at 1% significance is 3.32. As seen in Table 1, the F test to determine if there was structural change between the different regressions produced a result of 9.20, so the null hypothesis that the coefficient vectors for the two periods were the same would be rejected.

After having said all of the above, the Durbin-Watson test (D-W) for the presence of autocorrelation among the residuals of the regressions stood at 0.625 for the pooled time period and 0.63 for the 1985-97 years. These figures lie outside the acceptable critical value of 1.59 D_L and 1.76 D_U, and show positive autocorrelation. For the 1998-2000 period, the D-W test also showed autocorrelation but in a negative direction. Although autocorrelation is generally expected to be found when dealing with time series data, because of the nature of the data itself, especially dealing with the related variables used in this model, we will not take any corrective action. For the time being, however, it must be noted that these results prohibit any reliance on the figures found in Table 1 being unbiased, especially the error terms and *t* statistics upon which the proof of the null hypothesis depends. Therefore, conclusions should not be drawn until the results of the added lagged-data regressions are shown and discussed below.

Proceeding with the addition of a one-year lag for each variable (except gross tonnage) to the regression model and running each period separately produced the results shown in Table 2 on page 24.

For a 95% confidence level that there was no change in the coefficient vectors between the two time periods, using 7 degrees of freedom in the numerator and 181 in the denominator, the critical value is 2.01, while at a 99% confidence level, the critical value is 2.64. As seen from the Chow test for structural change shown in Table 2, the results produced a value of 12.41, which, taking into account a one-year lag, would again cause us to reject the null hypothesis that the coefficient vectors for the two periods were the same.

Adding the one-year lag also provided a greater delineation between the two time periods: the R square figures went from 0.95 for the pre-fixed-rate competitor years to 0.85 for the post ’98 period, which would indicate a loss of the variables’ explanatory power over

Table 1

Coefficients	1985-2000	Standard Error	t-stat	1985-1997	Standard Error	t-stat	1998-2000	Standard Error	t-stat
Intercept	9.305	4.714	1.974	4.194	4.886	0.858	28.213	10.069	2.802
Losses Paid	0.916	0.072	12.670	0.994	0.085	11.695	0.664	0.098	6.805
Surpluses	0.060	0.021	2.926	0.121	0.028	4.390	0.017	0.024	0.725
Gross Tonnage	0.031	0.183	0.167	-0.234	0.208	-1.128	0.204	0.268	0.760
R Squared	0.773	**D-W =** 0.625		0.807	**D-W =** 0.63		0.798	**D-W =** 2.81	
Standard Error	39.400	+ Autocorrelation		37.748	+ Autocorrelation		29.940	- Autocorrelation	
Sum of Squares	318238.51			239388.13			29581.27		
Observations	209			172			37		
F Test/Chow	49269.10747			268969.4028					
	4			201					
	12317.27687			1338.156233					
	F(4, 201) =9.20								

Table 2

Coefficients	1 Lag 1985-2000	Standard Error	t-stat	1Lag 1985-1997	Standard Error	t-stat	1 Lag 1998-2000	Standard Error	t-stat
Intercept	4.645	3.104	1.496	2.320	2.617	0.887	19.658	10.444	1.882
Losses Paid	0.495	0.084	5.862	0.517	0.074	6.978	0.660	0.215	3.069
Surpluses	0.209	0.028	7.444	0.393	0.036	10.996	0.097	0.039	2.477
Gross Tonnage	0.344	0.124	2.770	0.229	0.115	1.997	0.422	0.266	1.586
Premiums t-1	0.715	0.046	15.425	0.690	0.041	16.753	0.283	0.157	1.804
Losses Paid t-1	-0.216	0.088	-2.455	-0.140	0.078	-1.793	-0.248	0.223	-1.112
Surpluses t-1	-0.270	0.030	-8.948	-0.450	0.036	-12.435	-0.113	0.047	-2.414
R Squared	0.915	F = 335.40		0.954	F= 516.20		0.849	F = 28.13	
Standard Error	24.625			19.075			27.131		
Sum of Squares	114002.74	**D-W =**	1.91	54942.36	**D-W =**	1.80	22082.48	**D-W =**	2.28
Observations	195			158			37		
F Test/Chow	36977.90			77024.84					
	7			181					
	5282.56			425.55					
	F(7, 181) =12.41								

current premiums in the second period. It should also be pointed out that the Dubin-Watson statistic in these one-year lagged regressions stands at 1.91 for the pooled data, 1.80 for 1985-1997, and 2.28 for 1998-2000. All of these fall within the acceptable critical levels of 1.57 D_L and 1.78D_U for the first two regressions, and between 1.07D_L and 1.83D_U for the second period regression, sustaining the lack of autocorrelation in each and disallowing a need of corrective measures to obtain unbiased results from the model.

Turning to look at the coefficients of the one-year lagged variables, several things come to light. First, the one-year lagged premium variable coefficient (PRt-1) declined in weight from 0.69 to 0.28 from the first period to the second, indicating a large reduction in its influence on the dependent variable. With critical *t* statistic values of 1.943 at the 95% confidence level, there was also a tremendous change in the corresponding *t* statistic from 16.75 to 1.8, losing its significance to the dependent variable in the process, which definitely underlines a structural change in premium pricing for the Clubs. T

Past losses (LPt-1) and past surpluses (SRt-1) both carried a negative coefficient in all three regressions, which signiies that current premiums respond inversely, falling when they rose and rising when they fell, although LPt-1 became statistically insignificant from zero in the latter period. This inverse relationship is tied to the member/owner structure of the P&I Clubs and the fact that when members are hit with paying high supplemental "calls" for a "bad" or high-loss policy year, they seek relief the following year in the form of lower premiums. This attitude is partly dependent upon the tight profit margins found in the shipping industry, which make cash outflows difficult in the short-term, and is especially true if the excess losses are collective and not of an individual member's making. In addition, any potential loss scenario is based on the conviction that each new year will not repeat a prior year's record and that any "bad" years' losses are random events. The same holds true for the inverse effect of lag surpluses; when they are high, then members are more prone to balk at paying a greater premium and vice versa.

Lag surplus coefficients (SRt-1) also showed a marked decline in regression weight, going from -0.45 to -0.11 from the first period to the second, also with a significant change in the *t* statistic, which fell from -12.44 to -2.41, though still significant. This reduction in importance is most likely the result of the high accumulations of surpluses begun in 1994, which leveled off during the end of the 90's, reducing the new for them to account for so much in establishing premium rates. In

addition, due to increased investment earnings that offset some of the loss figures for recent years, offering lower marginal increases to current premium became more feasible and was more palatable to P&I Club members. These factors, combined with a soft market, reduced the amount of premium increases that could be charged of members without potentially harming Club membership levels.

The most noted difference from the first period to the second is the increase in coefficient weight for current losses paid (LPt), which went from 0.517 to 0.66. Although the relative *t* statistic declined by about half, it still remained the most significant in the second period, and also indicates that the P&I Clubs had to modify their pricing structure after the entry into the market of the fixed-rate competitors. From the coefficient weight, he Clubs now seemed to be setting current premium levels based on the premise of mainly covering current losses, rather than as in the past, of allocating them among past and current losses and surplus maintenance. This may be explained by the fact that most losses in shipping are long-tailed with finalized figures only available once surveys have been performed to determine exact losses. If members wished to leave the Clubs for the new competitors, they needed to be charged upfront premiums that would more adequately reflect expected current losses, because they could not be relied upon to pay supplemental calls later, once they had been released. Basically, these figures say that the Clubs went from setting the largest portion of current premium levels based on past premium rates (meaning that a member would be charged based on his past level, assuming an unvaried risk profile), to discounting past premiums entirely as a measure of current premiums. This relates to the current losses paid figures stated above and certainly upholds the hypothesis that changes to current premium pricing were experienced by the Clubs in the years 1998-2000.

Continuing the regressions adding a 2-year lag to the independent variables, except for gross tonnage, produced the results seen in Table 3 on page 27. For a 95% confidence level that there was no change in the coefficients between the two time periods, using 10 degrees of freedom in the numerator and 161 in the denominator, the critical value is 1.83, and 2.32 at a 99% confidence level. As seen from the Chow test for structural change shown in Table 3, taking into account a two-year lag, the results produced a critical value, 13.66, that would again cause us to reject the null hypothesis of no structural change between the two periods. Critical *t* statistics stand at 1.833 at the 95% confidence level for these regressions, so the number of coefficients that became insignificant in the

Table 3

Coefficients	2 Lags 1985-2000	Standard Error	t-stat	2 Lags 1985-1997	Standard Error	t-stat	2 Lags 1998-2000	Standard Error	t-stat
Intercept	5.176	3.582	1.445	3.470	2.692	1.289	15.074	11.338	1.330
Losses Paid	0.584	0.095	6.138	0.467	0.078	5.949	0.662	0.227	2.919
Surpluses	0.156	0.030	5.154	0.413	0.036	11.359	0.101	0.051	1.965
Gross Tonnage	0.357	0.148	2.410	0.317	0.122	2.591	0.294	0.290	1.012
Premiums t-1	0.611	0.087	7.040	0.782	0.082	9.521	0.105	0.217	0.486
Losses Paid t-1	-0.201	0.121	-1.661	-0.188	0.097	-1.941	-0.467	0.323	-1.446
Surpluses t-1	-0.023	0.021	-1.080	-0.554	0.062	-8.965	-0.081	0.081	-1.003
Premiums t-2	-0.014	0.085	-0.165	-0.082	0.071	-1.152	0.462	0.340	1.357
Losses Paid t-2	0.002	0.104	0.015	0.026	0.080	0.323	-0.047	0.287	-0.163
Surpluses t-2	-0.195	0.039	-4.936	0.101	0.052	1.944	-0.040	0.108	-0.370
R Squared	0.903			0.959			0.861		
Standard Error	26.712	**D-W =**	1.91	18.461	**D-W =**	1.97	27.448	**D-W =**	2.00
Sum of Squares	122017.15			45666.86			20341.05		
Observations	181			144			37		
F Test/Chow	56009.24			66007.91					
	10			161					
	5600.924			409.99					
	F(10, 161) =13.66								

second period is noteworthy at 5, namely, the coefficients for gross tonnage, past premiums (PRt-1), past losses paid (LPt-1), and past surpluses (SRt-1 & SRt-2). This also reinforces the structural change in current premium pricing that occurred, removing variables that had been quite significant in the first period. The Durbin-Watson test figures continued to confirm the lack of autocorrelation.

Current losses paid (LPt) had the most significant coefficient during the second period, joining with current surplus (SRt), as the only coefficients retaining influence on current premiums in the second period. In addition, they both underscore the direct "pay-to-be-paid" principal behind the P&I Clubs' pricing, where a member must be accountable for not only his losses, but the collective as well. This has always been the philosophy for the Clubs, but had become more complex over the decades in accounting for other variables, as seen in the numerous significant *t* statistics for the pre'98 period. Afterwards, the change caused marginal changes that were very small with a net change of an 0.3 increase and an 0.3 decrease, almost negating any real impact.

As was seen in the one-year lagged regression, the coefficient weight increased from the first period to the second for losses paid (LPt), going from 0.47 to 0.66, while the *t* statistic decreased from 5.95 to 2.9. The same result as before was also observed in the coefficient and *t* statistic figures for past premiums (PRt-1) that declined drastically from 0.78 to 0.11 and 9.5 to 0.48, respectively, becoming insignificant. That being said, the logical assumption is that the explanation given in reference to the one-year lag results of how current premiums were being priced by the P&I Clubs remains valid for the two-year lag results.

The signs for the coefficients for past losses paid (LPt-1) and past surpluses (SRt-1) for the one-year lag during 1985-97 and for both the one and two-year lags during 1998-2000 were negative, signaling an inverse relationship with the dependent variable, but in the second period, both variables' coefficients became insignificant. Irregardless,these negative signs are seemingly colored by the entry of the fixed-rate competitors, because the *t* statistic for the one-year lag surplus (SRt-1) coefficient declined from –8.97 to –1.0, becoming.

Table 4

Coefficients	3 Lags 1985-2000	Standard Error	t Stat	3 Lags 1985-1997	Standard Error	t Stat	3 Lags 1998-2000	Standard Error	t Stat
Intercept	6.432	3.504	1.836	4.652	2.829	1.644	10.792	13.567	0.795
Losses Paid	0.508	0.094	5.382	0.423	0.082	5.129	0.658	0.294	2.240
Surpluses	0.199	0.031	6.470	0.431	0.039	11.188	0.127	0.071	1.794
Gross Tonnages	0.435	0.142	3.054	0.311	0.127	2.453	0.338	0.319	1.061
Premiums t-1	0.710	0.090	7.903	0.823	0.088	9.411	0.025	0.239	0.105
Losses Paid t-1	-0.200	0.119	-1.688	-0.149	0.100	-1.493	-0.593	0.344	-1.723
Surpluses t-1	-0.256	0.050	-5.135	-0.630	0.068	-9.268	-0.049	0.092	-0.538
Premiums t-2	0.083	0.125	0.659	-0.111	0.106	-1.040	0.679	0.420	1.616
Losses Paid t-2	-0.060	0.123	-0.486	-0.012	0.102	-0.122	0.009	0.303	0.031
Surpluses t-2	0.038	0.076	0.502	0.259	0.079	3.274	0.094	0.150	0.627
Premiums t-3	-0.251	0.089	-2.811	-0.090	0.073	-1.237	0.039	0.227	0.173
Losses Paid t-3	0.161	0.099	1.625	0.128	0.083	1.544	-0.167	0.223	-0.748
Surpluses t-3	-0.030	0.062	-0.488	-0.105	0.054	-1.964	-0.202	0.207	-0.975
R Squared	0.919			0.963			0.872		
Standard Error	24.859	**D-W =**	2.12	18.041	**D-W =**	1.97	27.919	**D-W =**	1.98
Sum of Squares	95165.985			38080.200			18706.92		
Observations	167			130			37		
F Test/Chow	38378.86			56787.13					
	13			141					
	2952.22			402.75					
	F(13, 141) =7.33								

insignificant and showing the diminished regression weight it held in the setting of current premiums during the second time period

It is interesting to note the past premiums coefficients' (PRt-1) behavior during the two time periods, as they moved from an insignificant coefficient of -0.082 to a stronger positive 0.462, and from a *t* statistic of –1.152 to 1.357, which although not high, was the third most significant figure for 1998-2000. The facts that can be drawn from both circumstances underscore the relationship of premium pricing for member/owners and how the play between a declining coefficient for past losses paid (LPt-k) and past surplus (SRt-k) contrasts with a positive coefficient for past premiums (PRt-k). This can provide some motive for Club premiums increases, even if limited by a more competitive market, as elaborated in the discussion above.

Proceeding with the regressions using a three-year lag produced the results as seen in Table 4 on page 29. For a 95% confidence level that there was no change in the coefficients between the two periods using 13 degrees of freedom in the numerator and 141 in the denominator, the critical value is 1.75. As seen from the Chow test for structural change shown above, the results produced a critical value of 7.33 that would again cause us to reject the null hypothesis taking into account a three-year lag. Here again, the Durbin-Watson test did not indicate the presence of autocorrelation. The critical values at the 95% confidence level for the t statistic was 1.771.

The coefficient for premiums from the one-year lag (PRt-1) remained influential at 0.82 during the pre-competitor period, but dropped to 0.025 during the second period, with a corresponding decrease in the *t* statistic, from 9.4 to 0.105 to become insignificant. This continues the trend seen in both the earlier lagged regression results, reinforcing the hypothesis of a change in premium pricing by the Clubs in the second period. The reinforcements continue: the strong decline in the t statistic for current surpluses (SRt) from the first to the second period, from 11.19 to 1.79; the increase in the current losses paid (LPt) coefficient, from 0.42 to 0.66, but with a declining significance; and negative signs for the one-year lagged losses paid (LPt-1) and surplus (SRt-1) coefficients for all three regressions, but for the three-year lag only (LPt-3 and SRt-3) during the post '98 period.

Being as the regressions produced results that disproved the null hypothesis, the question arises as to how the dependent variable might have been most affected by the shift in dynamics that occurred from the entry of the fixed-rate competitors into the market in 1998. To look at possible changes, the averages were computed for each independent variable for each separate time period and compared. The coefficients for both the pre and post fixed-rate periods were then applied to the post '98 averages to see if and how much they varied from the actual post '98 figures and the changes to the dependent variable calculated.

As seen in Table 5 on page 32, the average figures for premiums and the independent variables changed dramatically between the two periods. Much of this change was due to internationally-noted events that caused increases in liabilities related to shipping; for example, catastrophic oil spills and sinkings with loss of life.

The table below shows the calculators for the premiums for both pre and post '98 coefficient data:

P&I Clubs Data

Pre 98	*Coefficients*	*Standard Error*	*t Stat*
Losses Paid	0.423	0.082	5.129
Surpluses	0.431	0.039	11.188
GT	0.311	0.127	2.453
Prem t-1	0.823	0.088	9.411
Losses Pd t-1	-0.149	0.100	-1.493
Surpluses t-1	-0.630	0.068	-9.268
Surpluses t-2	0.259	0.079	3.274
Surpluses t-3	-0.105	0.054	-1.964

Post 98	*Coefficients*	*Standard Error*	*t Stat*
Losses Paid	0.658	0.294	2.240
Surpluses	0.127	0.071	1.794
Losses Pd t-1	-0.593	0.344	-1.723

Table 5

Pre 1998
P&I Club Data

PREMIUMS		*LOSSES PAID*		*SURPLUSES*		*GT*	
Mean	$105,806,496.60	**Mean**	$87,623,449.73	**Mean**	$186,414,699.26	**Mean**	34,253,975
Standard Error	$6,498,911.75	**Standard Error**	$4,949,098.01	**Standard Error**	$13,538,177.71	**Standard Error**	2,103,524
Median	$77,262,500.00	**Median**	$73,500,500.00	**Median**	$144,022,500.00	**Median**	34,017,500
Standard Deviation	$85,232,428.57	**Standard Deviation**	$64,906,811.91	**Standard Deviation**	$177,551,536.13	**Standard Deviation**	27,587,462
Range	$524,170,400.00	**Range**	$336,417,015.61	**Range**	$903,775,126.75	**Range**	119,675,000
Minimum	$6,558,600.00	**Minimum**	$5,542,984.39	**Minimum**	$17,694,873.25	**Minimum**	1,250,000
Maximum	$530,729,000.00	**Maximum**	$341,960,000.00	**Maximum**	$921,470,000.00	**Maximum**	120,925,000
Sum	$18,198,717,414.55	**Sum**	$15,071,233,352.95	**Sum**	$32,063,328,272.19	**Sum**	5,891,683,629
Count	172	**Count**	172	**Count**	172	**Count**	172

Post 1998
P& I Club Data

PREMIUMS		*LOSSES PAID*		*SURPLUSES*		*GT*	
Mean	$124,449,233.89	**Mean**	$121,626,657.05	**Mean**	$338,488,067.33	**Mean**	46,977,950
Standard Error	$10,480,810.43	**Standard Error**	$12,343,604.06	**Standard Error**	$42,999,548.38	**Standard Error**	4,861,000
Median	$114,511,000.00	**Median**	$104,510,000.00	**Median**	$341,770,000.00	**Median**	40,000,000
Standard Deviation	$63,752,280.96	**Standard Deviation**	$75,083,212.28	**Standard Deviation**	$261,556,041.68	**Standard Deviation**	29,568,307
Range	$238,780,759.95	**Range**	$267,021,726.22	**Range**	$1,058,696,518.91	**Range**	96,950,000
Minimum	$29,472,240.05	**Minimum**	$18,094,273.78	**Minimum**	$24,456,481.09	**Minimum**	3,050,000
Maximum	$268,253,000.00	**Maximum**	$285,116,000.00	**Maximum**	$1,083,153,000.00	**Maximum**	100,000,000
Sum	$4,604,621,654.05	**Sum**	$4,500,186,310.78	**Sum**	$12,524,058,491.09	**Sum**	1,738,184,158
Count	37	**Count**	37	**Count**	37	**Count**	37

Taking only the statistically-significant coefficients and multiplying the average figures by them, we obtain the following:

Premiums using Pre'98 coefficients

$135,116,848.63 = $51,444,038 (LPt) + $145,969,227 (SR) + $14,604,593 (GT) + $102,480,579 (PRt-1) + -$18,141,898 (LPt-1) + -$213,141,759 (SRt-1) + $87,533,950 (SRt-2) + -$35,631,882 (SRt-3)

This equation contrasts with the one we have using only the statistically-significant coefficients from the second period:

Premiums using Post '98 coefficients

$105,999,197.56 = $79,986,064(LPt) + $43,006,833(SRt) + -$72,124,484(LPt-1)

Taking the difference between the two premium figures above gives us a figure of **-$29,117,651.07**, which represents the amount of average premium income for the P&I Clubs not earned during the second period. This serves as verification, according to the null hypothesis, that there was, indeed, a structural change in premium pricing methods that occurred between the period 1985 to1997 and the period 1998 to 2000.

Chapter 4
Conclusion

Generally speaking, the fixed-rate underwriters have seemed to have changed the premium rate structure used by the P&I Clubs prior to their entry into the market. All the regression results confirmed the structural change that occurred with the 1998 policy year. As seen by the Clubs, these changes lie outside the normal parameters utilized in pricing, such as taking into account past losses, and premiums, and led to increasing overall market capacity unwarranted by actual market demands. In the recent soft marine insurance market, premium rates have seen declines of over 60% in the past two years. And according to the Clubs, with premium levels below those needed to cover outstanding policy limits, any negative trend in claims for losses points to a potential area of concern for the fixed-premium facilities' solvency over the long-term.

It is now known that many P&I Clubs have operated at a negative underwriting level for the past several years, depending on positive investment income to make-up for any deficiency in underwriting results. This may have been in response to the fixed-rate competitors. However, recent market losses combined with the underwriting climate after September 11, where increases in reinsurance rates averaged over 20%, caused the Clubs to increase premium rates by 20-30% and strongly decrease deductibles for the 2002-2003 policy year.

More interestingly, the number of fixed-premium underwriters in marine liability insurance has steadily declined since 1998, with some firms having suffered losses averaging 10% per annum after expenses. Several, including the Lloyd's syndicate whose entrance in the market in 1998 sparked much of the furor, are now in run-off (involving closing out outstanding policy and creditor claims, because they ceased underwriting new business under bankruptcy conditions).

In summary, this simple analysis provides some confirmation that a change in premium pricing began with the 1998 policy year which reinforces the P&I Clubs' position that the fixed-rate underwriters were engaged in unfair pricing in the attempt to enter the

market when losses were low, ultimately causing undue hardships to long-term insurance operators and ultimately, the shipowners.

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