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DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
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* * * * *
The Ohio State University
1977

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CHAPTER I

GENERAL INTRODUCTION

Statement of the Problems

Problems in Rate Regulation of Property-Liability Insurance

Unlike the prices of goods or services provided by most private industries, the prices of many types of property-liability insurance contracts are subject to the constraints of rate regulation. These constraints, embodied in the state insurance codes, generally provide that rates shall not be inadequate, excessive, or unfairly discriminatory. However, most state laws, with few exceptions, do not provide definitions of these terms.

The result has been considerable disagreement and controversy about the meanings of these rate standards, particularly about the first two standards. It has been left to the insurance commissioner to implement these broad criteria via administrative rulings.

The interpretation of the criteria have varied widely "according to views and background of the insurance commissioner and according to the traditions or precedents
of his office."\(^1\) As a result, the criteria remain couched in subjective terminology and the insurance commissioners must exercise judgment in interpreting those criteria and in applying them to a proposed rate filing.

In general, the rates established are designed to provide income sufficient for the company to 1) pay losses, 2) cover business expenses, and 3) realize a margin of profit. According to one author, "rates are considered reasonable (not too high or inexcessive) and adequate (not too low) when they produce sufficient revenue to pay all losses and expenses of doing business, and in addition, produce a reasonable profit."\(^2\) In defining the standard of "excessiveness of rates" the California insurance code uses the phrases "unreasonably high for the insurance provided" and "a reasonable degree of competition."\(^3\) These interpretations and definitions hardly provide clear-cut objective standards for judging the excessiveness and adequacy of proposed rates. In the absence of clear-cut definition and procedures to follow in computing rates, which are provided by rate regulatory laws,


\(^{3}\)California Insurance Code (1955), Section 1852 (a).
the actuary has no choice but to rely on his subjective judgment in determining rates which, he believes, are proper and will satisfy the statutory criteria expressed in vague manners. It has not been easy for the actuary to determine rates under the circumstance. The problem encountered by rate regulatory authorities in reviewing proposed rates is equally difficult to the actuary's problem.

One of the specific problems with which the present study is concerned is the absence of objective standards or formulae with which rate regulatory authorities can review proposed rates in objective manner to achieve the legal objectives of rate regulation.

Another important and controversial issue in rate regulation of property-liability insurance is the question of whether investment income should be considered or not in ratemaking process. Since interstate cooperation in establishing uniform standards for ratemaking commenced in 1921, the majority of states have given no place to the element of investment income in the actuarial calculation used to set property-liability insurance rates. In the Commissioner's 1921 Standard Profit Formula, adopted by the National Convention of Insurance Commissioners, it was clearly provided that in making rates no part of
investment income should be considered at underwriting profit.\textsuperscript{4}

In recent years the controversy of investment income has been intensified. Although only several states have required formal consideration of investment income in property-liability insurance ratemaking,\textsuperscript{5} this question has become a major issue at public hearings in many jurisdictions.

The issue is usually stated as a claim that policy-holders are entitled to some decrease in rates in consideration of investment income. This argument is based on the premise that this income is not adequately considered, if at all, in the ratemaking process. The major argument in favor of inclusion of investment income as part of the ratemaking formula is that the rates are excessive and inadequate are unrealistic without this factor. The investment income controversy is expected to be continued for at least the foreseeable future.

The specific question raised in the present study in respect of investment income controversy is how the


\textsuperscript{5}Those states which have ordered the formal consideration of investment income in automobile insurance ratemaking are Maryland, Virginia, New Jersey, Pennsylvania, and New Hampshire.
investment income should be reflected in the process of rate regulation, if it is formally required to reflect the investment income in the ratemaking process of property-liability insurance.

In addition to the problems discussed above, the current rate regulation of property-liability insurance has been criticized because it applies a uniform underwriting profit provision to all kinds of property-liability insurance, regardless of underwriting risk associated with each line of insurance. Because of uniform underwriting profit provision underwriting risk is not adequately recognized in the pricing process. It has been suggested that the use of uniform underwriting profit provision has caused the problem of unavailability of certain lines of insurance in the competitive insurance market.


In an attempt to solve the problems in the current rate regulation of property-liability insurance, the present study is going to develop a new rate regulation model founded on the concept of cost of policyholders' surplus (fair rate of return on policyholders' surplus) derived in the framework of mean-variance capital asset pricing.
model developed by Sharpe, Lintner, and Mossin.\(^6\)

Since the development of the capital asset pricing model, the cost of equity capital of firms and investment decisions have been analyzed in the framework of the model.\(^7\) In applying the capital asset pricing model to obtain the cost of policyholders' surplus for the purpose of using the cost as the basis for rate regulation, there is one practical problem and one theoretical issue to be resolved in the first place.

When the capital asset pricing model is used to estimate the cost of equity capital of firms, the systematic risk of equity capital is customarily measured based on market data. However, there are many situations where market data are not available. This implies that the capital asset pricing model utilizing the systematic risk measured based on market data is of limited use in its practical application to estimation of the cost of equity capital.

---


capital. This problem is particularly serious in the property-liability insurance industry. For example, market data are not available in the following cases: 1) stock property-liability insurance companies whose stocks are not traded in the open market, 2) stock property-liability insurance companies wholly-owned by large conglomerates or holding companies, 3) property-liability division of all-line insurance companies, and 4) mutual property-liability insurance companies. The seriousness of the problem is indicated by the fact that the majority of property-liability insurance companies belong to the above cases.

One issue raised in recent years in the study of cost of policyholders' surplus is related to the unique nature of the operations of property-liability insurance companies. The major activities of property-liability insurance companies are underwriting and investment operations. These two operations are so distinct of each other that, as one author suggested, if one is to assess the propriety of the rate of return and risk of policyholders' surplus, the risks associated with underwriting and investment operations should be jointly but explicitly considered.8

---

Therefore, the specific problem dealt with in the present study in this regard is how the risks associated with underwriting and investment operations can be explicitly incorporated into the conventional capital asset pricing model.

Purpose of the Study

The present study is an attempt to apply certain financial theories to rate regulation of property-liability insurance in order to solve some of the problems in the current rate regulation of property-liability insurance.

This study specifically purports to achieve the following objectives:

Objective 1: To develop a rate regulation model for property-liability insurance, which has the following characteristics:

a) model based on the concept of cost of policyholders' surplus (the concept of fair rate of return on policyholders' surplus) derived from the modified capital asset pricing model developed in this study

b) model based on the concept of total rate of return on policyholders' surplus (which means the model takes into account not only
underwriting income but also investment income and their risks)

**Objective 2:** To develop a modified capital asset pricing model for property-liability insurance companies, which has the following characteristics:

a) model which can be practically applicable in situations where market data are not available
b) model which incorporates jointly and explicitly the risks associated with underwriting and investment operations

**Objective 3:** To empirically test the following items in the framework of the modified capital asset pricing model developed in the present study:

a) the association between the market-based estimates of systematic risk and the accounting determined risk measure
b) the relationship between the cost of policyholders' surplus and the size of companies
c) the relationship between the cost of policyholders' surplus and the insurance leverage
d) the profitability of property-liability insurance industry.
Scope and Limitation of the Study

The major limitation of the study is related to the sample size used in the empirical study. Although total number of companies included in the empirical study are sixty, due to unavailability of market data (stock price and dividends) over a long period from 1956 to 1975, only twenty companies were utilized to test the association between the market-based estimates of systematic risk and the accounting determined risk measure. In addition, sampling was limited to fairly large firms whose average total asset size over the period from 1961 to 1975 ranked from 1st to 150th in the property-liability insurance industry. Any bias that might be associated with the sample size and the sampling may be carried into the result of the empirical study, and this may prevent the results from being generalized.

The basic methodology used in the empirical study assumes the general validity of the mean-variance general equilibrium capital asset pricing model; accordingly, any findings that suggest the model is suspect will be detrimental to the results of the study as a whole since the mean-variance model is used as the framework.

The study is limited to stock property-liability insurance companies. Therefore, the rate regulation model
is developed from the standpoint of stock property-liability companies. However, it is equally applicable to the other types of insurers.

Organization of the Study

Chapter I deals with general introduction. It contains statement of the problems, purpose of the study, scope and limitations of the study, and organization of the study. Chapter II reviews rate regulation of property-liability insurance. The review concentrates on the investment income controversy and various existing approaches in ratemaking and rate regulation of property-liability insurance.

Chapter III deals with review of cost of equity capital theory and the capital asset pricing model. More specifically, it reviews the concept of cost of capital in finance theory, alternative approaches to estimating cost of equity capital, the capital asset pricing model, and recent studies dealing with measurement of systematic risk via accounting determined risk measures.

In Chapter IV, a modified capital asset pricing model for property-liability insurance companies is developed, along with review of previous studies in the cost of capital of property-liability insurance companies. Chapter V develops a rate regulation model based on the concepts
of cost of policyholders' surplus (fair rate of return on policyholders' surplus) and total rate of return on policyholders' surplus.

A series of empirical tests is performed in Chapter VI. The tests include the degree of association between the market-based estimates of systematic risk and the accounting determined risk measure, specifically the accounting earnings variability measured by the standard deviation of rate of return on policyholders' surplus, the relationship between the cost of policyholders' surplus and size of company, the relationship between the cost of policyholders' surplus and insurance leverage, and the profitability of the property-liability insurance industry. In addition, the cost of policyholders' surplus for the sample of sixty companies are measured in the course of the above tests. Finally, summary and conclusions are presented in Chapter VII.
CHAPTER II

REVIEW OF PROPERTY-LIABILITY
INSURANCE RATE REGULATION

Introduction

For the majority of states an effective and strict rate regulation for property-liability insurance started after the All-Industry Model Bills were approved by the NAIC in June 1946, after enactment of Public Law 15 (McCarran Act) by the Congress in March 1945. In more than forty states, the rating laws adopted followed the All-Industry Model Bills or were some modification of it. Other states, such as California, Texas, North Carolina, and Virginia have experimented with laws substantially deviating from the All-Industry Model.

The forms of regulation of property-liability insurance rates in the United States may be classified according to three basic approaches. First is the restrictive approach, in which the state fixes the rates directly, or indirectly by compelling insurers to belong to a rating bureau. Second is the middle approach, in which rates are filed and either used after a specified period in the absence of disapproval of the rates, or used immediately,
or, in the case of rates varying in certain respects from existing rates, used upon approval. Third is the permissive approach, in which rates are determined in the marketplace and not filed, the state confining itself to assuring genuine competition.

A recent study on competition by the staff of the NAIC cites nine different forms of rate regulation in the United States. The following systems for regulating rates are listed: 1) state-made rates; 2) mandatory state rating bureaus; 3) prior approval; 4) modified prior approval; 5) file and use, adherence to bureau rates required; 6) file and use, bureau rates advisory only; 7) use and file, bureau rates advisory only; 8) no file, bureau rates advisory only; and 9) no file, no rating standards, no rates in concert.\(^9\)

**Basic Purpose of Insurance Regulation**

The goals of insurance regulation have been described from many different viewpoints by many people, including insurance scholars, economists, lawyers, and regulatory officials.

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Kimball maintains that the objectives of insurance regulation are composed of "internal goals" and "external goals." The internal goals are those which relate directly to the internal working of the insurance business. They include: 1) solvency of the insurer in all reasonably foreseeable situations, and 2) fairness, reasonableness, and equity in regard to the treatment of the policyholders. The external goals of regulation are those relating the insurance business to the rest of society. The external goals include such basic aims as democracy, liberty, localism, federalism, socialization of risk, and freedom of enterprise.

Kulp and Hall stated that there are three primary purposes of insurance regulation. They are: 1) to protect revenue through taxation, 2) to protect domestic insurers against competition from foreign and alien insurers, and 3) to protect the public against insolvency and inequitable treatment by insurers. In the early years, regulation was aimed primarily at the first two purposes. Today the primary purpose of regulation is the


protection of the public through assuring solvency of insurers, the provision of reasonable and equitable rates, and the provision of a market where insurance is readily to those who need it and can reasonably qualify for it.

Denenberg et al observed that the central and most important purpose has been described as that of maintaining the solvency of the insurer. Williams and Heins described the major objectives of insurance regulation as 1) preserving financial solvency of the companies, 2) regulating rate to avoid excessiveness, inadequacy, or unfair discrimination in pricing, and 3) controlling trade practice to encourage fair competition and marketing.

In a speech concerning the public purpose of insurance regulation, Richard E. Stewart, former superintendent of New York during the late 1960s, remarked that government is trying to help people get the most insurance for their money. He suggested the following specific objectives of insurance regulation: 1) insurance must be made


available to those who want and need it; 2) regulators must make certain that the insurance product is of high quality and reliability; and 3) the price of insurance must bear some relationship to the quality of protection purchased and the ability to pay.

Although it appears impossible to summarize a simple rate regulation theory, the basic purposes of insurance regulation may be described as protecting the public interest by means of maintaining solvency of insurance companies and reasonable prices, and assuring fair treatment of public.

Solvency of insurance companies is considered as one of the most important objectives of insurance regulation. When an individual purchases an insurance policy, he merely receives a piece of paper containing a promise to pay a contingent claim in the future. The quality of this promise to the policyholder is dependent upon the ability of the insurer to pay any and all claims incurred during the policy period. In other words, the insurance policy is only as good as the solvency of the company that issues it.

The solvency of the insurer is important not only to the policyholders but also to the general public. Insurance is generally classed as a business which is
"affected with a public interest"\textsuperscript{15} and the stability of insurance industry is generally considered indispensable to the functioning of the free enterprise system.

\textbf{The Statutory Basic Rate Standards}

Regardless of forms of rate regulation, most state insurance laws, with a few exceptions, generally provide that rates shall not be excessive, inadequate, or unfairly discriminatory. These rate standards have been the foundation for most existing systems of property-liability insurance regulation.

The exact meaning of these standards have been unclear, for most statutes do not provide definitions for these standards. Consequently, the interpretations of these standards have varied widely among states, and they have been subject to the views and background of insurance commissioners.

The legislatures of a few states have promulgated statutes which define the criteria in terms of the coverage provided and/or the existing competitive environment.

\textsuperscript{15}See German Alliance Insurance Company vs. Lewis Case, 233, U.S. 389 (1914). In this case, U.S. Supreme Court proclaimed the insurance industry to be "affected with a public interest."
Excessiveness

The legislatures of twelve jurisdictions have attempted to define or at least qualify the meaning of excessiveness. For example, the Arizona and Idaho statutes provide that "no rate shall be held to be excessive if ... free competition exists in the area and the classification covered by such rate." The determination of whether or not free competition exists is left with the insurance regulatory authority. Florida, Georgia and Indiana have adopted a provision similar to the California provision which states that:

No rate shall be held to be excessive unless 1) such rate is unreasonably high for the insurance provided and 2) a reasonable degree of competition does not exist in the area with respect to the classification to which such rate is applicable.

The phrases "unreasonably high for the insurance provided" and "a reasonable degree of competition" in the California definition, for example, hardly provide clear-cut objective standards for judging the excessiveness of proposed rates. What is meant by "unreasonably high rate"? What is meant by a "reasonable degree" of

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17 California, Insurance Code (1955), Chapter 9, Section 1852 (a).
competition? One may wonder whether the qualifications do much to eliminate uncertainty about the meaning of the standard of excessiveness.

In the interpretation of the standard of excessiveness there are three basic approaches: one focusing on underwriting profits; one on a comparison of rate being charged for the same or similar coverage; and one on the degree of prevailing rate competition. Under the underwriting profits approach, if it is indicated (by the use of formula) that, after appropriate allowance for expenses and claim losses, a rate has or will provide an underwriting return or profit above a certain target level, then the rate is characterized as excessive. This approach seems to provide a straightforward and objective standard for judging the excessiveness of proposed rates. There is, however, fundamental weakness in this approach.

First, under this approach the rate excessiveness is judged only based on the underwriting profits. The validity of this approach is attacked by those who support the idea that investment income of an insurer should be reflected in the process of ratemaking. They assert that the standard used by insurance departments to determine whether rates are excessive or not is unrealistic without consideration of investment income.
Even if it is conceded that the underwriting profits approach is appropriate in its theory, there is still an unresolved problem in practical application. Traditionally most insurance departments of states have used the uniform five percent of gross premium as their target level, conforming to the profit formula recommended by the NAIC. The major controversy in using five percent of gross premium as the target level of underwriting profit are: how the figure (5%) is derived; and what theoretical basis is applied to determine the target level. No rate regulatory authority has provided a theory or an experimental results to support the five percent guide line or the validity of the target level approach in general.

An alternative interpretation of excessiveness is based on the idea that if a reasonable degree of competition prevails in the market for a particular kind of insurance, it follows that rates cannot be excessive. Under this approach, whether the underwriting profits of some insurers are above a target level is irrelevant.

The reasoning in support of examining the level of competition is based on the principle that in a competitive market sellers are effectively precluded from charging excessive prices over the long run since potential buyers will be attracted toward competitors offering lower prices. Thus, competition will insure that
consumers pay only what a particular product or service is reasonably worth, and nothing more.

This approach involves two complicated issues: what constitutes a sufficient amount of competition to preclude excessive rates; and how can the state insurance department determine whether or not such a reasonable degree of competition exists?

The third approach is based on a pragmatic comparison of proposed rates with those currently in effect for the same or similar coverage. If the proposed rates are higher than those being charged by other insurers, such rate may be considered excessive.

The effect of this interpretation of excessive is to pit companies against one another to keep rates down, not necessarily by competitive action or by limiting profit margins, but by administrative refusal to allow rate increases as long as some insurers are motivated, for whatever reasons, to charge lower rates.

Inadequacy

Some thirteen jurisdictions have qualified the term inadequate. California, Florida, Georgia, Idaho and Indiana have very similar provisions. In California

a situation apparently could exist where an insurer could use a bureau rate which, because of the insurer's inefficiency, endangers its solvency but which could not be held to be inadequate because it is not unreasonably low for the insurance provided.

In Minnesota, a rate is not to be held inadequate if the rate filer's supporting information shows that the business being written at the rate proposed in filing is being written by the insurer at a profit.

The Nebraska provision differs from California's because: 1) no reference is made to the destruction of competition or creation of a monopoly and 2) consideration is expressed for experience outside the state.

Tennessee requires that rate shall not be "inadequate for the safety and soundness of the insurer." Mississippi, North Carolina, and Rhode Island make reference to profit or loss.

The variety of definition of inadequacy provided by different states is an evidence that no clear-cut objective criterion of inadequacy exists. It is only observed that these various tests of rate adequacy rely upon one
or more of three factors: destruction of competition, company solvency, and company profit.\textsuperscript{19}

**Unfair Discrimination**

Controversies surrounding the meaning of unfair discrimination have been relatively few. Perhaps one explanation for the dearth of litigation over unfair discrimination is that evidence of such discrimination rarely appears on the face of a rate filing which is reviewed by the state insurance department. Unfair discrimination, if it occurs at all, does not arise from the way a rate is made, but from its application, which is difficult for the state to regulate.

In conclusion, despite the attempts to legislate appropriate definitions of the rate standards, the standards still remain obscure and they are couched in subjective terminology. Therefore, regardless of the presence or absence of statutory definitions, the final regulatory decision rests on the judgment of the insurance commissioner.

\textsuperscript{19}Fredick G. Crane, *Automobile Insurance Rate Regulation*, Columbus, Ohio, Bureau of Business Research, Ohio State University, 1962.
Controversy of Investment Income in Ratemaking of Property-Liability Insurance

While investment income has long been considered in making life insurance rates, it traditionally has received little formal recognition in property-liability insurance ratemaking. No state at any time in the period from 1921 to 1965 has required that investment earnings be included in rate calculation.\(^{20}\)

However, over the past sixty years, one of the more heated controversies in regard to property and liability insurance has involved whether or not the investment income a company earns should be reflected directly in ratemaking procedures. In recent survey concerning the current status of the investment income controversy,\(^ {21}\) some twenty-one states out of fifty states indicated that the investment income from unearned premium reserve is directly considered in the approval of rates for property and casualty insurance.

The traditional attitude toward the investment income was codified in the cannon that has become known


as the 1921 Standard Profit Formula. It defined underwriting profit as earned premiums less incurred losses and expenses and defined a reasonable underwriting profit as 5%, plus 3% for conflagrations. The formula also included the following statement:

No part of the so-called banking profit (or loss) should be considered in arriving at the underwriting profit or loss.\textsuperscript{22}

In 1947, a major criticism was made of the Standard Profit Formula in the McCullough report. It advocated a redefinition of three fundamental parts of the 1921 formula.

First, it challenged the definition of underwriting profits; second, it denied that underwriting profits should be independent of banking profit; and third, it did not believe that 5% for underwriting profit plus 3% allowance for conflagrations was reasonable.\textsuperscript{23} In particular, it recommended the "establishment of a flexible means for determining the profit allowance factor in the rate structure based on the return on capital and considering the rate of investment yield . . . ."\textsuperscript{24}

\textsuperscript{22}The quotation is taken from PNAIC (Chicago, 1948), p. 74.


\textsuperscript{24}PNAIC (Chicago, 1948), p. 121.
Except for New York, however, the respective states chose to ignore the McCullough recommendations until the middle 1960s. Although only several states have required formal consideration of investment income in property-liability rate filings, this question has become a major issue at public hearings in more than fifteen jurisdictions since late 1960s.

Arguments Against Inclusion of Investment Income in Ratemaking

Supporting the traditional position codified in the principle of the 1921 Standard Profit Formula, the insurance industry overwhelmingly agrees that investment income should not be directly incorporated in the property-liability insurance ratemaking. Some of the important arguments against inclusion of investment income in ratemaking are summarized below.25

First, if investment income and other investment gains were to be included in ratemaking formula, it logically follows that provision for investment losses should be included. The industry contends that the insurance

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buying public should not be exposed to the investment risk of a company.

Second, the nature of investment income is such that the great bulk of the companies' investment income has no relation to its current underwriting operations. The major portion of investment income has its origin in funds representing either contributions of stockholders in the past or the reinvestment of past profits from various sources. It is also claimed by the industry people that the income from the investment of unearned premium reserve or loss reserve contributes to very negligible amount to the total investment income of a company. Consequently, although inclusion of investment income form these funds as part of the mathematical projections undertaken might theoretically result in rate reduction, the savings would be so small that they would be outweighed by the administrative and regulatory expense and other predicted adverse effects.

Third, the policyholder should be given only what he asks and pays for--his insurance policy and the protection it affords him. He is not buying a share in the property of the insurance company when he pays his insurance premium; therefore, he is not entitled to any investment profit. This view has been backed by courts which have ruled that an insurance policy is a contract between
the company and the policyholders, and that the company's only legal obligation is to pay the insured's legitimate claims.

Fourth, to use aggregates of investment income for ratemaking would tend to make companies seek higher yield investments rather than the safety and security which is the real purpose of insurance investments. In this recent study, Flanigan concluded that the investment policy of a property-liability insurance company might shift from conservative and income-oriented investments to more aggressive and growth-oriented investments.26

One industry executive noted that investment income, in proper perspective, can be considered in the ratemaking process and is in fact; but, direct injection into the ratemaking formulae is dangerous and can be disastrous to the financial stability of the property and liability business. This could limit its capability to cope with expanding market needs unless a realistic attitude is adopted and adequate provision is made in the ratemaking process to offset the recognition given in the ratemaking formulae, where investment income is included instead of considered, as an element in the total financial picture.27


Arguments in Favor of Inclusion of Investment Income in Ratemaking

While the insurance industry overwhelmingly takes the position that investment income should not be directly reflected in the ratemaking process, arguments in favor of inclusion of investment income in ratemaking process have been intensified in recent years among many different groups, such as regulators, academicians and consumer protection groups.

Many critics of the industry contend that the problem in the investment income controversy is basically that of ownership of assets. They assert, for instance, that unearned premium reserve is actually held in trust for the policyholders and any interest or investment income, including capital gains, from assets pertaining to these funds should be returned to the policyholders by considering them part of the underwriting profits. It is also argued that such assets are directly attributable to underwriting activities, being contributed by policyholders, and are therefore components of underwriting income.

In addition to the argument focusing on the problem of ownership of assets, some arguments in favor of including investment income are made based on the concept of total profitability of insurance enterprise, and on the fact that the insurance industry is regulated and the
property-liability insurance rates are subject to the statutory rate standards, namely, adequacy and inexcessiveness.

The basic argument under this approach is predicated on the fact that all rate regulatory legislation prohibits inadequate and excessive rates, and on the premise that inadequacy and excessiveness of rates should be judged in consideration of total profitability of insurers.

Such profitability of insurers is determined by examining the two major sources of the industry profits: one designated underwriting profits; and one designated investment profits. These two sources of profits are described as inseparable, inasmuch as premiums are the largest source of funds of companies, from which are derived underwriting and investment income. It is further asserted that since all investment income is a logically inevitable part of insurance business, such income should be reflected in ratemaking. From the standpoint of those who favor the inclusion of investment income on this ground, the rate standards used by insurance departments to determine whether rates are inadequate or excessive are considered unrealistic if the standards do not consider the investment income.

This view is supported by some insurance scholars. In the analysis of whether investment income should be
included formally in ratemaking, Cooper concluded that a premium will be reasonable and thus satisfy the statutory standards of adequacy and inexcessiveness only if the profit provision included therein is reasonable. Since the total rate of return on the invested capital required to generate the insurance business and the expected return from the investment of the stockholders' capital and the premium generated statutory reserve are indispensable factors in the determination of a reasonable profit provision, these factors must be given formal consideration in making and regulating property-liability insurance rates. He further indicated that an expected underwriting profit would be regarded reasonable if it could be expected to yield a competitive total rate of return on the invested capital when combined with the expected return from the investment of stockholders' capital and the investment of the premium generated statutory reserve.

In the study reported by Hedges, the problem of investment income in ratemaking was analyzed in the framework of "fair rate of return" principle. It was implied

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28 Robert Cooper, Ibid., p. 17.

29 Robert Cooper, Ibid., p. 113.

by the concept of "fair rate of return" that the equity owners of firms are entitled to a certain level of return on their investment which should be commensurate with returns on investment in other enterprises having corresponding risks. Stockholders in insurance companies are believed to place their capital at the risk of the insurance business in the expectation that they will realize fair rate of return on their investment.

It was indicated in the study that the determination of adequacy or nonexcessiveness of rates should be judged based on the concept of fair rate of return. Since the two major sources of income for property-liability insurance companies are underwriting income and investment income, income from underwriting operation and investment operation should be counted together in the process of determining the rate of return on equity owners investment.

He concluded that rates are adequate but not excessive when the premiums they are expected to produce, less expected claims and expenses, plus the net investment profit which can be expected from the kinds and amount of assets reasonably devoted to backing those premiums, add up to a rate of return on investment appropriate to risks assumed and the rate of growth need in the property-liability insurance business.
As indicated earlier, the current trend in regard to the controversy of investment income in ratemaking is to directly credit investment income in ratemaking to reduce underwriting profit allowance. Here are some of the cases indicative of this trend.\(^{31}\)

Over the period of five years from 1965 through 1969 the state of Virginia has moved in steps 1) from no credit for investment income, 2) to credit interest, dividends, and rents on the unearned premium reserves, 3) to credit for interest, dividends, and rents on the unearned premium and loss reserved, and 4) to credit for realized capital gains on the insurance reserves in addition to interest, dividends and rents. As a part of this process, the underwriting profit allowance was moved down successively from 5% to 4.5% to 3.4% to .1%. This state provides an excellent illustration of the evolving concept of considering investment income in ratemaking.

In Maryland, investment income plus realized gains of losses in the two insurance reserves are credited to policyholders. Maryland has found that interest, dividends, and rents are quite stable and present no trending problems when calculations are being made. Forecasting

\(^{31}\)For discussion of this trend in detail, see PNAIC, Vol. 2 (1970), pp. 818-821.
realized capital gains or losses has proven to be much more difficult.

In the case of Kentucky, the insurance commissioner issued in 1967 a ruling in which he concluded that interest, dividends, and rents on the unearned premiums and loss reserves should be considered in making rates.

Early 1970, the Tennessee insurance department crystalized a practice which had been in operation for about a year and issued a ruling requiring that investment income on the unearned premium and loss reserves should be credited. The credit was estimated at somewhat between 1% and 2% of earned premiums. The return was based on total invested assets. Almost the same ruling was issued by the state of New Hampshire.

In Pennsylvania, the state elected to confine the crediting of investment income to that earned on funds underlying the unearned premium reserve in 1969.

Summary

The purpose of this review was to present the current status of investment income controversy and to summarize some of the arguments for and against inclusion of investment income in ratemaking process.

While the insurance industry overwhelmingly has opposed to inclusion of investment income in ratemaking,
other groups, such as regulators, academicians and consumer protection groups have argued in favor of including investment income in ratemaking process.

Although it is evident that in recent years quite a number of states tend to take the position of directly including investment income in ratemaking, it is still controversial as to whether or not investment income should be included in ratemaking process. The controversy has been protracted mainly because of conflicting interests among different groups involved and the complicated nature of the issue.

It seems that there is no greater weight of logic itself on one side of the argument than on the other. However, the argument for inclusion of investment income is more consistent with finance theory and economic theory of firm. Most of the arguments against inclusion of investment income are related to the practical problems which might occur in the course of implementing the idea.

From the standpoint of financial theory, a regulated premium rate will be reasonable and thus, satisfy the statutory criteria of adequacy and nonexcessiveness only if the expected return on equity capital is reasonable. Since the return on equity capital of property-liability insurance companies must be determined based on total income earned from all income generating activities
of property-liability insurance companies, both underwrit-
ing and investment income should be reflected in the return on equity capital, and thus, should be reflected in rate-
making process, if one is to regulate the premium rates based on financial theory.

One of the major purposes of the present study is to develop a rate regulation model which incorporates explicitly underwriting income as well as investments income, and the risks associated with those activities under the premise that any regulated premium rates must be based on the return on equity capital and the return on equity capital should be determined on the basis of income from all sources.
Current Practice and Existing Theories in Ratemaking and Rate Regulation of Property-Liability Insurance

Currently existing approaches in ratemaking and rate regulation of property-liability insurance may be broadly classified into two categories: a conventional approach and a new approach.\(^2\)

The conventional approach includes the ratemaking method and rate regulation process currently utilized by the industry and rate regulatory authorities. The basic characteristics of the conventional approach can be described as: 1) in the process of ratemaking rates are determined without proper recognition of underwriting risk faced by insurer; and 2) investment income is not directly reflected in ratemaking.

On the other hand, the new approach may include all kinds of ratemaking methods or rate regulation models which have been suggested in attempts to solve the problems of current ratemaking and rate regulation.

The general trend is the new approach is to properly incorporate underwriting risk or investment income

\(^2\)This classification is first attempted by the present author in the present study.
and risk into the method of ratemaking and rate regulation.

Conventional Approach

In the conventional approach, the property-liability insurance price is determined by adding the estimated mean pure premium and business expenses plus a uniform underwriting profit provision, being calculated by taking fixed percentage of gross premium. The gross premium is obtained by the following formula:

\[ G = pp + E + kG \] ...........................(1)

where

- \( G \) = gross premium
- \( pp \) = expected mean pure premium
- \( E \) = expected average business expense
- \( k \) = uniform underwriting profit percentage

This formula has been used for ratemaking of property-liability insurance and applied in reviewing proposed rate by regulatory authorities.

In case of rate revision, the underlying idea of the conventional approach is generally accomplished by comparing the two loss ratios, that is, the ratio of currently earned premium, and an expected loss ratio. In reviewing proposed rate revision, the reasonableness of
the proposed rate is determined based on the following formula:

\[ M = \frac{(L + A)}{(1 - (E + k))} \] (2)

where

- \( M \) = the indicated modification factor
- \( L \) = ratio of incurred losses to earned premiums
- \( A \) = the current ratio of internal loss adjustment expenses to earned premiums
- \( E \) = ratio of current expenses to written premiums
- \( k \) = allowance for underwriting profit and contingencies

The modification factor \( M \) is applied to written premiums of the most recent year. A value of \( M = 1.5 \), for example, indicates a 50% increase in insurance premiums.

From formulae (1) and (2), it can be noticed that:

1) income from investment is not accounted for; and 2) underwriting risk does not play any explicit role in ratemaking.

The conventional method of ratemaking has been criticized in many respects. Several studies indicated that underwriting risk is not adequately recognized in

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33 The formula was recommended by Fire Insurance Research and Actuarial Association in 1964.
the conventional ratemaking process. Actuarial approach to property-liability insurance pricing is based upon only the mean values of loss experienced, administration cost, and uniform profit provision. Nowhere is the concept of risk in terms of standard deviation of variance or some other means accounted for in ratemaking process.

This would appear to be inconsistent with economic theory and finance theory. Classically, profit is related to uncertainty of the undertaking. In general it is assumed that individuals are averse to risk; therefore, for certain jobs there should be returns corresponding to the risk undertaken in order to induce someone to undertake it. The use of a uniform profit provision could imply that the degree of uncertainty is the same for all classes and lines of insurance business. But it is not true. Some of the problems due to the neglect of underwriting risk in ratemaking will be discussed later in this section.


New Approach

In attempts to solve the problems existing in the conventional approach, several authors proposed new types of ratemaking method or rate regulation models in recent years. In the following, some of the important studies are reviewed study by study.

Witt Study\(^{36}\)

Utilizing the random sampling model suggested by Houston,\(^{37}\) Witt developed a model to determine net premium for property-liability insurance in recent study. The motive to develop the model is to explicitly recognize underwriting risk in ratemaking process, and by doing so he tried to solve pricing and availability problems in automobile liability insurance.

In the first place, he analyzed the method of determining a static net rate which includes a mean pure premium and a risk charge (a profit allowance for the underwriting risk faced by insurer). Under the certain assumptions employed in the study, the net rate, \(R\) is given by:

\[^{36}\text{R. C. Witt (1974), op. cit.}\]
\[^{37}\text{D. B. Houston (1964), op. cit.}\]
where

\[ R = U + 2.33 \frac{\sigma}{\sqrt{N}} \]  

(3)

In the equation (3) the risk charge for underwriting risk is represented by \( 2.33 \frac{\sigma}{\sqrt{N}} \) and it is proportional to the standard error of the sample mean pure premium.

The random sampling model discussed above provides several important implications to the study of ratemaking method. First of all, the net premium level depends upon not only the mean pure premium but also the risk charge, which is determined by three factors: 1) standard deviation of pure premium, 2) number of sample size, and 3) the confidence multiplier. This means that the net premium structure explicitly considers the underwriting risk in terms of variability of pure premium. Second, in contrast with the conventional approach, the underwriting profit is explicitly associated with the underwriting risk faced by the insurer. It implies that the provision for underwriting
profit is not uniform for all classes and lines of insurance. This appears to be consistent with economic theory and finance theory where profit is generally related to risk. Finally, it should be noted that the underwriting risk charge included in the net premium varies inversely with the number of risks to be covered by insurer. Therefore, it is likely that the risk charge by a larger company with the larger expected number of risk is smaller than that of a smaller company with the smaller expected number of risks.

Based on the random sampling theory, Witt further extended the static net premium model to a dynamic net premium model and to a model which includes the investment income in net premium structure. The final model developed in the study includes investment income and it is given by

$$R_1 = \bar{X} - \frac{C}{N_1} - \frac{E(I)}{N_1} + 2.33 \sqrt{\frac{S_o^2}{N_1} + \frac{S_o^2}{N_o} + \frac{\sigma^2(I)}{N_1}}$$

where

- $R_1 = \text{dynamic net premium with investment income considered}$
- $\bar{X} = \text{sample mean pure premium}$
- $C = \text{insurer's capital and surplus}$
- $E(I) = \text{expected investment income}$
- $S = \text{unbiased sample standard deviation}$
\[ N_2 = \text{sample size} \]
\[ \sigma^2(I) = \text{variance of investment income} \]

The risk charge, in this case, is given by the last term of the equation (4).

As to the expense loading in making gross premium, he suggested that the expense loading should consist of two parts: variable cost and fixed cost. Compared with the conventional method in which the expense loading is expressed as fixed percentage of the gross premium, Witt's method would appear to be more logical, since the expenses would vary with the risk-adjusted net premium and the fixed cost which could vary from company to company, depending upon the volume of its business and many other factors.

**Cooper Study**

Cooper developed a model for generating reasonable underwriting profit provisions for a given line of insurance based on the premise that investors in stock property-liability insurance companies, like those in any other business, should be able to earn a competitive rate of return on their capital investment. In this study, he used the Sharpe-Lintner's capital asset pricing theory as the

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theoretical background of the model. The model, which generates permissible underwriting profit provisions that satisfy the statutory criterion of reasonableness, is expressed symbolically as follows for a particular line of insurance j:

\[ a) \quad r_p - I^* = U^* \]
\[ b) \quad U^* \times R_j = U_j \]
\[ c) \quad U_j \times \frac{k}{E_j} = P_j \]
\[ d) \quad \frac{P_j (E_j) (1 - e^{j'})}{(1 - (e^{j} + p_j)) (E_j) + e^{j"} (E_j) + p_j (E_j)} = p_j \]

The fundamental nature of the model may be summarized as below. First, the reasonable underwriting profit provision \( (p_j') \) varies with the competitive total rate of return on necessary invested capital \( (r_p) \) and the expected rate of return from the applicable investment activities \( (I^*). \) Second, investment income is considered in determining the reasonable underwriting profit provision. Third, the reasonable rate of return from underwriting activities in all lines \( (U^* \) is the difference between the total competitive rate of return on necessary invested capital and the expected rate of return from applicable investment activities. Fourth, the reasonable rate of
return for each line of insurance is apportioned from the total reasonable rate of return for underwriting activities in all lines based on the relative risk coefficient for each line ($R_j$). Finally, the reasonable underwriting profit provision for each line of insurance is converted from the profit provision expressed as percentage of the necessary invested capital ($P_j$) to the profit provision expressed as a percentage of expected earned premium ($p_j'$).

The model itself is quite logical and appealing in that the approach taken is new and it is developed based on the advanced financial theory. However, there are some controversial points in applying the financial theory to determination of the model inputs.

In his study, the competitive total rate of return was estimated in the framework of the Sharpe's theory of market equilibrium. Specifically, he used capital market line (CML), that is, $E_i = R_f + b\hat{\sigma}_i$. He computed the competitive total rate of return on the necessary invested capital by substituting the estimate of the insurance portfolio's predicted risk, as measured by the standard deviation of the combined loss and expense ratio, $\hat{\sigma}_p$, into the estimated capital market line (CML), that is, $E_i = \hat{R}_f + b\hat{\sigma}_i$.

The procedures used in his study raise several theoretical problems. First of all, the equilibrium
market risk-return model used in the study is theoretically only applicable to determine the expected rate of return of efficient asset portfolios. Since the insurance portfolio of an insurance company cannot be considered as an efficient asset portfolio, it appears theoretically incorrect to estimate the expected rate of return on the invested capital in support of an insurance portfolio by utilizing the capital market line.

In the Sharpe's capital asset pricing theory, the equilibrium expected rate of return on individual security or inefficient asset portfolios is estimated by so-called security market line (SML), instead of CML. The CML is only applicable to the efficient portfolios. Furthermore, it should be noted that the standard deviation of return is used as risk measure for only efficient portfolios.

Second, he used the standard deviation of the combined loss and expense ratio, which is considered underwriting risk, as the risk for the invested capital of property-liability insurance companies. This implies that the nature of the risk of the invested capital of property-liability insurance company can be accounted for by analyzing only the underwriting operation of the company. In fact, the risk of the equity capital, or the invested capital, of property-liability insurance company is not only affected by the nature of underwriting
operation, but also affected by investment operation. Therefore, if one is to assess the risk of the equity capital of property-liability insurance company, he must consider both underwriting risk and investment risk.

Finally, suppose the underwriting risk can be legitimately used as the surrogate of the risk for the equity capital of property-liability insurance company. In the study, the underwriting risk was measured as the standard deviation of the combined loss and expense ratio. Then, the value of the standard deviation was directly substituted into the estimated capital market line in order to estimate the equilibrium expected rate of return on the invested capital.

This procedure does not appear to be theoretically correct at all. The estimated capital market line equation is constructed based on the rates of return on capital assets. Therefore, the risk measure used in the equation is the standard deviation of rate of return on capital assets. On the other hand, the underwriting risk is measured by the standard deviation of the combined loss and expense ratio which is the ratio of loss and expense incurred to earned premium. It is apparent that the two risk measures are different from each other in their measurement dimensions. Consequently, it is wrong to directly substitute one for another. There should be developed
a method to link the two risk measures, if one is to use the standard deviation of the combined loss and expense ratio in the framework of the capital asset pricing theory.

In summarizing the Cooper's study, the major objective of the study was to develop a model for generating reasonable profit provision, based on the concept of the competitive rate of return on the invested capital and reflecting the investment income explicitly, in the framework of capital market theory. The structural concept of the model is very helpful for the study of ratemaking. However, there are some theoretical problems to be noticed. First, a wrong equilibrium market risk-return relationship model was used in determining the competitive rate of return on the invested capital. Second, only underwriting risk was reflected in measuring the risk of the invested capital, leaving out the risk associated with investment operation. Finally, the underwriting risk, as measured by the standard deviation of the combined loss and expense ratio, was directly substituted as the surrogate of the risk of the invested capital in support of the insurance portfolio.

Haugen and Kroncke Study

Haugen and Kroncke suggested an alternative approach to regulating property-liability insurance rate
in their recent study. In developing the procedure for regulating property-liability insurance rates, they followed the objective of public utility rate regulation: to allow the insurer a rate of return on equity investment sufficient to compensate for the risks incurred in providing the service.

As a departure of the study they developed a method to estimate the required rate of return on the equity capital (cost of equity capital) in the framework of Sharpe-Lintner-Mossin capital asset pricing model.

Using the required rate of return on the equity capital, \( E(R_j^*) \), expected internal rate of return on the equity capital, \( E(R_j') \), and the book value of the equity capital, \( A \), they formulated a model for the market value of the equity capital as below:

\[
V = \frac{(1 + E(R_j')) \cdot A}{1 + E(R_j^*)} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots
\]

where \( V \) is the market value of the equity capital.

Under their basic assumption that the proper regulatory objective is to allow a rate of return to equity capital sufficient to compensate for all factor

cost and for the risks incurred in underwriting and investment, they suggested the following rate regulation model derived from the market value model (5):

\[
\frac{1 + E(R_j^{'})}{1 + E(R_j^{*})} = \frac{V}{A} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots (6)
\]

They indicated that the reasonable rates are those that equate the market value of the company's stock, V, with its book value, A. In other words, regulators have to set rates so as to equate the market value of the company's stock with its book value.

Although the model appears to be theoretically possible, the model has at least two drawbacks in its practical application. First, it is only applicable to stock property-liability insurance companies whose common stocks are traded in the market. Another significant defect of the model is the tremendous difficulty in its application by rate regulatory authorities. For example, the book value of the company's common stock in the economic sense is very difficult to measure, if not indefinable.

Other Studies

Kahane and Levy suggested an econometric model for determination of net premium in automobile insurance in
conjunction with problems in rate regulation of the industry. The suggested model is a linear regression model and supposed to determine the effect of various factors on the probability of claim and the degree of damage associated with it.

They asserted that if different groups of policyholders have different probabilities and/or damage level, a different rate should be applied to each. The model involves two regression equations: one to estimate probability, and the other to estimate the average claim amount. As the dependent variables, they used probability of a claim being filed during the year, and the average amount claimed. The independent variables include various factors, such as, address, number of drivers using the car, claim record, engine horse power, and etc.

This econometric model approach provides for a new analytical tool to analyze the ratemaking problems. The method of determining net premium by way of multiplying the probability of a claim by the average amount of a claim has been used, however, the econometric model may be effectively used to select important and significant factors among many various factors which are believed to

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affect the probability and the amount of claim, and it may give some insights into the problems in classification of policyholders.

Nye and Kahane suggested a portfolio approach in connection with determination of underwriting profit provision for different line of insurance in their recent study. 41

Criticizing the use of uniform profit provision in the current rate regulation, they suggested that the underwriting profit provision for an insurance line should be related to the degree of correlation, in terms of underwriting profit, with all other lines in the firm’s insurance portfolio. Regulators should not load the same rate of underwriting profit on all lines, but rather should take into account the contribution of the line to the total riskness of the firm’s portfolio.

Summary

In this chapter, the current practice and some existing theories in ratemaking and rate regulation have been reviewed. The current practice in ratemaking and

rate regulation has been criticized for many years mainly because: 1) underwriting risk is not adequately recognized in the pricing process and rate regulation, and 2) investment income is not directly reflected in ratemaking process.

Being aware of many problems in pricing and other related areas under the conventional approach, many authors have attempted to develop new methods of ratemaking and rate regulation. As shown in the above, the new approach is diverse in its theoretical frameworks. However, it might be said that most of the suggested methods or models are developed based on either micro-economic theory or finance theory. It is notable that many authors applied the mean-variance portfolio theory and the modern capital market theory recently developed in the field of finance as the basic theoretical framework. This trend also has been appearing in the rate regulation of public utility industry.42 It is quite natural that the model developed in the present study is also based on finance theory, particularly the theory of cost of equity capital derived in the framework of the modern capital market theory.

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42 For example, see Stewart C. Myers, "The Application of Finance Theory to Public Utility Rate Case," The Bell Journal of Economics and Management Science (Spring, 1972).
CHAPTER III

THE CONCEPT OF COST OF CAPITAL

AND THE CAPITAL ASSET PRICING MODEL

The Concept of Cost of Capital

in Finance Theory

Perhaps no other subject has received as much attention in the financial literature of recent years as the cost of capital. There has been two principal reasons for this emphasis. First, the importance of the concept of the cost of capital as a vital factor in the financial decision-making of the firm has come to be recognized. Second, the concept is an elusive one about which little agreement has been reached. Therefore, controversy has been rampant, and opinions have proliferated.

Since the concept of cost of capital is utilized in developing a rate regulation model in the present study, it is intended to discuss the basic concept of cost of capital used in finance theory. It should, however, be noted at the outset that the discussion will be confined only to the fundamental notion of cost of capital,
and not deal with all the controversies in the theory of cost of capital.

To discuss the concept of cost of capital used in finance, it may be logical to begin with the discussion of the objective of the firm in a free enterprise economy.

Broadly speaking, firms are considered to make two types of financial decisions: investment decision and financing decisions. What should be the objective of the firm in making its financial decisions? An objective is required in order that these decisions be made on a rational basis. Without an objective, the firm lacks a criterion by which to measure the effect of proposed decisions.

In the recent financial literature, it is generally advanced and agreed that the objective of the firm in making financial decision should be to maximize the economic welfare of its owners. Then, it is widely accepted that the operationally meaningful decision criterion in financial decision-makings should be the maximization of the market value of the equity holder's share, that is, the market value per share of its stock in order to achieve this objective. Although there have been proposed other

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decision criteria, such as, maximization of profits, maximization of rate of return either on assets or owners' investment in the business, and maximization of earnings per share, these criteria have been rejected for one reason or another.

Under the assumptions that: 1) the capital market is perfect, and 2) the objective of individual investors is to maximize the utility of his consumption over time, it is widely held that the market value maximization decision criterion is consistent with the objective of the firm, namely, the maximization of economic welfare of the owners.

When the firm adopts as its objective the maximization of the market value of its stock, each proposed decision should be appraised in terms of its impact upon the market value of the share. Therefore, such an objective requires a valuation model for the share of the firm. If the firm is to maximize the market value of its shares, its managers, who make its financial decisions, must know or at least assume the factors upon which market price depends and the way in which each operates.

Considerable controversy exists as to an appropriate valuation model for a common stock. However, it is assumed that the price of a share of a firm's common stock is equal to the present value of the future benefits of
ownership. The benefits include dividends paid while the share is sold. Then, the formula for the price of a common stock in a world of certainty is generally expressed as follows:

$$P_0 = \frac{\sum_{t=1}^{\infty} \frac{d_t}{(1 + R)^t}}{... \ldots \ldots \ldots \ldots (7)}$$

where \(d_t\) is the (certain future dividend payment per share at year end is \(t\). \(R\) is the risk-free rate of interest. It is discount rate under certainty.

In a world of uncertainty, the formula is expressed as follows:

$$P_0 = \frac{\bar{d}_t}{(1 + k)^t} \ldots \ldots \ldots \ldots \ldots (8)$$

where \(\bar{d}_t\) is the expected future dividend payment per share at year end is \(t\). \(k\) is the discount rate under uncertainty.

From the above two formulae it follows that the price of a common stock is affected by two factors: 1) the stream of future dividends to be paid on the share, and 2) the discount rate or rate by which the market discounts this stream. Thus, any proposed financial decision of the firm may be appraised in terms of its effect upon the stream of future dividends and the rate of discount applied by the market to this stream.
The concept of cost of capital may be introduced by means of explaining the rate of discount. The rate of discount is explained in the two cases: the certainty, and the uncertainty. In the world of certainty, the rate of discount is equivalent to the market rate of interest. This means that the price of a common stock is the present value of the future dividends discounted at the market rate of interest. Since the market price of a common stock is determined by discounting future dividends at the market rate of interest, an investment project, whose rate of return is greater than the market rate of interest or whose net present value is positive when discounted at the market rate of interest, will increase the market value of the share. Therefore, the project should be accepted. This implies that the cost of capital for this project is equal to the market rate of interest. In the world of certainty, the cost of capital is equal to the market rate of interest, regardless of how the funds are acquired.

In the world of uncertainty, the market rate of interest is no longer an appropriate measure of the cost of capital. Unlike the certainty world case, the magnitude of dividend payment is not known with certainty. If a firm was in a very stable industry, the uncertainty regarding the future dividend stream would be relatively small. Conversely, a firm in a risky industry would have
a dividend stream with a high degree of uncertainty. Since it is assumed that people are risk-averse, the market will demand increasing rate of return if it is to be induced to invest in increasingly risky stocks. The market value of a common stock now is obtained by discounting the future stream of expected dividends at a discount rate that reflects and compensates for the uncertainty associated with the dividend stream.

For convenience of exposition, it is assumed that the firm is all-equity financed. Since the objective of the firm is to maximize the market value of its shares and the market value of the share is obtained by discounting the future dividend payment at the appropriate discount rate which is determined by reflecting the uncertainty associated with the dividend stream, the proper rate of discount for proposed investment projects in the world of uncertainty should be the risk-adjusted discount rate. In the world of uncertainty, a proposed investment project is accepted if the rate of return on the investment is greater than the risk-adjusted discount rate or if the net present value is positive when the project is discounted at the risk-adjusted rate. Therefore, in the world of uncertainty, the cost of capital is equivalent to the risk-adjusted discount rate. The symbol "k" in the formula (8) represents the risk-adjusted discount rate and it is cost of capital.
The terms cost of capital and discount rate are used interchangeably, meaning that these are the minimum required expected rate of return that the investment project must earn to make it acceptable to the firm. Although it is generally agreed in the field of finance that the discount rate or cost of capital of the firm is the minimum required expected rate of return, it is still an unresolved problem that what the minimum required expected rate of return should be and how it is determined.

Realization of the multifaceted nature of the rate of discount may serve to unify the concept of cost of capital. From the viewpoint of the firm, the rate of discount is the rate at which future dividends are discounted in order to arrive at market price. It represents an explicit cost of capital which is defined as the discount rate that equates the present value of future dividends to be paid on a share with the net proceeds from the issuance of that share. In addition, the rate of discount is an opportunity cost to the firm since it is the rate of return that could be earned on the repurchase of shares. From the viewpoint of the market, it is an opportunity cost or implicit cost of capital. It is the rate of return on the best opportunity that would be forgone if the share were purchased.

From the viewpoint of the existing shareholders, it is also an opportunity cost in the sense that it is the
rate of return demanded by investors on the shares of the firm and on other securities with similar risk characteristics.

As indicated above, the cost of capital can mean various things depending upon different viewpoints. However, for the purpose of the present study, the cost of capital is understood as the rate of return that investors could earn elsewhere on investments of equivalent risk. It is the minimum required rate of return which a proposed investment project must earn to make it acceptable to the firm. This is the concept of cost of capital from the viewpoint of investor's opportunity cost.

The logic in developing a cost of capital consistent with the concept of investor's opportunity cost goes as follows: 44

1) The firm is one of a class with similar risk characteristics.

2) At any point in time there is a unique expected rate of return prevailing in capital markets for this degree of risk.

3) The share price of the firm in question will adjust so that it offers an expected rate of return to investors.

44 Stewart C. Myers (1972), op. cit. p. 63.
4) This rate, the investors opportunity cost, should be the rate of discount for a proposed investment project and therefore, the cost of capital. Otherwise, the firm's shareholders' wealth will not be maximized. This sequence of logic defines the appropriate discount rate or cost of capital for the firm or for project which does not change the firm's risk characteristics.

In summary, the concept of cost of capital is explained in the two cases: the certainty case and the uncertainty case. In general, the cost of capital can be defined as the capitalization rate for the future benefits. In the certainty case, the cost of capital is equivalent to the market rate of interest, regardless of the capital structure of the firm.

In the uncertainty case, the cost of capital can mean various things. For the purpose of the present study, the cost of capital is defined from the investor's viewpoint. It is defined as the rate of return that investors could earn elsewhere on investments of equivalent risk, and it is the minimum required rate of return which a proposed investment project must earn to make it acceptable to the firm.

In the competitive capital market, a firm is required to yield a rate of return on its share, assuming
all-equity financed, at least equal to or greater than the cost of equity capital in order to obtain funds from the market. If the firm fails to yield the expected rate of return, that is, cost of equity capital, no investors are induced to invest their funds in the firm. As a result, the firm cannot survive in the free enterprise economy. Suppose an insurance company or insurance industry could not yield a rate of return on their equity capital at least equal to the cost of its equity capital. Can the company or the industry continue their business to provide free insurance to the society?

**Estimating the Cost of Equity Capital**

In this section, it is intended to briefly discuss several alternative approaches to estimate the cost of equity capital. This discussion is confined to only those approaches in which the cost of equity capital is estimated in terms of investor's opportunity cost, that is, investor's expected rate of return.

The basic proposition underlying the concept of cost of equity capital is that at any point in time securities are so priced that all securities of equivalent risk offer the same expected rate of return. For a given firm the basic problem is to determine the expected rate of return for the class in which the stock falls. It should
be mentioned at the outset that at the present state of art there is no complete mechanical way to do this. Measurement of expectation is intrinsically difficult. However, in recent years one approach is more preferred to others and it has become widely accepted in the field of finance and economics. This is the so-called capital asset pricing model.

Ex Post Rates of Return to Investors

Averaging of ex post rates of return give some indication of the relevant range in which expectation lies. These averages are most helpful to the extent that they cover a long period of time and many stocks. One cannot very well rely on a short period of history for the specific industry as a guide to investors' expectations for the future. This measure gives insufficient bases for estimating a particular firm's cost of equity capital.

Discounted Cash Flow

The basic premise of this approach is that stock price is the present value, discounted at investors

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expected rate of return, $k$, of the stream of expected dividends. The idea is to infer $k$ from the observed price, $P_o$, and an estimate of what investors expect in the way of future dividends. This method has been used in many cases of testimony.

The basic price formula under discounted case flow method is represented by the following equation:

$$P_o = \frac{\sum_{t=1}^{\infty} d_t}{(1 + k)^t}$$

This formula assumes that $k$ is constant over time. In practice a number of simplification of equation (9) are employed in using the discounted cash flow method. Suppose for example, that the dividend stream is expected to grow indefinitely at some rate $g$ which is less than $k$. Then, the equation (9) can be simplified to

$$P_o = \frac{d_1}{k - g}$$

$$k = \frac{d_1}{P_o} + g$$

For some industries, for which a constant, moderate long-term trend in earnings and dividends is often identifiable, equation (11) can be a reasonable rule of thumb for estimating $k$. A danger is that temporary growth trends are apt to be mechanically projected to infinity. Likewise,
it is tempting to assume without checking that expected future growth is constant. However, there is nothing in equation (9) that requires a single, perpetual growth rate. One can easily assume that different growth rates are anticipated for different periods.

In general, the Discounted Cash Flow model--either equation (11) or some more complicated variant of equation (9)--has to be fit to the case at hand. The point of analysis is to answer the question; what would a rational unbiased investor expect from a long-term investment in this stock at the prevailing price? This rate of return is taken to be k on the assumption that the prevailing price is based on the opportunity of investment in equivalent risk securities.

Earnings-Price Ratios

Earnings-price ratios can be used to measure the cost of equity capital in some cases. There are two cases in which the cost of equity capital is equivalent to earnings-price ratio.\(^4^6\)

The first case is that a firm whose future earning per share are expected to be the same as current earnings

per share and whose dividend-payout ratio is 100%. Under this situation, the valuation model can be expressed as

\[
P_0 = \frac{\sum_{t=1}^{\infty} \frac{E_1}{(1 + k)^t}}{1 + k}
\]  \hspace{1cm} (12)

where \( E_1 \) is the current earnings per share. The equation (12) can be expressed as the equation (13) in the case of perpetuity.

\[
P_0 = \frac{E_1}{k}
\]  \hspace{1cm} (13)

Thus, the cost of equity capital is given by

\[
k = \frac{E_1}{P_0}
\]  \hspace{1cm} (14)

In fact, the equations (13) and (14) are simply equations (10) and (11) but with \( D_1 = E_1 \) and \( g = 0 \). Thus it is said that \( \frac{E_1}{P_0} \) measures the cost of equity capital for "no-growth" firms.

The second case in which the cost of equity capital equals the earnings-price ratio involves an expansion where the firm is able to invest in projects that provide an expected perpetual return of \( k \) on the equity capital. It should be noted that expansion differs from a growth situation in which the firm has investment opportunities that provide an expected return in excess of \( k \) on the equity capital. For growth situation, the earnings-price
ratios underestimate the cost of equity capital.

In summary, the cost of equity capital can be estimated by using earnings-price ratio. However, this method is appropriate only under certain circumstances: 1) future earnings per share are expected to be same as the current earnings and retention ratio is zero; and 2) expansion situation.

Capital Asset Pricing Model

In contrast with the approaches discussed in the above, which try to measure the cost of equity capital from the data pertaining to a company or an industry in question, the capital asset pricing model was developed to estimate the expected rate of return on any assets in the framework of general market equilibrium risk-return relationship.47

The basic postulate underlying finance theory is that assets with the same risk should have the same expected rate of return. That is, the prices of assets in the capital market should adjust until equivalent risk asset have identical expected returns.48

47 The capital asset pricing model was originally developed by Sharpe, Lintner, and Mossin. See W. Sharpe (1964), op. cit., John Lintner (1965), op cit., and Jan Mossin (1966), op. cit.

In finance theory, there have been developed two operational definitions of risk: one is variability of return; and the other is volatility of returns which is a relative index of systematic risk or nondiversifiable risk (beta). Given that the beta measure of risk would appear to be more relevant for the pricing of securities, returns expected by investors should logically be related to systematic risk as opposed to total risk.

Based on the basic premise that securities with higher risk should have higher expected return, the capital asset pricing model shows the equilibrium market risk-return relationship as follows:

\[ E(R_j) = R_f + (E(R_m) - R_f) \cdot \beta_j \]  \hspace{1cm} (15)

or

\[ E(R_j) = R_f + (E(R_m) - R_f) / \sigma_m^2 \cdot \text{Cov}(R_j, R_m) \]  \hspace{1cm} (16)

where

- \( E(R_j) \) = the expected rate of return on asset \( j \)
- \( R_f \) = the risk-free rate of interest
- \( E(R_m) \) = the expected rate of return on the market portfolio
- \( \sigma_m^2 \) = the variance of return on the market portfolio

\[ ^{49} \text{A theoretical development of the capital asset pricing model is presented in Appendix A.} \]
\[ \text{Cov}(R_j, R_m) = \text{the covariance between the return on asset } j \text{ and the return on the market portfolio, and} \]
\[ \beta_j = \text{market beta for asset } j \]
\[ \frac{\text{Cov}(R_j, R_m)}{\sigma_m^2} \]

The equation (16), capital asset pricing model, shows that the expected rate of return on asset \( j \) is equal to the risk-free rate of interest plus a risk premium given by the product of the market risk premium, \( (E(R_m) - R_f)/\sigma_m^2 \), and the risk of the asset \( j \), as measured by the covariance with the return on the market portfolio.

Since the cost of equity capital of a firm is defined as the expected rate of return on the equity capital by investors in the capital market, the capital asset pricing model can be used to estimate the cost of equity capital of a firm.

Three steps are involved in using the capital asset pricing model to estimate a firm's cost of equity capital: 1) estimation of the market risk premium, 2) estimation of the risk-free rate of interest, and 3) estimation of the systematic risk of the equity capital.

In practice, the expected rate of return on market portfolio is surrogated by the mean of the rate of return on some market index, such as Standard & Poor's 500 Stock
Indes, over the sample period. When using the past mean of the rate of return on market index as the expected rate of return on market portfolio, one problem is that the expected rate of return \( E(R_m) \) varies widely depending on the holding period examined. The importance of the base year is reduced if long holding period is used, but using a very long holding period means using possibly irrelevant data.

The expected risk-free rate of interest is also, in practice, inferred from the past record of market rate of interest over the sample period. For practical applications, the short-term government bill rate would appear to be most consistent with the capital asset pricing theory, but this question has not been completely resolved.

The choice of risk-free rate of interest obviously affects the magnitude of the expected rate of return on assets. Therefore, there will be different results in the cost of equity capital, depending upon the choice or risk-free rate of interest. As a general rule, during periods when long-term rates exceed short-term rates, high risk stocks (those with beta coefficient greater than 1.0) will have a higher estimated cost of equity capital if the short-term rates are used as the risk-free rate of interest than if the long-term rates are used. The converse holds for low beta stocks. The difference in the estimated cost of equity capital is not great for stocks with beta close
to 1.0 and no problems arise long and short-term rates are close together.

The systematic risk of equity capital is customarily estimated by the so-called market model which takes the following ordinary least-square regression form:

\[ R_{jt} = \alpha_j + \beta_j R_{mt} + e_{jt} \quad \ldots \ldots \ldots \ldots \quad (17) \]

where

\[ R_{jt} = \frac{D_{jt} + P_{jt} - P_{jt-1}}{P_{jt-1}} \]

\[ P_{jt} = \text{market price per share at end of } t \]
\[ P_{jt-1} = \text{market price per share at beginning of } t \]
\[ D_{jt} = \text{dividend paid per share during } t \]
\[ R_{mt} = \text{realized return on the market portfolio during the period } t, \text{ and} \]
\[ \alpha_j \text{ and } \beta_j = \text{parameters to be estimated} \]

More often than not, the systematic risk is estimated by the following regression equation (18) in order to obtain more reliable estimate of beta by adjusting the fluctuation in market rate of interest over time:

\[ R_{jt} - R_{ft} = \alpha_j + \beta_j (R_{mt} - R_{ft}) + e_{jt} \quad \ldots \ldots \ldots \quad (18) \]

where \( R_{ft} \) is the risk-free rate of interest during the period \( t \).
In this section several important methods of estimating the cost of equity capital is discussed. However, it should be noted that there are many recent attempts to estimate the cost of equity capital via more complicated mathematical tools, such as simulations and econometric models. Such models may improve the accuracy of the estimates and certainly will make the required judgments more explicit. There is much evidence that the cost of capital is estimated via econometric techniques, but the approaches taken are so diverse that it is not discussed here.

**Accounting-Based Estimates of Systematic Risk**

It was shown that in the framework of the capital asset pricing model the equilibrium expected rate of return on a security is linearly related to the systematic risk of the security. The systematic risk is, in general, defined in terms of the covariance of an security's return with the return from the market portfolio. The relationship is often standardized by dividing the covariance by the variance of the return from the market portfolio, and this measure of standardized systematic risk is referred to as beta.

The beta is customarily measured by means of the market model using the market data. This measure of
systematic risk is often called "market beta" or "market-based estimate of systematic risk."

On the other hand, in recent years there have been quite a few attempts to measure the systematic risk based on the accounting data of a firm. These attempts may be justified on the ground that the accounting risk measures can be applied to decision-setting where market determined risk measures are not available. Such situations may include: 1) privately held-firms "going public" for the first time, and multi-division firms with divisions operating on different parts of the risk spectrum.

The purpose of this section is to review the current studies concerning the measurement of systematic risk via accounting-determined risk measures, and to provide for theoretical and empirical background for the modification of the conventional capital asset pricing model attempted in the present study.

Ball and Brown Study

They investigated the association between the market-based estimate and the accounting-determined systematic risk. They computed cross-sectional correlations between

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measures of the comovements in ex post security rates of return and comovements in accounting numbers. Specifically they correlated the following two covariability measures: a) the covariability between a security's return and the market return, measured by the $R^2$ (coefficient of multiple determination) of the market model, and b) the covariability between the firm's accounting income and an index of aggregate income for all firms, measured by the $R^2$ of an accounting market model.

In measuring the covariability between the firm's accounting income and an index of aggregate income for all firms they specified several different accounting market models, using different forms of variables, such as income in levels, income in first differences, and income over total market value of common stock in levels and in first differences. They also used three definitions of income, i.e., operating income, net income, and earnings per share.

From the results of the study they made two tentative conclusions. First, there is a considerable degree of association between accounting and market measures of comovement. Second, of the two alternative forms of expressing the income variable, changes in the income variables appear to be a more appropriate specification than levels for estimating procedures.
This study attempted to explore the relationship between accounting determined and market determined measures of risk. Specifically, the authors investigated associations between various accounting measures of risk suggested in the financial statement analysis and the market-based estimate of systematic risk.

The major purpose of this analysis was to discover the extent to which accounting risk measures are impounded in the market-based estimate of systematic risk, and ultimately to provide an answer to the question of whether or nor accounting risk measures can be useful to the investor in assessing the riskiness of securities, such that he can select portfolio which maximizes his utility.

**Accounting Measures of Risk**

Traditional accounting risk measures are not defined in terms of covariance of return, yet they are supposed to indicate various aspects of the uncertainty associated with the earning's stream of the firm. The accounting risk measures can be viewed as surrogates for the total variability of return of a firm's common equity.

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security. Thus, the accounting risk measures reflect both the systematic and unsystematic risk components. If the systematic and unsystematic components are positively correlated, then it is reasonable to view the accounting risk measures as surrogates for systematic risk as well.

The accounting risk measures considered in the study include: dividend pay-out ratio, growth, leverage, liquidity, asset size, variability of earnings, and covariability of earnings. While the study used the market model to measure the market beta, each of the accounting risk measures was specifically defined in the following manner for each firm:

Dividend Pay-out: It is defined as average payout, as measured by cash dividends divided by earnings available for common stockholders. The rationalization for measuring risk by the dividend payout ratio rests on the phenomenon of dividend stabilization; firms are usually reluctant to change drastically, and in particular to cut dividends, once a certain level has been established. Consequently, firms with a high degree of earnings variability will probably distribute a lower percentage of earnings than more stable firms, in order to avoid the necessity of reducing dividends in rough years. The dividend payout ratio can be viewed as a surrogate for management's
perception of the uncertainty associated with the firm's earnings.

Growth: It is defined as average asset growth, as measured by the annual change in total assets. High growth is sometimes achieved by investing in assets whose riskiness exceeds the firm's previous risk or the industry's average risk. Growth brought about by investment in such above-average risk projects may therefore be associated with higher levels of security risk.

Leverage: It is defined as average leverage, as measured by the ratio of total senior securities to total assets. As debt is introduced, the earning streams of the common stockholders become more volatile. Hence the leverage ratios can be used as a measure of the risk induced by the capital structure.

Liquidity: It is defined as average liquidity, as measured by the ratio of current assets to current liabilities. It can be agreed that liquid assets or current assets have a less volatile than noncurrent assets. Therefore, a high current ratio may be associated with a low level of risk. However, it is not expected that liquidity relationship will have high association with the market determined risk measure because it is believed that the differential riskiness among firms is more explained by the differential riskiness in their noncurrent assets than
it is by the fraction of noncurrent assets they hold.

Asset Size: It is defined as average asset size, as measured by the firm's total assets. It is widely believed that larger firms are less risky than smaller firms. In terms of default risk, the evidence indicates that the belief is a correct one. In terms of portfolio theory, larger firms are less risky than smaller firms only if the average beta of the assets in which they invest is lower than that of the smaller firms.

Variability in Earnings: It is defined as earnings variability, as measured by the standard deviation of the earnings-price ratio.

\[
\text{Earnings Variability} = \left( \frac{1}{T} \sum_{t=1}^{T} \left( \frac{E_t}{P_{t-1}} - \frac{(E/P)_{t-1}}{T} \right)^2 \right)^{1/2}
\]

where

\[
\frac{E_t}{P_{t-1}} = \frac{\text{income available for common stockholders}}{\text{market value of common stock }}
\]

In contrast with the other variables discussed above, which can be viewed as measures that attempt to reflect some aspect of the total variability of the earning's stream, this variable is an explicit measure for earning's variability. This variable is believed to be positively associated with the firm's risk, as measured by the market-based estimate of systematic risk.
Covariability in Earnings: The market beta is the market-based estimate of systematic risk of a security. It is possible to compute an analogous beta value for accounting income by regressing the firm's time series of earnings on an index of average accounting earnings for the economy. This was done by Ball and Brown (1969). The covariability in earnings is defined in the study as accounting beta, and it is measured by the following formula:

\[
\text{Accounting Beta} = \frac{\sum_{t=1}^{T} \left( \frac{E_t}{P_{t-1}} - \frac{E}{P} \right) (M_t - \bar{M})}{\sum_{t=1}^{T} (M_t - \bar{M}) (M_t - \bar{M})}
\]

\[
= \frac{\text{Covar} \left( \frac{E_t}{P_{t-1}}, M_t \right)}{\text{Var} (M_t)}
\]

Addressing themselves to the question of why the study does not solely restrict to the account beta, they gave two reasons for expanding the scope of the study to include the other measures. First, because of the potential inability to separate the systematic and unsystematic risk components, measures of total variability might perform as well as or better than an accounting beta. Second, the other accounting measures are, in fact, used by investors as surrogates for risk. For this reason, it is important to know that a strategy of selecting portfolios
according to the traditional accounting risk measure is equivalent to a strategy that uses the market determined risk measures.

The authors contended, based on some empirical evidence, that a measure of total variability, such as the standard deviation of the earnings-price ratio, might perform as well as or better than the accounting beta. The study showed that the accounting beta has mean values close to one but slightly below one, similar to those of the market determined beta. However, the standard deviation of the accounting measure is almost four times as large as that of the market beta. In fact, about 10 percent of the accounting beta were negative. One reason for the result was believed to be the relatively small number of observations upon which the accounting beta is being computed. The sampling error for such a small number (9 observations) of observations is very large.

Another area for concern is the behavior of \( M_t \), used as the economy-wide measure of earnings-price ratio. It exhibits a strong downward trend over the 19 years studied, and the first order autocorrelation in the series is extremely high. Its counterpart, the market determined, \( R_{mt} \), exhibits not trend nor any serial correlation.

These two factors may result in a reduction of the association between the accounting and market determined beta, especially at the individual security level.
The superiority of performance of the accounting beta, compared to other accounting risk measures, particularly the earning's variability, becomes more suspicious when the stationarity of the accounting risk measures are examined. The stationarity of the accounting risk measures are examined via the cross-sectional correlation coefficients between a given risk measure in period one and that same risk measure in period two. The correlation of the accounting beta is the lowest of the several variables studied. In fact, there appears to be virtual independence between the accounting beta in each of the two periods.

The evidence suggests that the accounting beta may be subject to a large amount of error and that other accounting measures of risk will have to be introduced in searching for correlates with the market risk measure.

Association Between Accounting and Market Risk Measures

To measure the association between accounting and market determined risk measure, they computed cross-sectional correlation coefficients between each of the seven accounting variables and the market beta value for 307 Compustat firms. These correlation coefficients were computed for individual securities as well as for portfolios.

The results of the test indicated that: 1) the sign of all the correlation coefficients are in the
expected direction, 2) the correlation coefficients of four variables—dividend payout ratio, leverage, earning's variability, and the accounting beta—are statistically significant in the test periods, 3) the degree of association is highest for the earnings variability measure, and 4) all correlation coefficients for portfolios are larger than those for individual securities. The high correlation coefficients for the earning's variability measure led the authors to conclude: 52

The evidence indicates that accounting risk variables can be used to select and to rank portfolios such that the ranking has a high degree of correlation with ranking the same portfolios according to the market risk measure. The evidence is consistent with the contention that the accounting risk measures are impounded in the market risk measures.

Forecasting Market Beta with the Accounting Risk Measures

The second stage of the study was concerned with the ability of accounting risk measures to predict market determined risk. Specifically, the analysis concerned itself with the ability of accounting risk measures in

period one (1947-1956) to forecast the market determined risk measure in period two (1957-1975).

The market determined risk in period two was forecasted by means of instrumental variables approach, using the following cross-sectional linear regression equation:

$$b_1 = c_0 + c_1 z_1 + c_2 z_2 + \cdots + c_n z_n + w \ldots \ (19)$$

where \( \hat{b}_1 = b_1 - w \), and it is the forecasted value for the market determined risk in period two.

- \( z_i \) = accounting risk measure \( i \)
- \( w \) = error term, reflecting error in \( b_1 \)
- \( b_1 \) = measure of market determined risk in period one obtained from diagonal market model.

Since there was no well specified procedure for the selection of the instrumental variables, initially all seven accounting risk measures were included in the regression equation. It was found that the inclusion of all seven variables was unnecessary and potentially harmful. There was multicollinearity between the two earning variables, and the partial correlation coefficients for the leverage, liquidity, and size variable were near zero. As a result, the final instrumental equation contained only three
accounting measures—payout, growth, and earnings variability.

The predictions based on the final instrumental equation were compared with a naive no-change forecast (i.e., the value of market determined risk measure in period two will equal that of the first period). Results indicated that the prediction of the market determined risk measure based on accounting risk variables was superior to the naive forecast.

**Implication of the Study**

From the empirical evidence, provided by the study, on the relationship between the market determined and accounting determined risk measures, we can draw several important implications to the study of analysis of firm's risk based on accounting risk measures. First, the evidence that some of the accounting risk measures are highly associated with the market risk measure implies that these accounting risk measures can be used as surrogates for the market risk measure. The fact that accounting risk measures can be used as surrogates for market determined risk measure suggests the possibility that the risk-return analysis for non-traded firms or for division of a firm can be achieved based on accounting risk measure, such that investors as well as the managements of firms or divisions can come up with the same decisions that
might be arrived at based on the market determined risk and return measures.

Second, it was shown that of several accounting risk measures, the two accounting risk measures based on earnings' variables, that is, earnings' variability and covariability of earnings, are most highly correlated with the market determined risk measure. This suggests that in the analysis of firm's risk based on accounting risk measures, the two accounting risk measures should be considered first and must be given much emphasis. However, it was noted in the study that the covariability of earning measure (accounting beta) may be subject to a large amount of measurement error, and that the earnings variability measure might perform as well as or better than the accounting beta.

Finally, the B-K-S study provides an empirical evidence that the instrumental variables approach using accounting risk measures as independent variables can be effectively used to estimate the market determined measure of risk, the market beta. This implies that for publicly traded firms as well as non-traded firms or division of a firm the market determined measure of risk can be estimated based on accounting measures of risk. The usefulness of the instrumental variables approach is more critical to the cases of non-traded firms or division of a firm,
for which market data required for measuring market beta are not available, than the case of publicly traded firms. The instrumental variables approach makes it possible to indirectly estimate the systematic risk of non-traded firms or division of a firm.

It is no doubt that the B-K-S study significantly contributed to the study of firms' risk analysis based on accounting measures of risk. However, it should be pointed out that the two important accounting measures of risk were not derived from pure accounting variables. In determining the earnings variability and accounting beta, they used earnings-price ratio—net income divided by market price of stock—thus, incorporation the market data into the accounting measures of risk. Setting aside the criticism of spurious correlation between the accounting measures of risk and the market measure of risk, the use of earnings-price ratio as the basic variable in determining the accounting measures of risk is inconsistent with one of the basic purposes of the firm's risk analysis based on accounting measures of risk. That is, the earnings-price ratio is simply not available for non-traded firms or division of a firm. Therefore, if one is to analyze the risk of non-traded firms or division of a firm in the framework of instrumental variables approach suggested in the B-K-S study, he has to define the
earnings' variability and the covariability of earnings with only pure accounting variables.

**Gonedes Study**

Gonedes also investigated the association between market-based and accounting-based estimates of systematic risk. In this study attention was given to accounting income numbers and evidence was presented on the correlation between market beta and accounting beta.

The market beta were secured via the market model as the B-K-S study and others did. The accounting beta was obtained from the accounting analogue of the market model proposed by Ball and Brown (1969).

In estimating accounting beta, he used four different forms of expressing income variables, that is, income levels, first differences, scaled income levels, and scaled first differences. For the latter two cases, income was scaled by total asset.

In analyzing the association between market-based and accounting-based estimates of systematic risk, he computed cross-sectional correlation coefficients

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between the estimated coefficients of determination, $R_m^2$, from the market model and the estimated coefficients of determination, $R_a^2$, from the accounting income number models. In addition, he computed cross-sectional correlation coefficients between the estimated regression coefficients from the market model and those from the accounting income number model.

According to the results of his study, he concluded that "there is in general a statistically significant relationship between market-based and accounting-based estimates of systematic risk if the accounting-based estimates of systematic risk are derived from first differences in income numbers or scaled first differences. This finding suggests that accounting income numbers, if appropriately transformed, do reflect a statistically significant amount of the information impounded in market prices of securities (traded on the New York Stock Exchange)."\(^5^4\)

**Gordon and Halpern Study \(^5^5\)**

This study presented an idea to measure the cost of capital for non-traded firms or for division of a

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\(^{54}\) Nicholas J. Gonedes, Ibid., p. 433.

publicly traded firm in the framework of the Sharpe-Lintner capital asset pricing model. As indicated by the authors, despite the considerable controversy on the correct way to measure a firm's cost of capital, one thing all the alternatives have in common is the use of market data in arriving at the measure considered correct. However, the market data required do not exist for non-traded firms or for division of a division of a publicly traded firm.

The major concern of the study was how the systematic risk of non-traded firms or division of a publicly traded firm could be estimated by using non-market data, and how the cost of capital for non-traded firms or for divisions of a firm could be determined by utilizing the systematic risk estimated based on the non-market data.

They contended that once the systematic risk is estimated based on non-market data, it would be possible to establish the yield at which a non-traded firm or division of a firm would sell if it were publicly traded by applying the non-market measure of systematic risk to the capital asset pricing model.

The underlying idea to estimate the yield at which the stock of a non-traded firm would sell if it were publicly traded was to substitute an indirect measure of systematic risk of the non-traded firm into the capital
asset pricing model. The indirect measure of systematic risk for the non-traded firm was secured by the following regression model.

\[ B_j = \alpha_0 + \alpha_1 C_j + e_j \quad \ldots \ldots \ldots \ldots \quad (20) \]

where \( B_j \) = market-based estimated of systematic risk for firm j (market beta for firm j)

\( C_j \) = a statistics based on non-market data for firm j, and it is representing the so-called accounting beta

Under the assumption that \( B_j \) and \( C_j \) is highly correlated, the market beta could be estimated based on accounting beta as in the following estimation equation.

\[ \hat{B}_j = \hat{\alpha}_0 + \hat{\alpha}_1 C_j \quad \ldots \ldots \ldots \ldots \quad (21) \]

Given the assumption that the equation (21) holds also for non-traded firms, the systematic risk for non-traded firms can be estimated by using the relationship as shown in the equation (21).

One of the major tasks in the study was to find a measure of risk based on non-market data with which the market beta is expected to be highly correlated. In the study, they presented \( C_j \) as the non-market measure of
systematic risk and $C_j$ was obtained by the following regression model:

$$g_{jt} = r_j + C_j q_{mt} + w_{jt} \ldots \ldots \ldots \ldots (22)$$

where $g_{jt}$ = rate of growth in earnings per share of firm $j$

$q_{mt}$ = rate of growth in corporate profits of a diversified portfolio of firms in the market

$C_j$ = the parameter to be estimated, and it is called the non-market measure of systematic risk for firm $j$, accounting beta

This idea of measuring accounting beta is in fact the same as those of Ball and Brown (1968), the B-K-S study (1970), and Brealey (1969), which have shown that there is a positive relation between the earnings of a firm and the earnings of the market as a whole. It was contended that the use of earnings, particularly the rate of growth in earnings, as the variable in measuring the accounting beta is a superior way.

The theoretical reasons for believing that the market beta, $B_j$, and the accounting beta, $C_j$, are highly correlated was summarized as follows in the study. If the earnings of a firm grow at a constant rate over time,
the price and the dividend will grow at the same rate. The realized rate of growth in earnings and the realized return on the share will fluctuate over a wide range around their expected values from one period to the next. Changes in the realized return on the share will be accounted for largely by changes in the realized rate of growth in price per share, and it in turn should be highly correlated with change in the rate of growth in earnings. It was also contended that if the rate of growth in earnings and the rate of return on share were correlated on the level of traded firms, they should be correlated for all firms. In that event, $B_j$ and $C_j$ would be correlated, and then, $C_j$ could be used to estimate $B_j$.

In the empirical test in the study, they found that there was a significant positive relationship between $B_j$ and $C_j$. The regression of $B_j$ on $C_j$ produced the following regression coefficients:

$$\hat{B} = .564 + .251 C \quad \ldots \ldots \ldots \ldots \ldots \ldots (23)$$

Using this general relationship between $B$ and $C$, they proceeded to the cost of capital for the mail division of the airline industry in the framework of the capital asset pricing theory model.

The Gordon and Halpern study provided for several important implications to the study of measuring systematic
risk and cost of capital for non-traded firms or for division of a firm. First of all, it suggested that a meaningful estimate of the cost of capital for non-traded firms or division of a firm could be obtained in the framework of the capital asset pricing theory model. Second, the systematic risk for non-traded firms or division of a firm can be estimated through the general relationship between the market beta and the accounting risk measures established for publicly traded firms. The general relationship between the market beta and accounting risk measures established for the traded firms was said to be held for all firms, including non-traded firms and divisions of firms. Third, it was shown that the accounting beta is highly correlated with the market beta, therefore, the accounting beta can be used to estimate the market beta.

In summary the Gordon and Halpern study provides some ideas to measure the systematic risk and the cost of capital for non-traded firms or for divisions of a firm for which the market data required for estimating the systematic risk do not exist. However, it should be noted that the present study will only apply to the structural concept of making association between the market beta and the accounting risk measures in developing a modified capital asset pricing model for property-liability
insurance companies, instead of using the same procedures and techniques as suggested by them.

Other Studies

In addition to the studies discussed above, there is a considerable number of studies in regard to the measurement of systematic risk based on accounting data. Some of the major conclusions from these studies are presented in a summarized manner.

Beaver and Manegold examined the association between market and accounting beta under a variety of specifications. Their primary purpose was to discover how sensitive the association is to the form of the specification. They made the following tentative conclusions. First, there is statistically significant association between market beta and the accounting beta as measured under a variety of specifications. Second, evidence from several aspects of the study suggests that accounting beta contains considerably more error than the market beta. Third, the net income to market value beta appear to produce more explanatory power than do pure accounting beta. The pure accounting beta also exhibit substantial correlation with the market beta.

Breen and Lerner regressed cross-sectional market beta values for several hundred Compustat firms on the following seven financial variables: the debt to equity ratio, the debt to equity ratio squared, a measure of earnings' growth, a measure of the stability of earnings' growth, the size of firm, the dividend payout ratio, and the number of shares traded.  

The regression coefficients of the stability of earnings' growth, size, payout ratio, earnings' growth rate, and the number of shares traded had expected to sign and were statistically significant in the majority of the regressions.

Bildersee correlated the systematic risk of preferred stocks, as measured by the beta values derived from the market model, with some traditional accounting risk measures, such as the current ratio and leverage. The association was generally significant and in the expected direction. When the preferred stocks in the sample were divided into groups of high and low quality, accounting

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measures were found to be strongly associated with the latter group and slightly with the former.

Foster investigated the association between accounting earnings and stock prices of insurance companies. He made separate analysis of sub-earnings of insurance company, i.e., underwriting, investment, and capital gain and losses. Underwriting earnings has the strongest association with stock price changes. The investment showed lower association than underwriting, but the degree of association was still statistically significant. Of the three earnings series, capital gains and losses has statistically less significant association with the stock price changes.

One of the interesting aspects of the study is the fact that the study has decomposed the total earnings number into several sub-earnings series so as to make more effective an analysis of the association between stock prices and the sub-earnings series of insurance companies.

In the process of estimating the systematic risk of insurance companies, Water and Quirin introduced the "internal beta" concept in their recent study.  


The "internal beta" is computed by fitting the following regression:

\[ r_{it} - R_{ft} = a_i + B_i (R_{mt} - R_{ft}) + e_i \ldots (24) \]

where

- \( r_{it} \) = rate of return on the policyholders' surplus of ith company during the year \( t \)
- \( R_{ft} \) = risk-free rate of interest during year \( t \)
- \( R_{mt} \) = rate of return on the market portfolio during year \( t \), and this is based on market data
- \( B_i \) = the "internal beta" to be estimated

The "internal beta" is different from the other accounting beta discussed in the above in that the "internal beta" is estimated by regressing the internal rate of return on the net worth on the return on market portfolio based on market data. They have examined the relationship between internal beta and the market beta elsewhere.\(^{61}\)

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Summary

Various studies reviewed in this section have shown that there is significant association between the market measure of risk and accounting risk measures. Although different studies used different accounting variables in determining accounting risk measures and used different procedures in making associations between these risk measures, it may be generalized that the accounting risk measures derived from properly specified accounting variables can be used as surrogates for market risk measures. It is further noted that the market risk measures can be estimated or predicted based on the accounting risk measures for publicly traded firms as well as non-traded firms.

Of many accounting risk measures, the two accounting risk measures based on earnings variable, i.e., earnings variability and earnings covariability (accounting beta) have been suggested as most appropriate accounting risk measures which can be used as surrogates for market risk measures or can be used to predict or estimate the market risk measures.

In view of the purpose of the present study, the most valuable implication of the previous studies is that
it is possible to analyze the risk of non-traded firms or division of a firm based on pure accounting variables in the same manner as based on the market data if they would be publicly traded, and that the decisions made based on accounting risk measures or on estimated market risk measures via accounting risk measures can be considered essentially equivalent to the decisions based on market-based estimate of systematic risk.
CHAPTER IV

A MODIFIED CAPITAL ASSET PRICING MODEL
AND THE COST OF POLICYHOLDERS' SURPLUS
OF PROPERTY-LIABILITY INSURANCE
COMPANIES

Studies in the Cost of Capital of
Property-Liability Insurance Companies

Very little work has been done in the study of
cost of capital for insurance companies, although several
studies have been reported in recent years. This sec­
tion will review two recent studies which have analyzed
the cost of capital of property-liability insurance com­
panies in the framework of the capital asset pricing
model.

Haugen and Kroncke (1971) investigated the effect
of financing by selling insurance on the propriety of the

62 R. Haugen and C. Kroncke, "Rate Regulation and
the Cost of Capital in the Insurance Industry," Journal
of Financial and Quantitative Analysis (December 1971);
Quirin and Waters (1975), op. cit.; J. J. Launie, "The
Cost of Capital of Insurance Companies," Journal of Risk
and Insurance (June 1971).
rate of return to equity capital of insurance companies and analyzed the risk-return relationship of the equity capital under insurance regulatory environment in the framework of the capital asset pricing model.

An insurance company was regarded in their study as a financial intermediary whose main activities are:
1) to generate funds by means of selling insurance, and
2) to invest the funds as well as its equity capital.
Therefore, the rate of return to equity capital depends on the return on investment and the cost of funds financed by selling insurance.

If the underwriting profit is zero, then the rate of cost funds attracted is zero. If the underwriting profit is greater than zero, the rate of cost of the funds generated by selling insurance is negative. The investment opportunity of insurance companies is represented by the capital market line.

Given the above conditions, they developed the following relationship in order to explain how the underwriting and investment activities of an insurance company affect the rate of return on its equity capital.

\[ E(r'_j) = aE(r_j) + (1 - a)E(r_e) \]  

(25)

where \[ E(r'_j) = \] the expected rate of return on equity capital of insurance company \( j \)
$E(r_j) = \text{the expected rate of return on investment in asset } j$

$E(r_e) = \text{the expected rate of cost of the portfolio of insurance policies it sells}$

$a = \text{the proportion of equity capital invested in asset } j$

$(1 - a) = \text{the position in insurance portfolio } e$

The above relationship implies that if $E(r_j) > E(r_e)$, then $E(r'_j) > E(r_j)$. This means simply that an insurance company can give higher rates of return to the equity holders by leveraging through selling insurance, if the expected rate of cost for funds generate by selling insurance is less than the expected rate of return on investment.

As to the determination of the cost of equity capital (the required rate of return on equity capital), they suggested that it may be determined based on equilibrium risk-return relationship in the framework of the capital asset pricing model, and that the risk associated with both underwriting investment activities must be reflected together in the process of estimating the required rate of return.

The degree of risk of the levered equity capital was measured by the covariance of the rate of return on the levered equity capital with the return on the market
portfolio. They established the following formula to measure the covariance:

$$\text{Cov}(j',p) = a \text{Cov}(j,p) + (1-a)\text{Cov}(e,p). \quad (26)$$

where

- $\text{Cov}(j',p) =$ covariance of rate of return on the levered equity capital of insurance company $j$ with the return on the market portfolio
- $\text{Cov}(j,p) =$ covariance of rate of return on investment in capital asset $j$ with the return on the market portfolio, and
- $\text{Cov}(e,p) =$ covariance of rate of cost for insurance policies with the return on market portfolio.

Then it was shown that the required rate of return on the equity capital was the expected rate of return corresponding the risk of the equity capital as measured by the covariance, $\text{Cov}(j',p)$.

The major contributions of this article to the study of the cost of equity capital of insurance companies may be summarized as follows. First, both investment and underwriting risks of insurers are jointly considered in assessing the propriety of the rate of return on equity capital. Second, the required rate of return on the
equity capital (cost of equity capital) of insurance companies is analyzed in the framework of the capital asset pricing model. Finally, the method of measuring the covariance may be used in case of absence of market data.

The major drawback of this article may be the simple analogy between the cash flow of premium income by selling insurance and money-borrowing by issuing bonds. The nature of property-liability insurance companies' operations including underwriting and investment activities are not so simple that the rate of return on equity capital can be expressed as their formula, that is, $E(r_j') = aE(r_j) + (1-a)E(r_e)$, even on a simplified theoretical basis. Therefore, it is also doubt that the formula for covariance term is appropriate to measure the risk of the equity capital of property-liability insurance companies.

Another paper to be reviewed is a study recently reported by Quirin and Waters. In this study, they were primarily concerned with the question of what allowance, if any, should be incorporated for underwriting profits in setting rates for property-liability insurance. They indicated that the answer to the question is dependent upon evaluation of the cost of capital to the insurers.

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63 | Quirin and Water (1975), op. cit.
In discussing the cost of capital of an insurance company, the capital structure was assumed to consist of debt and equity, and the debt consists of unearned premium reserve and loss reserve. In conjunction with the question of underwriting profit allowance, their analysis was focused on the cost of the funds generated by selling insurance. Associated with the cost of the funds, they were concerned about a variable called underwriting profit, rather than cost of the funds. They considered that the cost of the funds was negative as long as underwriting profits were positive.

In order to analyze the effects of positive underwriting returns on the risk-return relationship of insurance companies in the framework of the capital asset pricing model, they developed formulae for expected rate of return on policyholders' surplus and its standard deviation.

\[ \bar{R}_k = R_i + (\bar{R}_u + R_i) \frac{P}{K} + (\bar{R}_m - R_i) \frac{S}{K} \]  \hspace{1cm} (27)

\[ \sigma_k = \left( \sigma_u^2 \frac{P}{K} \right)^2 + \sigma_m^2 \left( \frac{S}{K} \right)^{\frac{1}{2}} \]  \hspace{1cm} (28)

where

\( P = \) premium written

\( S = \) average investment in stock during the planning period
\( K = \text{policyholders' surplus} \)

\( R_u = \text{underwriting profit margin} \)

\( R_i = \text{rate of return on bond investment} \)

\( R_m = \text{rate of return on stock portfolio} \)

\( R_k = \text{rate of return on policyholders' surplus} \)

Using the above two formulae, they computed values of expected rate of return (\( \bar{R}_k \)) and risk (\( \sigma_k \)) for various alternative combinations of "Insurance exposure," (\( P/K \)), and "investment leverage," (\( S/K \)). The risk-return points obtained in the above were plotted on the risk-return space against the capital market line. The results indicated that an insurance company, given that underwriting profit is positive, is able to earn higher rate of return than the competitive rate of return shown by the capital market line by increasing the "insurance exposure," (\( P/K \)), ceteris paribus. It was indicated that an insurance company is able to achieve these positions by borrowing at a negative interest rate, corresponding to a positive value of underwriting profit (\( R_u \)). If the underwriting profit was equal to the negative of the risk free rate of interest, then an insurance company could earn only the competitive market rate of return on its policyholders' surplus.

Under the assumption that the underwriting income is uncorrelated with outcomes on the market portfolio,
that is, free of systematic risk, they concluded that the cost of funds generated by selling insurance should be equivalent to return on a risk free asset.

**Justification for Modifying the Capital Asset Pricing Model**

In the present study, the conventional capital asset pricing model is utilized to estimate the cost of policyholders' surplus of property-liability insurance companies for the purpose of rate regulation of property-liability insurance. In practical application of the conventional model for the purpose of estimating the cost of policyholders' surplus of property-liability insurance companies, the conventional model has to be modified on the following two specific reasons.

**Unavailability of Market Data**

When the conventional capital asset pricing model is used to estimate the cost of equity capital of a firm (required rate of return on equity capital), the systematic risk of the firm is measured customarily based on the market data. The method of measuring systematic risk based on the market data is not practically applicable to certain cases where the market data do not exist.
This technical problem in measuring systematic risk is particularly serious in the property-liability insurance industry. A method of measuring systematic risk based on other than market data has to be developed for the following cases: 1) stock property-liability insurance companies wholly owned by large conglomerates or holding companies, 2) stock property-liability insurance companies which are privately held and whose stocks are not traded in the open market, 3) property-liability divisions of all-line insurers, 4) individual property-liability lines of multiple-line insurers, and 5) mutual property-liability insurance companies.

If rates of property-liability insurance are to be regulated on the basis of the cost of policyholders' surplus, there should be a uniform method of measuring systematic risk based on other than market data, which is applicable to every case mentioned above.

Unique Nature of Operations of Property-Liability Insurance Business

Another reason to modify the conventional model is related to the unique nature of operations of property-liability insurance business. The major operations of any property-liability insurance companies consist of underwriting and investment operations. These two operations are so distinct of each other in their nature that
if one is to properly analyze the cost of policyholders' surplus of property-liability insurance companies, he must reflect the risks associated with these operations jointly and explicitly. The rate regulation model to be developed in the present study will be developed in such a way that rates are ultimately determined based on the cost of policyholders' surplus, which is in turn determined based on the risk-return relationship in the framework of the capital asset pricing model. Since the cost of policyholders' surplus (the required rate of return on the policyholders' surplus) is affected by both underwriting risk and investment risk, it is necessary to analyze the effect of each risk on the risk of policyholders' surplus and accordingly on the cost of policyholders' surplus.

Expressed otherwise, even if the risk associated with underwriting operation is the same for two companies, the prices of insurances offered by these companies may be different if the risk associated with investment activities is different from each other. Therefore, regulators would like to analyze how the risks associated with each operation affects the ultimate prices of insurance sold by each company. In other words, in the framework of the rate regulation model to be developed in the present study, regulators have to properly evaluate the relationship between the price and the cost of policyholders' surplus,
and the relationship between the cost of policyholders' surplus and the risks associated with underwriting and investment activities in order to justify their approval for the proposed rates.

In the conventional capital asset pricing model, the systematic risk of equity capital is estimated based on the characteristics of the ultimate return on the equity capital without taking into account the relative contribution of component operations of a firm to the return on the equity capital. Therefore, the conventional model has to be modified in order to explicitly incorporate the investment and underwriting risks into the model.

In sum, the conventional model is to be modified so that the modified model may be used in the case of absence of the market data and it may explicitly and jointly incorporate the risks associated with underwriting and investment operation of property-liability insurance companies.

Development of a Modified Capital Asset Pricing Model for Property-Liability Insurance Companies

The purpose of this section is to develop a modified capital asset pricing model for property-liability insurance companies. The modified model to be developed
has the following two features: 1) it can be applicable to the cases where the market data do not exist; and 2) it would incorporate jointly and explicitly the risks associated with underwriting and investment operations.

The Conventional Model and Measurement of Systematic Risk

The conventional capital asset pricing model developed by Sharpe, Lintner, and Mossin is expressed as

\[
E(R_j) = R_f + (E(R_m) - R_f) \cdot B_j \quad \ldots \quad (29)
\]

or

\[
E(R_j) = R_f + \left[ \frac{(E(R_m) - R_f)}{\sigma_m^2} \right] \cdot \text{Cov}(R_j, R_m) \quad \ldots \quad (30)
\]

where

- \( E(R_j) \) = the equilibrium expected rate of return on equity capital of firm \( j \)
- \( R_f \) = the risk-free rate of interest
- \( E(R_m) \) = the expected rate of return on market portfolio,
- \( B_j \) = the index of market-based estimate of systematic risk of equity capital of firm \( j \)
- \( \text{Cov}(R_j, R_m) \) = the covariance between the rate of return on equity capital of firm \( j \) and the rate of return on market portfolio.
\[ \sigma_m^2 = \text{the variance of return on market portfolio} \]

The equilibrium expected rate of return on equity capital of firm \( j \) (required rate of return on equity capital of firm \( j \)) is equal to the risk-free rate of interest plus its risk premium, as measured by the product of the market price of risk and the risk of equity capital of firm \( j \) which is represented by the market beta \((B_j)\) or the covariance term, \( \text{Cov}(R_j,R_m) \).

The systematic risk of equity capital of firm \( j \), \( B_j \) or \( \text{Cov}(R_j,R_m) \) is estimated customarily based on the market data. As discussed in the above, the method of measuring the systematic risk based on market data is of limited use in the cases where the market data do not exist. Therefore, a method has to be developed to estimate the systematic risk of non-traded firms or division of a firm.

Estimation of Systematic Risk Via Accounting Determined Risk Measures

One of the major steps in developing a modified capital asset pricing model in the present study is to solve the problem of unavailability of the market data in measuring the systematic risk for non-traded property-liability division of all-line insurers, and various line of insurance business.
It has been shown in Chapter III that various accounting risk measures can be properly used as surrogate for the systematic risk, and that the systematic risk can be appropriately estimated by means of instrumental variables approach using accounting risk measures as independent variables.

The instrumental variables approach states that although the market risk measure, the market beta, for non-traded firms or division of a firm cannot be directly observable, it can be indirectly estimated by means of instrumental equation which is formulated based on the general association between the market risk measure and instrumental variables for publicly traded firms.

The general association between the market risk measures and accounting risk measures (instrumental variables) can be established from the following cross-sectional linear regression model:

$$B_j = a_0 + a_1z_{1j} + a_2z_{2j} \ldots + a_nz_{nj} + e.$$ (31)

where $B_j$ = the market risk measure (market beta) for company $j$, obtained from the market model

$z_i$ = accounting risk measures $i$ for company $i$

$a_i$ = parameters to be estimated, and

$e$ = residual term
Under the assumption that the instrumental equation shown by equation (32) is statistically significant, the market risk measure (market beta) for publicly traded firms can be estimated with only accounting risk measures.

$$\hat{B}_j = \hat{a}_0 + \hat{a}_1 z_{1j} + \hat{a}_2 z_{2j} \ldots + \hat{a}_n z_{nj} \ldots \ldots \ldots \ldots \ldots \ldots (32)$$

The general relationship between the market beta and the accounting risk measures for publicly traded firms, as shown in equation (32), can be applied to the estimation of the systematic risk for non-traded firms, and the systematic risk obtained in this manner can be considered essentially equivalent to the market beta of non-traded firms if they would be publicly traded.

The structural concept of instrumental variables approach enables us to estimate the systematic risk for non-traded firms with only access to the accounting risk measures.

A. Accounting Determined Risk Measures

Even though there are various types of accounting risk measures which appeared in the financial statement analysis literature, the present study initially considered two accounting risk measures which are derived from accounting earnings variables, specifically, variability
of earnings and covariability of earnings. Although other accounting risk measures can be reviewed as measures that attempt to reflect some aspect of firm's risk, it would be more reasonable and appropriate to use explicit measures of firm's risk in an attempt to make general association between the market beta and the accounting risk measures.

The variability in accounting earnings can be viewed as surrogate for total variability of return of a firm's common equity securities. Thus, it reflects both the systematic and unsystematic risk of equity securities. If the systematic and unsystematic risks are positively correlated, then it is reasonable to view the measure of variability in accounting earnings as surrogate for systematic risk as well.

If the market beta, $B_j$, is being used as the market determined concept of risk, then the most direct approach would be to make general association between the market beta and the accounting determined beta, that is, accounting beta. The accounting beta can be derived in a similar manner to the market beta--that is, from a time series regression with some kind of firm's accounting earnings variable as the dependent variable and some economy-wide average of accounting earnings variable of all the companies in the market at the independent variable. Since previous studies, such as, Ball and Brown (1969),
the B-K-S study (1970), Gonedes study (1973), and the B-M (1975), showed that there is significant association between the market beta and the accounting beta, it would be reasonable to choose the accounting beta as one of accounting risk measures in the analysis.

The two accounting determined risk measures are defined in the following manner for each firm.

**Earnings Variability**

The earnings variability of each property-liability insurance company is defined as the standard deviation of net income before tax over policyholders' surplus, and it is given by

\[
S_j = \left( \frac{1}{T} \sum_{t=1}^{T} (\frac{NI_t}{ps_{t-1}} - \frac{NI}{ps})^2 \right)^{1/2} \quad \ldots \ldots \quad (33)
\]

where

- \( S_j \) = earnings variability for firm \( j \)
- \( NI_t \) = net income before federal income tax during period \( t \), and this consists of underwriting income and investment income
- \( ps_{t-1} \) = the amount of policyholders' surplus at end of period \( t-1 \)

\[
\left( \frac{NI}{ps} \right) = \frac{1}{T} \sum_{t=1}^{T} \frac{NI_t}{ps_{t-1}}/T
\]
The term, \( NI_t / ps_{t-1} \), can be viewed as a measure of rate of return on policyholders' surplus, and it would be essentially the counterpart of the market rate of return on equity capital. It is theoretically reasonable to assume that the variability in the rate of return on policyholders' surplus would be reflected in the variability of market rate of return on equity capital. This implies that there must be some relationship between the variability in the rate of return on policyholders' surplus and the variability in the market rate of return on equity capital, and accordingly, with the market determined systematic risk of equity capital.

Covariability of Earnings: Accounting Beta

The covariability of earnings (accounting beta) for each firm is defined as the regression coefficient of the following regression model.

\[
A_{jt} = a_j + b_j M_t + u_j \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad (34)
\]

where

- \( A_{jt} = NI_t / ps_{t-1} \), it is rate of return on policyholders' surplus
- \( M_t \) = the market index of accounting rate of return on net worth, calculated as an average of the rate of return on net worth in year \( t \) of all firms in the market
\[ M_t = \left( \frac{\sum_{j=1}^{N} \text{EBIT}_{jt}/\text{NW}_{jt-1}}{N} \right) / N \]

where

\( \text{EBIT}_{jt} \) = earnings before income tax for firm \( j \) during period \( t \)

\( \text{NW}_{jt-1} \) = net worth for firm \( j \) at end of period \( t-1 \)

\( N \) = number of Compustat firms for which earnings and net worth data are available for year \( t \)

\( b_j \) = the regression coefficient to be estimated, and it is called accounting beta

\( a_j \) = intercept term, and

\( u_j \) = residual term

This method of estimating accounting beta is equivalent to estimating the market beta from the market model. Therefore, the accounting beta can be viewed as the counterpart of the market beta. It is expected that there must be some relationship between the accounting beta and the market beta.

One of the reasons for including only two accounting determined risk measures, namely, earnings variability and covariability of earnings, excluding all other types of accounting determined risk measures, in the present
study lies in the fact that in the present study the author ultimately attempts to explicitly incorporate the risks associated with underwriting and investment operation of property-liability insurance companies into the conventional capital asset pricing model. In order to achieve this purpose, the market beta should be estimated via either earnings variability or covariability of earnings. In addition, since earnings variability and covariability of earnings are viewed as explicit measures of firm's risk in terms of its earnings stream, it would be reasonable to expect that the earnings-based accounting risk measures have higher association with the market determined risk measure than other types of accounting determined risk measures.

B. General Association Between Market Beta and Accounting Determined Risk Measures

The next step required in the process of estimating the market beta via accounting determined risk measures is to establish general association between the market beta and the accounting determined risk measures. Initially, the following three cross-sectional regressional models were considered:
\[ B_j = r_o + r_1 S_j + r_2 b_j + u_j \]  \hspace{1cm} (35)  \\
\[ B_j = a_o + a_1 S_j + e_j \]  \hspace{1cm} (36)  \\
\[ B_j = c_o + c_1 b_j + w_j \]  \hspace{1cm} (37)

where \( B_j \) = market beta for firm \( j \), and it was obtained from the following market model:

\[
\frac{p_{jt} + d_{jt}}{p_{jt-1}} = a_j + B_j \cdot \ln(I_t) + u_j \]  \hspace{1cm} (38)

where

\( p_{jt} \) = market price of \( j \)th firm's common stock at time \( t \) (adjusted capital change)  \\
\( d_{jt} \) = dividend payment on \( j \)th security at time \( t \)  \\
\( I_t \) = the price relative of a representative market index (S&P 500 stock price index) at time \( t \) (adjusted for dividend and capital changes)  \\
\( S_j \) = earnings variability of firm \( j \), and it was defined in the above,  \\
\( b_j \) = covariability of earnings for firm \( j \), and it was also defined in the above
The model (35) is a multiple regression model with the market beta as dependent variable and earnings variability and covariability of earnings as independent variables. The models (36) and (37) are simple regression models with earnings' variability and covariability of earnings as independent variables, respectively.

In a pilot study, an examination of regression statistics for the model (35) indicated that the inclusion of the two variables was unnecessary and potentially harmful. The partial correlation coefficient for the covariability of earnings was not significant at all. In fact, the standard error of the estimate increased when the covariability of earnings was added. The regression statistics for the model (37) also indicated that the correlation coefficient and the slope coefficient were not significant at any level of significance. In other words, it was revealed that there was not any significant association between the market beta and the accounting beta.

It was very surprising that the regression analysis showed no significant relationship between the market beta and the accounting beta. However, an examination of the accounting betas obtained for the sample companies gave some explanation about the result. About 35% of the accounting betas estimated were negative, while none of
market beta was negative. Furthermore, more than 70% of the "t" values for the accounting betas were not significant at any level of significance. It may imply that the accounting beta cannot efficiently estimate the true systematic risk of firms.

One reason may be due to the unique nature of operation of property-liability insurance industry. The rate of return on the policyholders surplus for each company had been in general downward, while the market index of the rate of return on net worth had been upward over the 20 years studies. This phenomenon may be explained by the fact that during the past five to ten years, most of property-liability insurance companies experienced bad underwriting results and their income from investment activities has been generally shrunk due to capital loss in their investment.

On the other hand, the regression statistics for the model (36) showed that the correlation coefficient and the slope coefficient were significant at the level of .01 significance. This indicated that there was significant relationship between the market beta and the accounting earnings' variability.

As a result, the final instrumental equation which will be used to estimate the market beta includes only the earnings variability as the independent variable.
The final instrumental equation for estimating the market beta is given by

\[ \hat{\beta}_j = \hat{\alpha}_0 + \hat{\alpha}_1 S_j \]

where \( \hat{\beta}_j \) = market beta estimated via earnings variability

\( S_j \) = accounting earnings' variability of firm \( j \)

This general relationship between the market beta and the accounting earnings variability will be applied to estimate the accounting-based estimate of market beta for non-traded firms or division of a firm.

Formulation of a Modified Capital Asset Pricing Model for Property-Liability Insurance Companies

For the purpose of estimating the market beta via the accounting determined risk measure, i.e., earnings variability, an instrumental equation has been developed in the above. This instrumental equation enables us to formulate a modified capital asset pricing model which can be used to estimate the required rate of return on equity capital of firms or division of a firm for which the market data do not exist. Furthermore, the instrumental equation also makes it possible to formulate a modified
capital asset pricing model in which the risks associated with underwriting and investment activities of property-liability insurance companies are explicitly incorporated. This section formulates a modified capital asset pricing model which is not only useful for non-traded firms or division of a firm, but also explicitly incorporate the underwriting and investment risks of property-liability insurance companies.

In addition to the assumptions employed in the process of developing the conventional capital asset pricing model, the following assumptions are also made:

1. The planning period of property-liability insurance companies is one-year horizon.
2. All insurance premiums are paid at the inception of each policy.
3. All claims mature during the planning period and are payable at the end.
4. Federal corporation income tax is not considered.
5. Senior securities are not used as the source of capital.

Theoretical Model for Earnings Variability of Property-Liability Insurance Companies

Given the above assumptions and another assumption that the major sources of earnings for property-liability
insurance companies are underwriting earnings and investment earnings, one period total earnings for the companies is given by

$$\text{TE}_t = \text{UE}_t + \text{IE}_t \quad \ldots \ldots \ldots \ldots \quad (39)$$

where

- $\text{TE}_t = \text{total earnings during period } t$
- $\text{UE}_t = \text{earnings from underwriting operation during period } t$
- $\text{IE}_t = \text{earnings from investment operation during period } t$, and this includes net investment income and capital (realized and unrealized) gains or losses

The unexpected underwriting earnings at time $t$ is given by

$$\overline{\text{UE}}_t = (1 - \overline{LR}) \cdot P_t \quad \ldots \ldots \ldots \ldots \quad (40)$$

where

- $\overline{LR} = \text{expected combined loss and expense ratio, and}$
- $P_t = \text{premium written during period } t$

The expected investment earnings at time $t$ is given by

$$\overline{\text{IE}}_t = E(I_p) \cdot F_t \quad \ldots \ldots \ldots \ldots \quad (41)$$

where

- $E(I_p) = \text{expected rate of return on investment portfolio of a firm}$
\[ E(I_p) = \sum_{i=1}^{n} x_i \cdot r_i \quad i = 1,2,3 \ldots n \]

where \( x_i \) = the proportion of funds invested in asset \( i \) to total investable funds \( (F) \)

\( r_i \) = the expected rate of return on investment in asset \( i \)

\( F_t \) = total investable funds at time \( t \), and this includes unearned premium reserve, loss reserve and policyholders' surplus

Given the above definitions, the expected rate of return on policyholders' surplus can be given by

\[ \bar{R}_{ps} = \frac{(1 - LR) \cdot P + E(I_p) \cdot F}{ps} \quad \ldots \ldots \ldots \quad (42) \]

where \( \bar{R}_{ps} \) = expected rate of return on policyholders' surplus, and

\( ps \) = the amount of policyholders' surplus

Based on the formula for expected rate of return on policyholders' surplus shown in equation (42), the standard deviation of return on policyholders' surplus (earnings variability) can be given by
\[ S = \left\{ \sigma^2_{(1-LR)} \cdot \left( \frac{P}{ps} \right)^2 + \sigma^2_{(I_p)} \cdot \left( \frac{F}{ps} \right)^2 \right\} \]

\[ + 2 \left( \frac{P}{ps} \right) \left( \frac{F}{ps} \right) \cdot \text{Cov}[(1-LR) (I_p)] \right\}^{\frac{1}{2}} \]

Under the assumption that the covariance between the underwriting profit margin, \((1 - LR)\), and the return on investment portfolio, \((I_p)\), is zero, the standard deviation of return on policyholders' surplus can be given by

\[ S = \left\{ \sigma^2_{(1-LR)} \cdot \left( \frac{P}{ps} \right)^2 + \sigma^2_{(I_p)} \cdot \left( \frac{F}{ps} \right)^2 \right\}^{\frac{1}{2}} \]

where

\[ \sigma^2_{(1-LR)} = \text{variance of underwriting profit margin} \]

\[ \sigma^2_{(I_p)} = \text{variance of the rate of return on investment portfolio} \]

A Modified Capital Asset Pricing Model for Property-Liability Insurance Companies

Since the market beta estimated via earnings variability, \(\hat{B}_j\), can be used as surrogate for the market beta, \(B_j\), \(B_j\) in the conventional model can be replaced by \(\hat{B}_j\). By replacing \(B_j\) in the conventional model
with $\hat{B}_j$, the conventional model takes the following form:

$$E(R_j) = R_f + (E(R_m) - R_f) \cdot \hat{B}_j \quad \ldots \ldots \ldots \ (45)$$

By substituting equation (38) for $\hat{B}_j$ in equation (45) the equation (45) takes the following form:

$$E(R_j) = R_f + (E(R_m) - R_f) \cdot (\hat{a}_o + \hat{a}_1 S_j) \quad \ldots \ldots \ldots \ (46)$$

The symbol $S_j$ in equation (46) represents the standard deviation of rate of return on policyholders' surplus. Therefore, by replacing the right-hand side of equation (44) the final form of the modified capital asset pricing model can be given by

$$E(R_j) = R_f + (E(R_m) - R_f) \cdot \left\{ \hat{a}_o + \hat{a}_1 \sigma^2 (1 - LR)_j \cdot \right.$$

$$
\left. \left( \frac{P}{ps} \right)_j^2 + \sigma^2 \right( \frac{I_p}{ps} \right)_j^2 \cdot \left( \frac{F}{ps} \right)_j^{2 \frac{1}{2}} \right\} \quad \ldots \ldots \ldots \ldots \ (47)$$

The above modified capital asset pricing model not only incorporates the risks associated with underwriting and investment operations of property-liability insurance companies jointly and explicitly, but also it can be useful to estimate the required rate of return on policyholders' surplus for non-traded firms or division of a firm, for all the variables required for estimation of the systematic
risk are accounting variables. The underwriting risk is accounted for by the term \( \sigma^2_{(1-LR)} \cdot (P/ps)^2 \), and the term \( \sigma^2_{(I_p)} \cdot (F/ps)^2 \) indicates the risk associated with investment operation.

**Summary and Conclusion**

Since the development of the conventional capital asset pricing model the discussion of its practical application in regard to determination of cost of capital has been by and large confined to publicly traded firms for which the market data required to estimate the systematic risk are available. This mainly attributed to the fact that the systematic risk has been customarily obtained based on the market data. Therefore, the usefulness of the capital asset pricing model in determining the cost of capital for non-traded firms or division of a firm has been very restricted. The property-liability insurance industry has been one of the major victims of this phenomena.

The modified capital asset pricing model developed here is supposed to solve the problem related to unavailability of the market data, and to provide for an appropriate model to determine the cost of policyholders' surplus of property-liability insurance companies in the framework of the modern capital market theory.
There has been very little study concerning the cost of capital for property-liability insurance companies, particularly in the framework of the capital asset pricing theory. As a result, the management of the property-liability insurance companies has not utilized the concept of cost of capital derived from the modern capital market theory in decision-making processes for financing, capital budgeting, investment and pricing products.

With the modified capital asset pricing model available the management can determine the cost of policyholders' surplus in the framework of the modern capital market theory. Consequently, their decisions to be made based on the cost of policyholders' surplus obtained from the modified capital asset pricing model will be more rational and consistent with the modern finance theory.

On the one hand, in the framework of the modified capital market theory the cost of policyholders' surplus is determined in such a way that it explicitly and jointly reflects the risks associated with underwriting and investment activities. This implies that the management of property-liability insurance companies can analyze the direct effects of their policies concerning underwriting and investment operations upon the risk of the policyholders' surplus and upon its cost. Therefore, from the standpoint of the management the cost of policyholders'
surplus determined by the modified capital asset pricing model carries more meaning than those determined otherwise. The ability to analyze the relationship between the cost of policyholders' surplus and the risks associated with underwriting and investment activities in direct manner make it possible that the management can effectively utilize the cost of policyholders' surplus in making operational decisions as to underwriting and investment.

The modified capital asset pricing model also suggests an important implication to a rate regulatory system in which rates are ultimately determined based on the cost of policyholders' surplus. But for the modified capital asset pricing model, such a rate regulatory system might not be practically workable. In the next chapter, there will be developed a regulation model which is based on the concept of cost of policyholders' surplus derived from the modified capital asset pricing model.
CHAPTER V

DEVELOPMENT OF A RATE REGULATION MODEL

The major objective of this Chapter is to develop a rate regulation model for property-liability insurance. The model to be developed may belong to the category of the new approach in which ratemaking method or rate regulation model is devised in such a way that underwriting risk is properly recognized and investment income as well as risk associated with investment activities are adequately reflected.

Basic Premises of the Model

The model to be developed here is founded on the following two premises:

1. The purpose of rate regulation is to guarantee that no more or no less than "fair rate of return" on the policyholders' surplus (the cost of policyholders' surplus) necessary to conduct properly the property-liability insurance business will be reflected in premium level. Expressed otherwise, the essential aims of rate regulation are: 1) to prevent the insurance industry from extracting an
excess economic profit from public by virtue of its legal right to function as ratemaking coalition; 2) to prevent the insurance industry from suffering lack of capital supply from the capital market because of inadequate profitability; and 3) to prevent insurance companies from becoming insolvent as a result of cut-throat competition in price.

The first premise is related to the concept of "fair rate of return" which is essentially equivalent to the concept of cost of equity capital. The concept of "fair rate of return" is well established in economics and finance theory.

Rational men are generally risk-averse. Given the choice between the two situations with equal expected return, a rational man would generally choose that situation which offers a smaller risk. In the modern capital market theory, the equilibrium expected rate of return on an asset is positively related to risk. The expected rate of return on assets with same risks should be the same. Expressed otherwise, the required rate of return on equity capital of a firm should not be less than the rate of return on other investments having corresponding risks. Unless otherwise, the firm cannot attract capital and is unable to survive to provide goods, or services, to the society in a competitive capital market.
The "fair rate of return" is understood in terms of competitive standard, and it is the return that would be determined in the framework of general equilibrium market risk-return relationship.

This concept has been applied to the regulation of utility rates. The accepted legal principle is that "the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks," and sufficient to "attract capital" and maintain credit worthiness.

2. The major sources of earnings for property-liability insurance companies are earnings from underwriting and investment operations. If one is to regulate rate of property-liability insurance on the basis of the fair rate of return concept, he has to consider total income for property-liability insurance companies in generating rate of return on policyholders' surplus.

In other words, the residual income for equity holders of property-liability insurance companies is the result of total performance of firms. The residual income depends not only on underwriting performance, but also on investment performance. Therefore, the rate of return on policyholders' surplus should be calculated based on the total income, that is, sum of underwriting income and
investment income. The rate of return calculated in this manner is called total rate of return.

If a rate regulation model is to be developed on the above two premises, the following basic questions must be answered: 1) How should risk of a firm be measured? 2) How would risks associated with underwriting and investment operations affect the risk of a firm? 3) How should risks in various lines of insurance be measured? 4) How should fair rate of return (the cost of policyholders' surplus) be measured?

Definition of "Reasonableness" of Rates

As presented earlier in the present study, most state insurance codes generally provide that rate shall not be excessive or inadequate. However, with few exceptions, the state legislatures have not defined the terms "excessive" and "inadequate" in promulgating rate regulatory statutes. Consequently, the final regulatory decision on "reasonableness" of rates rests on the subjective judgments of the insurance commissioners.

The inability to provide for clear-cut objective definitions of the statutory rate standards was in part due to the fact that a proper theory has not been developed in the area of ratemaking and rate regulation.
In line with the basic premises of the rate regulation model mentioned above, "reasonableness" of rates are defined in the present study based on the concepts of fair rate of return and total rate of return. That is,

Rates are reasonable (adequate but inexcessive) when rates are expected to produce the rate of return on policyholders' surplus equal to the fair rate of return on policyholders' surplus.

This definition is to be implemented in the regulation model to be developed here. This definition provides an objective and clear-cut meaning of rate standards.

Theoretical Background of the Model

The rate regulation model developed in this study involves several input variable which are determined on theoretical bases. This section presents and discusses the theories on the basis of which the input variables are determined.

Determination of Fair Rate of Return and Its Relationship with Risks Associated with Underwriting and Investment Operations

In the present study, the operational meaning of the fair rate of return on policyholders' surplus is the cost of policyholders' surplus and the latter means the
required rate of return on policyholders' surplus determined in the framework of general equilibrium market risk-return relationship. Specifically, the required rate of return is determined by the modified capital asset pricing model developed in the present study. In the modified capital asset pricing model the overall risk of a firm or policyholders' surplus depends on two component risks, i.e., underwriting risk and investment risk. Underwriting risk is accounted for by the variability of underwriting margin and the insurance leverage (surplus ratio). As the variability of underwriting margin and insurance leverage increase, the underwriting risk increases. Increase in underwriting risk eventually causes the required rate of return on policyholders' surplus to increase. Increase in the required rate of return also leads to increase in price of insurance. In other words, underwriting risk is properly reflected in the price structure of insurance through the required rate of return on policyholders' surplus.

Investment risk of a firm is measured by the variability of return on investment portfolio and the investment leverage. The investment leverage is measured by the ratio of investable funds to the amount of policyholders' surplus. As the variability of return on investment portfolio increases, the investment risk increases.
Increase in investment risk eventually increases the required rate of return. Therefore, a company with higher risk investment portfolio needs higher required rate of return on its policyholders' surplus than that of a company with lower risk investment portfolio. However, the rate regulation model developed in this study is constructed in such a way that the effect of higher required rate of return upon the price of insurance is actually offset by the effect of higher expected rate of return from risky investment portfolio upon the price of insurance.

In sum, the model developed in this study properly recognizes and adequately reflects underwriting and investment risks in determining rates of insurance through the required rate of return in policyholders' surplus.

Determination of Minimum Required Amount of Policyholders' Surplus

In the model developed in this study the level of insurance premium depends, to some extent, on the amount of policyholders' surplus of individual companies. The larger the amount of policyholders' the higher the level of insurance premium tends to be, and vice versa. In the competitive insurance market, the problem of high price of insurance due to excessive amount of policyholders'
surplus, compared with the necessary amount, could be resolved effectively through competition. On the other hand, the cut-throat competition in price among insurers by means of reducing their policyholders' surplus may endanger the solvency of the insurers. Therefore, there should be a method by which the minimum required amount of policyholders' surplus can be determined.

The sample estimates of the population mean and variance of sum of loss and expense can be utilized to determine the level of the minimum required policyholders surplus.\footnote{64} The following formula is developed to statistically estimate the level of minimum required policyholders' surplus (ps) given a specified "degree of confidence" in the estimate:

\[
p_{s_i} = \bar{L}_i (1 + t_{\alpha}^{\hat{\sigma}(L)}) - P_i \quad \ldots \ldots \ldots \ldots \ (48)
\]

where \( p_{s_i} = \) the level of minimum required policyholders' surplus for insurance \( i \)

\( \bar{L}_i = \) estimated amount of loss and expense for insurance \( i \)

\footnote{64}{This approach has been suggested recently by Hofflander and Duval. See Alfred E. Hofflander, Jr. and R. M. Duval, "Ruin Problem in Multiple Line Insurance: A Simplified Model," Journal of Financial and Quantitative Analysis (March 1967).}
\( \hat{\sigma}(L) \) = the estimate of the population standard deviation of the amount of loss and expense for insurance \( i \), and

\( t_\alpha = "t" \) score relating a one-tail confidence level of \( 1 \) to the standard deviation

The term \( t_\alpha \hat{\sigma}(L) \) is a "upper-side" confidence limit. From a statistical standpoint, it can be said that one is \( 100(1-\alpha) \) percent confident that the expected amount of loss and expense for insurance \( i \) will be less than

\[ L_i(1 = t_\alpha \hat{\sigma}(L)). \]

According to the formula (48), the minimum required amount of policyholders' surplus is equal to the difference between the maximum probable amount of loss and expense at \( 100(1-\alpha) \) percent confidence level and the premiums to be written. This is illustrated in Figure 1.

As shown in Figure 1, the amount of loss and expense up to point \( P \) can be covered by the premiums to be written. If the amount of loss and expense exceeds the premiums to be written, then the excess amount of loss and expense should be covered by policyholders' surplus. The minimum required amount of policyholders' surplus is indicated by the area covered with black.

Determination of Other Input Variables

As to the expected amount of loss and expense for certain lines of insurance, it is assumed that a fairly
accurate estimation can be obtained on the actuarial basis.

The expected rate of return on investment is determined in the framework of general equilibrium market risk-return relationship. Individual insurance companies are allowed to decide their own investment policy within the constraint of investment regulations. Whatever the investment policy may be, each company is required to properly reflect the risk and return associated with its investment operation in determination of premium.
Development of the Model

The following general assumptions are employed in developing the model:

1. The planning period of property-liability insurance companies is one-year horizon.

2. All insurance premiums are paid at the inception of each policy.

3. All claims mature during the planning period and are payable at the end.

4. Federal corporation income tax is not considered.

5. Senior securities are not used as the sources of capital.

6. Major source of income for property-liability insurance companies are underwriting earnings and investment earnings.

In addition to the above general assumptions, it is assumed that a property-liability insurance company is selling only one line of property-liability insurance to a group of consumers with homogeneous loss characteristics.

Given the above assumptions, the expected rate of return on policyholders' surplus is given by

\[
\bar{R}_{ps} = \frac{P - L}{ps} + \frac{E(I_p) \cdot (P_u + L_r + ps)}{ps} \quad \ldots \ldots \ldots \ldots (49)
\]
where $$\bar{R}_{ps} = \text{expected rate of return on policyholders' surplus}$$

$$P = \text{premiums to be written}$$

$$\bar{L} = \text{estimated amount of loss and expense}$$

$$E(I_p) = \text{expected rate of return on investment portfolio}$$

$$P_u = \text{unearned premium reserve}$$

$$L_r = \text{Loss reserve, and}$$

$$ps = \text{policyholders' surplus, including shareholders' equity, retained earnings, other surplus items and contingency reserves}$$

In line with the basic premises, i.e., fair rate of return and total rate of return, the expected rate of return on policyholders' surplus given by equation (49) should be equal to the required rate of return on policyholders' surplus to be determined in the framework of the modified capital asset pricing model. Accordingly, the following relationship is held:

$$E(R_i) = \bar{R}_{ps} = \frac{(P - \bar{L}) + E(I_p) \cdot (P_u + L_r + ps)}{ps} \ldots (50)$$

where

$$E(R_i) = \text{required rate of return on policyholders' surplus of a company selling insurance i,}$$
determined by the modified capital asset pricing model, that is, \( E(R_i) = R_f + (E(R_m - R_f) \times (a_o + a_l S_2) \)

Assuming that the sum of unearned premium reserve \((P_u)\) and loss reserve \((L_r)\) can be expressed as the proportion of the premiums to be written \((P)\), that is, \((P_u + L_r) = a \cdot P\), where \(a\) is proportional factor, and expanding the equation (50), then the equation (50) can be expressed as below:

\[
P - L + E(I_2) \cdot aP + E(I_3) \cdot ps\]
\[
E(R_i) = \frac{P - L + E(I_2) \cdot aP + E(I_3) \cdot ps}{ps} \quad \ldots \ldots \ldots (51)
\]

After algebraic manipulations of the equation (51), the level of premium \(P\) can be given by

\[
P = \frac{ps(E(R_i) - E(I_3)) + L}{1 + aE(I_p)} \quad \ldots \ldots \ldots (52)^{65}
\]

When the right-hand side of the equation (48) is substituted into the equation (52), the level of premium \(P\) can be also given by the following formula:

\[
P = \frac{\bar{L}(1 + \left(1 + t \hat{a}^2 (L) \right) \cdot (E(R_i) - E(I_p)))}{1 + E(R_i) - E(I_p)(1 - a)} \quad \ldots \ldots \ldots (53)
\]
The equation (52) is the final form of the rate regulation model for property-liability insurance. The level of premium determined by the formula is considered "reasonable" in the framework of the concepts of fair rate of return and total rate of return on policyholders' surplus.

The equation (52) indicates that the level of premium is function of several variables. Those variables are:

1) required rate of return on policyholders' surplus which is determined by the modified capital asset pricing model
2) estimated amount of loss and expense
3) amount of policyholders' surplus
4) expected rate of return on investment portfolio, and
5) value of \( a \), it is the proportional factor which indicates the relationship between the amount of written premium and the sum of unearned premium and loss reserves.

The equation (52) is developed for calculating the level of premium in aggregate term for a property-liability insurance company which sells a line of property-liability insurance \( i \) to a group of customers with homogeneous loss characteristics. However, the formula can be also used to determine the level of premium for an
individual policy. In this case, the amount of policyholders' surplus and the estimated amount of loss and expenses should be determined on the basis of individual policy unit.

Conclusion

It is claimed that the rate regulation model developed here has some unique features. First of all, the model provides rate regulatory authorities with a clear-cut formula with which they are able to evaluate the reasonableness of proposed rates in an objective manner.

Second, the model takes into account not only earnings from underwriting operation but also earnings from investment operation. Third, the model properly reflects risks associated with underwriting and investment operations by means of the required rate of return on policyholders' surplus to be determined in the framework of the modified capital asset pricing model.

Fourth, the premium determined by the model is expected to yield the required rate of return on the policyholders' surplus. Fifth, since the general level of the required rate of return and expected rate of return on investment depends on the condition of general economy, the general level of premium may depend on the condition of general economy.
Sixth, as shown in the formula, the level of premium is, to some extent, affected by the proportional factor \( a \) which indicates the relationship between the written premium and the sum of unearned premium and loss reserves. Since the proportion factor \( a \) may vary with the types of insurance, the effect of investment income on the level of premium may be different among different lines of insurance. This implies that the model takes into consideration the differences in nature of reserves among different line of insurance in the process of calculating premium.

Finally, the model can be used not only in the restrictive rate regulation systems, such as prior approval and file and use systems, but also in the permissive rate regulation system, i.e., open competition system. In a sense, the model may be considered more appropriate in the permissive system than in the restrictive systems. The applicability of the model to open competition system is attributed to the flexibility built in the model. The model is formulated in such a way that it can reflect all important factors which insurance companies operating in the open competition system have to consider in the process of determining the prices of their insurance.

In sum, the model is supposed to solve some of the current problems in rate regulation of property-liability insurance. It is particularly aimed to solve
the problems arising from the ambiguity in meanings of statutory rate standards and to provide for a practical answer to the investment controversy.
CHAPTER VI

EMPIRICAL STUDY

The specific objectives of this empirical study can be summarized:

1) to provide empirical evidence which will support the modified capital asset pricing model developed in Chapter IV

2) to measure the cost of policyholders' surplus, based on historical data, of a sample of sixty property-liability insurance companies in the framework of the modified capital asset pricing model

3) to test whether or not any significant positive relationship between the cost of policyholders' surplus and size of company

4) to test whether or not any significant positive relationship between the cost of policyholders' surplus and the insurance leverage of company

5) to test the profitability of the property-liability insurance industry in the past.
In addition to the above specific objectives, this chapter will discuss some implications of other results of the empirical study to the cost of policyholders' surplus and to the rate regulation of property-liability insurance.

Test of Association Between Market Beta and Accounting Earnings Variability

The purpose of this section is to test whether or not there is significant association between market beta and accounting earnings variability of property-liability insurance companies. If the modified capital asset pricing model developed in Chapter IV is held to be valid, there should be significant association between these two risk measures.

Companies Included in the Test

The final result of this test reported here is based on a sample of twenty property-liability insurance companies which met the following criteria: 1) earnings data available from 1955 to 1975, 2) annual stock price and dividend data available for the period from 1955 to 1975, and 3) major lines of business are property-liability insurance.
The number of companies included in this test appears to be small compared with the total number of stock property-liability companies existing during the period in the United States. However, this is due to several reasons. First, most of the common stocks of property-liability insurance companies are not traded in the market. Most companies are privately-held companies or wholly-owned by conglomerates or holding companies. Second, most of the stocks of property-liability insurance companies are traded in the over-the-counter market, and there is very few published data for stock prices and dividends for such a long time period. Finally, the trend of all-line insurers, mergers and holding companies, in recent years also limits the number of companies which meet the criteria set above. Several companies included in this test are all-line insurers. However, their major lines of business are property and liability lines.  

Sources and Means of Obtaining Data

The information on the stock prices and dividends were secured from A. M. Best Company by means of a special contract with the company.

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More than 50% of the total premium income for these companies came from property-liability insurance lines.
The information on the annual underwriting and investment earnings and the year-end amount of policyholders' surplus were obtained from the *Best's Insurance Report*, published yearly by A. M. Best Company.

**Test Period**

The market beta \((B_j)\) and the earnings variability measure \((S_j)\) of each company used in this test are calculated based on the 20-year period from 1956 to 1975.

**Test Design**

For the purpose of obtaining an empirical evidence on the association between the market beta \((B_j)\) and the accounting earnings variability \((S_j)\), the following cross-sectional linear regression model is used:

\[
B_j = a_0 + a_1 S_j + e_k 
\]

where \(B_j\) = market beta for company \(j\) obtained based on the 20-year period, and it is secured by means of the following market model

\[
\frac{P_{jt}}{P_{jt-1}} = r_o + B_j \cdot \ln(I_t) + u_{jt} \quad \ldots (55)
\]

where \(P_{jt}\) = the market price of jth firm's common stock at time \(t\) (adjusted for capital change)
$P_{jt-1} = \text{the market price of jth firm's common stock at time t-1 (adjusted for capital change)}$

$D_{jt} = \text{the dividend payment on the jth security at time t}$

$I_t = \text{the price relative of a representative market index (S & P 400 stock price index) at time t (adjusted for dividend and capital changes)}$

$r_0$ and $B_j = \text{parameters to be estimated, and}$

$U_{jt} = \text{residual term}$

$S_j = \text{the accounting earnings variability, and}$

it is defined as the standard deviation of net income before income tax over the policyholders' surplus

$$S_j = \left( \frac{20}{t-1} \left( \frac{NI_t}{ps_{t-1}} - \overline{(NI/ps)} \right)^2 / 20 \right)^{1/2}$$

where $NI_t^{67} = \text{sum of statutory underwriting gain (loss) and investment earnings at time t}$

---

The reason for using the statutory underwriting results is mainly because of availability of the data. The adjusted underwriting results may provide more accurate information on underwriting operation, however, it is not readily available. Furthermore, it is subject to more measurement error. It is almost impossible to calculate accurate adjusted underwriting gains or loss for large number of companies during limited time. From the long-run viewpoint, the statutory underwriting results may not distort the true results of underwriting operation.
investment earnings includes net investment income and realized and unrealized capital gains or loss

\[ p_{st-1} \] = the amount of policyholders' surplus at end of time \( t-1 \). This includes shareholders' equity, if any, retained earnings, other surplus items and contingency reserves.

\( a_0 \) and \( a_1 \) = parameters to be estimated, and

\( e_j \) = residual term.

Results of the Test

The regression of \( B_j \) on \( S_j \) produced the following regression coefficient for equation (54):

\[ \hat{B}_j = 0.333 + 2.786 S_j \]

The summary of statistics of the cross-sectional regression analysis is reported in Table 1.

The correlation coefficient between the two variables, \( B_j \) and \( S_j \), is 0.708 and this correlation coefficient is significant at 0.01 level of significance. The regression coefficient (\( \hat{a}_1 \)) is 2.786 and its "t" value is 4.256. This "t" value is significant at 0.01 level of significance.

In conclusion, it can be said that there is significant association between the market beta and the
TABLE 1
Summary of Statistics of the Cross-Sectional Regression of $B_j$ on $S_j$

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>S.D.</th>
<th>Reg. Coef.</th>
<th>S.Err.</th>
<th>&quot;t&quot; Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_j$</td>
<td>.916</td>
<td>.295</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$S_j$</td>
<td>.209</td>
<td>.075</td>
<td>2.786</td>
<td>.6545</td>
<td>4.256</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td>.333</td>
<td>.1450</td>
<td>2.299</td>
</tr>
</tbody>
</table>

Correlation Coefficient ($B_jS_j$): .708
Coefficient of Determination ($R^2$): .502
F-Statistics: 18.117
D-W Statistics: 1.200

accounting earnings variability of property-liability insurance companies. Therefore, it may be possible to use the accounting earnings variability-based estimate of systematic risk ($\hat{B}_j$) obtained from equation (55) as the surrogate of the market beta ($B_j$). This empirical evidence supports the validity of the modified capital asset pricing model developed in Chapter IV.

Estimates of Cost of Policyholders' Surplus of Property-Liability Insurance Companies

The cost of policyholders' surplus of a sample of sixty property-liability insurance companies are estimated
based on the historical data for the period of 20 years from 1956 to 1975 in the framework of the modified capital asset pricing model.

Companies Included in the Estimates

In addition to the twenty companies selected for the test of association between the market beta and the accounting earnings' variability in the proceeding section, another forty property-liability insurance companies were selected from the group of property liability insurance companies ranked from 1st to 150th in terms of average total asset size during the period from 1961 to 1975. The selected companies have been existing for more than twenty years at least from 1955 to 1975.

Estimation Period

The cost of policyholders' surplus is estimated based on the period of 20 years from 1956 to 1975.

Estimation Model

The modified capital asset pricing model developed in Chapter IV is used for this purpose. The risk-free rate of interest is calculated as an average of the annual yields on three-month U.S. treasury bills over the 20-year period from 1956 to 1975. The expected rate of return
on the market portfolio is substituted by an average of annual rate of return on S & P 500 stock price index (including dividend yields) over the 20-year period from 1956 to 1975. In order to obtain annual return on the market portfolio, initially, the yearly percentage change in S & P 500 stock price index is calculated. Each year's percentage change is added to the dividend yield on the same index.

Respectively, 4.168% and 8.032% were obtained by these procedures for the average returns on the risk-free securities and on the market portfolio. The final estimation equation is given by

\[ E(R_j) = 4.168 + (8.032 - 4.168)(0.333 + 2.768 S_j) \]  \hspace{1cm} (56)

Results of the Estimation

The results of the estimations of the cost of policyholders' surplus of sixty property-liability insurance companies are reported in Appendix B.

The estimates of the cost of policyholders' surplus range from 5.99% to 10.94% with a mean of 7.635%. This result appears to be interesting when it is compared with the result of a recent study made by Litzenberger
and Rao. In their study, they estimated the cost of equity capital for twenty-five chemical firms during the period of 1968 and 1969 in the framework of the capital asset pricing model. Their estimates of the cost of equity capital for twenty-five chemical companies ranged from 6% to 10% with a mean of 7.3%.

Concluding Remarks

Unlike the risk class equivalency assumption in the M-M electric utility study, the method employed in this study takes explicit cognizance of intraindustry differences in operation risks, namely, risks associated with underwriting and investment operations. Each firm may be considered to belong to a unique risk class, and each would have a unique cost of policyholders' surplus.

Although the present empirical study is based on a limited number of firms, the estimates of the cost of policyholders' surplus seem to be reasonable in magnitude.

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It should be, however, noted that the cost of policyholders' surplus estimated in this study is not suggested for use in rate regulatory procedures in the future, for these cost of policyholders' surplus were estimated based on the historical data.

The conventional capital asset pricing model is an ex-ante model and so is the modified capital asset pricing model. From the theoretical viewpoint, all the parameters in the model and the measure of systematic risk of each firm should be estimated based on future expectation, if the cost figures obtained by the model is to be used in decision making for future. However, in the practical application of the capital asset pricing model, the customary practice is to estimate the parameters and risk of firms based on ex-post data, mainly because of difficulties in obtaining future expectation.

Test of the Effect of Company Size on the Cost of Policyholders' Surplus

Statement of Hypothesis
The cost of policyholders' surplus is independent of the size of the company as measured by the total asset.
This null-hypothesis is to investigate the effect of the size of property-liability insurance company on the cost of policyholders' surplus.

While no previous study has been in this regard for the property-liability insurance industry, there is the general hypothesis, most recently urged by Scherer (1970), Weston and Brigham (1969), that the cost of equity capital of small industrial corporation is greater than that of large industrial corporation.  

In a recent empirical study reported by Alberts and Archer (1973), they provided some evidence that there tends to be negative relationship between size and variability of rates of return. According to them, since the cost of equity capital in the framework of the capital asset pricing model equals the sum of the risk-free rate of interest and a risk premium, the existence of a negative relationship between size and riskiness must necessarily imply a negative relationship between size and risk premiums and between size and the cost of equity capital.


Prior to the Alberts and Archer study (1973), there were several studies which investigated the relationship between size and the cost of equity capital. Benishay regressed a variant of the earnings-price ratio of a particular sample of industrial companies against the size (measured in terms of market value) of the companies, and he found a negative relationship between the two variables, and concluded that this relationship implies strong support for the hypothesis that cost of equity capital is negatively related to size.\textsuperscript{72}

Samuels and Smyth (1968), and Stekler (1964), in their respective studies, also concluded that there is a negative relationship between size and variability of profitability.\textsuperscript{73}

In contrast, Gordon (1971) and Archer and Faeber (1966) each carried out essentially similar regression analysis to Benishay's work for other sample of industrial companies, found an independent relationship between

\textsuperscript{72}H. Benishay, "Variability in Earnings-Price Ratios of Corporate Equities," \textit{American Economic Review} (March 1961), pp. 81-94.


Miller and Modigliani (1966) used regression analysis to estimate the values of the cost of equity capital itself for a sample of sixty-three electric utilities and then determined the relationship between these estimates and the sizes of the companies. They found that the cost of equity capital and size were largely independent.\footnote{75F. Modigliani and M. Miller (1966), op. cit.}

All previous empirical studies took the samples from either industrial corporations or electric utilities. Property-liability insurance companies have never been used as the basis for testing the relationship between size and the cost of equity capital. Since no previous study has been done in this regard for property-liability insurance industry and it is still uncertain whether or not there is, in general, any significant relationship between size and the cost of equity capital, any predictions cannot be made based on a theoretical proposition.
Intuitively it is expected that the cost of policyholders' surplus of large firms is generally lower than that of small firms. If the result of this test shows any significant relationship between size and cost of policyholders' surplus, further research is desirable to investigate how size of a firm affects its cost of policyholders' surplus. Any significant result of this test may contribute to the study of market structure and regulation of this industry.

Companies Included in the Test

The same sixty companies used for estimation of cost of policyholders' surplus in the proceeding section are included in this test. The range of size of companies included in the test is from 8.2 million to 1.8 billion in terms of average annual total assets over the 20-year period from 1956 to 1975. The details of the size group will be shown later in this section.

Test Design

Since in the modified capital asset pricing model, the cost of policyholders' surplus depends on the riskiness of policyholders' surplus measured by the market beta estimated via accounting earnings variability ($\hat{B}_j$), $\hat{B}_j = .333 + 2.768S_j$, the existence of a negative relationship between size and riskiness must necessarily imply a
negative relationship between size and the cost of policyholders' surplus \( (E(R_j)) \). Therefore, it was decided to test the relationship between size and riskiness \( (\hat{B}_j) \) in order to determine whether or not there is a significant relationship between size of the company and the cost of policyholders' surplus.

Two different statistical tools are employed for this test; one is linear regression analysis and the other is difference between means test.

A. Regression Test.

The following form of cross-sectional linear regression model is specified for examining the relationship between size and riskiness.

\[
\hat{B}_j = d_0 + d_1 \cdot (\ln(TA_j)) + w_j \ldots \ldots \ldots \ldots (57)
\]

where \( \hat{B}_j \) = the market beta estimated via accounting earnings variability

\( TA_j \) = average of annual total asset of firm \( j \) over the 20-year period from 1956 to 1975

\( \ln \) = symbol of natural logarithm

\( d_0 \) and \( d_1 \) = parameters to be estimated, and

\( w_j \) = residual term.
B. Differences Between Means Test

In addition to regression test, the relationship between size and riskiness is also examined by means of difference between means test. This test is employed in order to investigate whether or not there are any significant differences between means of riskiness among different groups of companies by size, if the relationship between size and riskiness does not appear to be linear at all.

For the purpose of this test, a sample of sixty companies are divided into three groups by size: large, medium, and small. The size of company is measured by average of annual total asset over the period from 1956 to 1975. Table 2 shows the distribution of the three groups. The differences between means test are performed only for three groups.

The same sixty companies are classified again into seven groups in order to examine whether or not there is any systematic trends in the degree of riskiness among different size groups. Table 3 shows the distribution of the seven groups.

Results of the Test

A. Result of Regression Test

The regression of $\hat{B}_j$ on $\ln(TA_j)$ produced the following regression coefficient for equation (57):
### TABLE 2

Distribution of the Sample of 60 Companies by Average of Annual Total Assets over the Period from 1956 to 1975

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Range of Size</th>
<th>No. of Cos.</th>
<th>Avg. Total Assets per Co. (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>300 M. over</td>
<td>21</td>
<td>826,275</td>
</tr>
<tr>
<td>Medium</td>
<td>100 M. - 300 M.</td>
<td>21</td>
<td>164,002</td>
</tr>
<tr>
<td>Small</td>
<td>≤100 M. below</td>
<td>18</td>
<td>47,464</td>
</tr>
</tbody>
</table>

### TABLE 3

Distribution of the Sample of 60 Companies by Average of Annual Total Assets Over the Period from 1956 to 1975

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Range of Size</th>
<th>No. of Cos.</th>
<th>Avg. Total Assets per Co. (000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000 M. over</td>
<td>8</td>
<td>1,289,282</td>
</tr>
<tr>
<td>2</td>
<td>400M - 1000M</td>
<td>7</td>
<td>720,955</td>
</tr>
<tr>
<td>3</td>
<td>250M - 400M</td>
<td>8</td>
<td>331,808</td>
</tr>
<tr>
<td>4</td>
<td>150M - 250M</td>
<td>8</td>
<td>190,752</td>
</tr>
<tr>
<td>5</td>
<td>100M - 150M</td>
<td>11</td>
<td>125,595</td>
</tr>
<tr>
<td>6</td>
<td>50M - 100M</td>
<td>9</td>
<td>69,464</td>
</tr>
<tr>
<td>7</td>
<td>50M below</td>
<td>9</td>
<td>25,462</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
\[ \hat{B}_j = 0.988 - 0.00832(\ln(\text{TA}_j)) \]  \hspace{1cm} (58)

The summary statistics for the regression is reported in Table 4. As intuitively expected, the sign of the slope coefficient shows negative. However, it can hardly be concluded that there is a significant negative relationship between size and riskiness. The correlation coefficient and the slope coefficient do not significantly differ from zero at any level of significance. The result indicates that size and riskiness are independent.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>S.D.</th>
<th>Reg. Coef.</th>
<th>S. Err.</th>
<th>&quot;t&quot; Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>( B_j )</td>
<td>.945</td>
<td>.2583</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>( \ln(\text{TA}_j) )</td>
<td>5.176</td>
<td>1.34</td>
<td>-.00832</td>
<td>.0248</td>
<td>-.336</td>
</tr>
<tr>
<td>Intercept</td>
<td>-</td>
<td>-</td>
<td>.988</td>
<td>.1323</td>
<td>7.469</td>
</tr>
</tbody>
</table>

Correlation Coefficient \( (B_j, \ln(\text{TA}_j)) \): -.044  
Coefficient of Determination \( (R^2) \): .0019  
F-Statistics: .113  
D-W Statistics: 1.734

It may be tentatively concluded that there is not a significant relationship between size and riskiness;
accordingly, the cost of policyholders' surplus and size of company are independent.

B. Results of Differences Between Means Test

In the process of performing this test Table 5 and 6 were produced. Table 5 shows the summary of mean and standard deviation of \( \hat{B}_j \) for each of the three size groupings and Table 7 for each of the seven size groupings.

Table 5

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Mean of ( \hat{B}_j )</th>
<th>Standard Deviation of ( \hat{B}_j )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>.915</td>
<td>.187</td>
</tr>
<tr>
<td>Medium</td>
<td>.963</td>
<td>.283</td>
</tr>
<tr>
<td>Small</td>
<td>.948</td>
<td>.176</td>
</tr>
</tbody>
</table>

Upon reviewing Table 5 and 6, it would be noticed that there is not any systematic trend in the mean values of \( \hat{B}_j \) among different size groupings. This may indicate that the riskiness of a firm is not significantly related to the size of the firm.

Differences between means tests are performed only for the three size groupings: large, medium and small. Data required for these tests are obtained from Table 5.
TABLE 6
Measures of Mean and Standard Deviation of $\hat{B}_j$
for Each of the Seven Size Groupings

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Mean of $\hat{B}_j$</th>
<th>Standard Deviation of $\hat{B}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.909</td>
<td>.212</td>
</tr>
<tr>
<td>2</td>
<td>.959</td>
<td>.198</td>
</tr>
<tr>
<td>3</td>
<td>.911</td>
<td>.167</td>
</tr>
<tr>
<td>4</td>
<td>.874</td>
<td>.114</td>
</tr>
<tr>
<td>5</td>
<td>1.018</td>
<td>.348</td>
</tr>
<tr>
<td>6</td>
<td>.897</td>
<td>.165</td>
</tr>
<tr>
<td>7</td>
<td>.969</td>
<td>.290</td>
</tr>
</tbody>
</table>

TABLE 7
Summary Statistics of Difference Between Means
Test: Relationship Between Size and Riskiness
of Company

<table>
<thead>
<tr>
<th>Dif. Between Means of $\hat{B}_j$</th>
<th>Std. Error of Dif.</th>
<th>&quot;t&quot; Observed Value</th>
<th>&quot;t&quot; Value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_1 - M_2 = -.048$</td>
<td>.074</td>
<td>-.649</td>
<td>1.303</td>
<td>n.s.</td>
</tr>
<tr>
<td>$M_2 - M_3 = .015$</td>
<td>.077</td>
<td>.195</td>
<td>1.308</td>
<td>n.s.</td>
</tr>
<tr>
<td>$M_1 - M_3 = -.033$</td>
<td>.0585</td>
<td>-.564</td>
<td>1.308</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

$M_1$: mean value of $\hat{B}_j$ for large group
$M_2$: mean value of $\hat{B}_j$ for medium group
$M_3$: mean value of $\hat{B}_j$ for small group
n.s. = not significant at .10 level of significance
The results are reported in Table 7.

Table 7 shows that differences between means of $B_j$ of any two groups are not significant at .10 level of significance. These results support the conclusion made in the regression test that there is not any significant relationship between riskiness of a firm and the size of the firm; accordingly, the cost of policyholders' surplus is independent of size of the firm.

Conclusion

In contrast with the general hypothesis that there is a negative relationship between size of company and cost of equity capital of a firm, the results of the tests here show that there is not any significant relationship between size and cost of policyholders' surplus of property-liability insurance companies. Therefore, we cannot reject the hypothesis that the cost of policyholders' surplus of property-liability insurance company is independent of the size of company as measured by the total asset.

Test of the Effect of Insurance Leverage on the Cost of Policyholders' Surplus

Statement of Hypothesis

The cost of policyholders' surplus is independent of the degree of insurance leverage of the company.
In a pioneering work of Modigliani and Miller (1958), they stated in the Proposition II that "the expected yield of a share of stock is equal to the appropriate capitalization rate $\rho_k$ for a pure equity stream in the class, plus a premium related to financial risk equal to the debt-to-equity ratio times the spread between $\rho_k$ and $r$.

Expressed otherwise, the M-M Proposition II says that the required rate of return on equity capital (or cost of equity capital) is a positive linear function of the degree of financial leverage employed by the firm, holding business risk constant. Since the work of Modigliani and Miller, it has been generally accepted that the degree of financial leverage employed by the firm has a positive effect on the required rate of return on the equity capital.

Since the development of the capital asset pricing model, the M-M Proposition II has been theoretically proved by several authors in the framework of the capital asset pricing model. Hamada (1969) and Rubinstein (1973) showed the theoretical relationship between the required rate of return on the levered equity capital and the

---

According to their studies, the required rate of return on the levered equity capital is given by the following equation:

\[ E(R_j) = E(R^*_j) + (E(R^*_j) - R_f) (B_j/S_j) \]  \hspace{1cm} (59)

where

- \( E(R_j) \) = the required rate of return on the levered equity capital
- \( E(R^*_j) \) = the required rate of return on the unlevered equity capital
- \( R_f \) = the risk-free rate of interest, and
- \( (B_j/S_j) \) = debt to equity ratio.

This equation is exactly the same as the M-M Proposition II, which is expressed as below:

\[ i_j = \rho_k + (\rho_k - r) (D_j/S_j) \]  \hspace{1cm} (60)

where

- \( i_j \) = the expected rate of return or yield of a share of stock
- \( \rho_k \) = the expected rate of return on the unlevered equity capital in class \( k \)
- \( r \) = the risk-free rate of interest, and
- this is the cost of the debt, and

\[ \frac{D_j}{S_j} = \text{debt to equity ratio} \]

As shown in equations (59) and (60), the required rate of return on the levered equity capital is a positive linear function of the financial leverage \( \left( \frac{D_j}{S_j} \right) \).

On the one hand, in a recent empirical study reported by Hamada (1972), in which he tested the effect of the firm's capital structure on the systematic risk of common stock,\(^7^8\) he concluded that the capital structure of the firm does considerably account for the magnitude of the systematic risk of the firm's common stock. In other words, there is a positive relationship between the financial leverage and the systematic risk of the firm's common stock.

In the field of insurance, insurance leverage, so-called surplus ratio, is defined as the ratio of written premiums to policyholders' surplus. Although the exact nature of written premium is different from that of debts issued by industrial corporations, a portion of the funds raised by selling insurance is generally considered analogous to debts issued by industrial corporations. The unearned premium is regarded as liabilities of insurance companies.

In view of the similarity between debts and written premium or unearned premium in their nature, the effect of insurance leverage on the cost of policyholders' surplus might be the same as that of financial leverage on the cost of equity capital. However, no empirical study has been done in respect of the effect of insurance leverage on the cost of policyholders' surplus.

On the one hand, in the modified capital asset pricing model developed in Chapter IV, the cost of policyholders' surplus is positively related to the degree of insurance leverage. From the standpoint of the modified capital asset pricing model, the effect of the insurance leverage on the cost of policyholders' surplus must be positive.

Companies Included in the Test

The same sixty companies used in the previous sections are included in this test.

Sources and Means of Obtaining Data

In the present test, insurance leverage is specified as the ratio of net written premium to policyholders' surplus. Data for calculation of insurance leverage of each company were obtained from Best's Insurance Report published yearly by A. M. Best Company.
Test Design

The test to be performed here is actually the test of relationship between the degree of insurance leverage and the market beta estimated via accounting earnings variability (\( \hat{B}_j \)). As discussed in the proceeding section, by testing the relationship between these two variables, we can infer the relationship between the insurance leverage and the cost of policyholders' surplus.

Two statistical tools were employed for this test: cross-sectional linear regression test and differences between means tests. The purpose of using differences between means tests is to examine whether or not the differences means of \( \hat{B}_j \) is significant among different groups classified by the degree of insurance leverage, even if the relationship is not linear.

A. Regression Test

The following form of cross-sectional linear regression model is specified for the test:

\[
\hat{B}_j = \epsilon_o + \epsilon_i SR_j + w_j \quad \cdots \cdots \cdots \quad (61)
\]

where \( \hat{B}_j \) = the market beta estimated via accounting earnings variability for firm j,
SR_j = the average of the year-end insurance leverage (net written premium/policyholders' surplus) over the 20-year period from 1956 to 1975

e_o and e_1 = parameters to be estimated, and
w_j = residual term

B. Differences Between Means Test

The sample of sixty companies are classified into three groups based on the degree of insurance leverage. Since there is no theoretical basis to choose the range of insurance leverage, the range of insurance leverage was chosen in such a way that the number of companies in each group would be relatively the same. Table 8 shows the distribution of the sample companies among three groups.

The same sample of sixty companies are classified into five groups based on the degree of insurance leverage. The purpose of this groupings is to see whether or not there is any systematic trend in the mean values of \( \hat{B}_j \) among those five different groups. Table 9 shows the distribution of the five groups.

From Table 9 it is noted that more than 70% of the sample companies belong to the insurance leverage range from 1.00 to 2.50. More than 40% of the sample companies belong to the range from 1.50 to 2.50.
TABLE 8

Distribution of the Sample of 60 Companies Among Three Groups Based on Average of the Insurance Leverage over the Period from 1956 to 1975

<table>
<thead>
<tr>
<th>Group I.D.</th>
<th>Range of Insurance Leverage</th>
<th>Number of Companies</th>
<th>Mean Value of Insurance Lev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.30 - 1.25</td>
<td>16</td>
<td>.87</td>
</tr>
<tr>
<td>2</td>
<td>1.25 - 2.00</td>
<td>24</td>
<td>1.579</td>
</tr>
<tr>
<td>3</td>
<td>2.00 over</td>
<td>20</td>
<td>2.777</td>
</tr>
</tbody>
</table>

TABLE 9

Distribution of the Sample of 60 Companies Among Five Groups Based on Average of the Insurance Leverage over the Period from 1956 to 1975

<table>
<thead>
<tr>
<th>Group I.D.</th>
<th>Range of Insurance Leverage</th>
<th>Number of Companies</th>
<th>Mean Value of Insurance Lev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.30 - 1.00</td>
<td>8</td>
<td>.61</td>
</tr>
<tr>
<td>2</td>
<td>1.00 - 1.50</td>
<td>19</td>
<td>1.283</td>
</tr>
<tr>
<td>3</td>
<td>1.50 - 2.00</td>
<td>13</td>
<td>1.74</td>
</tr>
<tr>
<td>4</td>
<td>2.00 - 2.50</td>
<td>12</td>
<td>2.21</td>
</tr>
<tr>
<td>5</td>
<td>2.50 over</td>
<td>8</td>
<td>3.25</td>
</tr>
</tbody>
</table>
Results of the Test

A. Regression Test

The cross-sectional regression of $\hat{B}_j$ on $SR_j$ (insurance leverage) produced the following regression coefficients for the regression (61)

$$\hat{B}_j = .715 + .133 \, SR_j \quad \ldots \ldots \ldots \ldots \quad (62)$$

The summary of the statistics of the cross-sectional regression analysis is reported in Table 10.

**TABLE 10**

Summary of Statistics of Cross-Sectional Regression of $\hat{B}_j$ on $SR_j$

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>S.D.</th>
<th>Reg. Coef.</th>
<th>S. ERR</th>
<th>&quot;t&quot; Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_j$</td>
<td>.945</td>
<td>.254</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$SR_j$</td>
<td>1.739</td>
<td>.811</td>
<td>.1326</td>
<td>.373</td>
<td>3.566</td>
</tr>
<tr>
<td>Intercept</td>
<td>-</td>
<td>-</td>
<td>.715</td>
<td>.0714</td>
<td>10.014</td>
</tr>
</tbody>
</table>

Correlation Coefficient ($\hat{B}_j, SR_j$): .4234

Coefficient of Determination ($R^2$): .18

F-Statistics: 12.67

D-W Statistics: 1.56
The correlation coefficient between $\hat{B}_j$ and $SR^*_j$ is .423 and this is significantly different from zero at .01 level of significance. The regression coefficient for $SR_j$ is .1326 and "t" score is 3.566. The regression coefficient for $SR_j$ is .1326 and "t" score is 3.566. The regression coefficient is significantly different from zero at .01 level of significance. The F-statistics show 12.67 and this indicates that the overall regressional model is significant at .01 level of significance.

The results of the regression analysis indicates that there is a positive relationship between the degree of insurance leverage and the market beta estimated via accounting earnings variability. Therefore, it can be inferred that there is a positive relationship between the insurance leverage and the cost of policyholders' surplus.

The fact that the value of $R^2$ is only .18 does not imply that there is not a positive relationship between the degree of insurance leverage and the market beta estimated via accounting earnings variability. It does imply that the degree of insurance leverage itself cannot predict the market beta estimated via accounting earnings variability.

B. **Difference Between Means Test**

In the process of performing this test, Table 11 and Table 12 were produced. Table 11 reports the summary
of the values for mean and standard deviation of $\hat{B}_j$ for each of the three groupings classified by the degree of insurance leverage. Table 12 shows the same summary for each of five groupings.

**TABLE 11**

Measures of Mean and Standard Deviation of $\hat{B}_j$ for Each of Three Groupings

<table>
<thead>
<tr>
<th>Group I.D.</th>
<th>Mean Value of $\hat{B}_j$</th>
<th>S.D. of $\hat{B}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.837</td>
<td>.152</td>
</tr>
<tr>
<td>2</td>
<td>.939</td>
<td>.205</td>
</tr>
<tr>
<td>3</td>
<td>1.309</td>
<td>.327</td>
</tr>
</tbody>
</table>

**TABLE 12**

Measures of Mean and Standard Deviation of $\hat{B}_j$ for Each of Five Groupings

<table>
<thead>
<tr>
<th>Group I.D.</th>
<th>Mean Value of $\hat{B}_j$</th>
<th>S.D. of $\hat{B}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.796</td>
<td>.083</td>
</tr>
<tr>
<td>2</td>
<td>.913</td>
<td>.220</td>
</tr>
<tr>
<td>3</td>
<td>.941</td>
<td>.167</td>
</tr>
<tr>
<td>4</td>
<td>.987</td>
<td>.239</td>
</tr>
<tr>
<td>5</td>
<td>1.126</td>
<td>.390</td>
</tr>
</tbody>
</table>
Table 11 and 12 show that the mean values of \( B_j \) for each groupings are systematically increasing as the degree of insurance leverage increase. This result implies that there is some positive relationship between the degree of insurance leverage and the market beta estimated via accounting earnings variability.

The differences between means test were performed only for the three groupings. The summary of the results of the tests is reported in Table 13.

**TABLE 13**

The Results of Differences Between Means Tests: Relationship Between \( \hat{B}_j \) and \( SR_j \)

<table>
<thead>
<tr>
<th>Differences Between Means of ( B_j )</th>
<th>Standard of Error Difference</th>
<th>&quot;t&quot; Observed Value</th>
<th>&quot;t&quot; Result Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( M_3 - M_2 = .099 )</td>
<td>.0748</td>
<td>1.324</td>
<td>1.648 n.s.</td>
</tr>
<tr>
<td>( M_2 - M_1 = .102 )</td>
<td>.0600</td>
<td>1.700</td>
<td>1.685 s</td>
</tr>
<tr>
<td>( M_3 - M_1 = .201 )</td>
<td>.0887</td>
<td>2.270</td>
<td>1.688 s</td>
</tr>
</tbody>
</table>

\( M_1: \) mean value of \( \hat{B}_j \) for group 1

\( M_2: \) mean value of \( \hat{B}_j \) for group 2

\( M_3: \) mean value of \( \hat{B}_j \) for group 3

n.s. = not significant

s. = significant
The results of this test indicate that the difference in means of $\hat{B}_j$ between group 1 and 2, and between group 1 and 3 are significant at .05 level of significance. The difference in means of $\hat{B}_j$ between group 2 and 3 is not significant at .05 level of significance, but it is significant at .10 level of significance. These results imply that the riskiness of firm, as measured by the market beta estimated via accounting earnings variability, is affected by the degree of insurance leverage of the firm.

Conclusion

In view of all the results of the present tests, it can be said that there is a positive relationship between the insurance leverage of a company and the riskiness of the firm, as measured by the market beta estimated via accounting earnings variability. This implies that the cost of policyholders' surplus is positively related to the insurance leverage. Accordingly, it is concluded that we can reject the hypothesis that the cost of policyholders' surplus of property-liability insurance companies is independent of the degree of insurance leverage of the companies.
Test of the Profitability of the Property-Liability Insurance Industry

Statement of Hypothesis

In the framework of general equilibrium market risk-return relationship, the stock property-liability insurance companies did not provide fair rate of return (required rate of return) to the policyholders' surplus in the past.

Toward the late 1960s and since then, along with the controversy of investment income in ratemaking and rate regulation of property-liability insurance, controversy as to the profitability of property-liability insurance industry has been intensified.

The first controversial study as to the profitability of the industry was reported by Arthur D. Little, Inc. (1967). 79 This report stimulated responses from the academic world. The main criticism came from their sources--Professor Norgard and Schick (1968), Hofflander

and Mason (1968), and Hammond and Schilling (1969). Three other professors also commented on it more favorably though not without some reservation—Professor Long (1969), Professor Webb (1969), and Professor Hedges (1968).

In the Little Report, the ultimate test of the profitability of the property-liability insurance industry was carried out in the framework of "risk-related rate of return." The rate of return for property-liability insurance companies was defined as below:

\[
\text{Rate of Return} = \frac{\text{Net Profit} + \text{Fixed Charges}}{\text{Total Investable Funds}}
\]

where Net Profit + Fixed Charge = underwriting profit + Interest and Dividends Received + Realized and Unrealized Capital Gains - Taxes Paid + Fixed Charges.

---


Total Investable Funds = policyholders' surplus +
unearned premium and
loss reserves.

As noted in the study, this rate of return has
been constructed for purpose of comparison with other
industries. This in no way implied that such a definition
of return is for other purposes. The rate of return for
other industries was defined as below:

\[
\text{Rate of Return} = \frac{\text{Net Income} + \text{Fixed Charges}}{\text{New Worth} + \text{Long-term} + \text{Debt in Current Liability}}
\]

This definition was considered by them equivalent to that
applied to the property-liability insurance industry. In
the study, risk was defined as the variability of the
rate of return over a certain long-term period, as mea-
sured by the variance of rate of return.

Using the data of average rate of return and vari-
ance for over sixty industries during the period from
1950 to 1965, they constructed economy-wide risk-return
relationship by means of cross-sectional regression model.

According to their calculation, the average rate
of return for the forty-three property and liability
stock companies studied for the 1955-1965 period was
4.4%; their risk, measured by the variance of the rate
of return, was 10.89. After plotting this risk-return point of property-liability insurance industry against the economy-wide risk-return regression line, they found that the point for property-liability insurance industry falls considerably below the regression line. With this result, they concluded that the property-liability insurance industry falls considerably below the regression line. With this result, they concluded that the property-liability insurance industry was not earning a rate of return commensurate with those earned in other economic activities on assets placed in similar risks.

In addition to the comparison in terms of "risk-related rate of return," they compared the average rate of return, measured in various definitions, of the property liability insurance industry with those of other industries. They also concluded that there was no evidence to support the contention that the rate of return earned in the property-liability insurance industry was above average when compared to all other industries.

Most criticism of the ADL report has focused on use of the concept of "return on total investable funds." The major points of the criticism may be summarized as below. In the ADL report, they equated the two large reserve items of property-liability insurance companies, the unearned premium and loss reserves, with the long-term
debt of other industries. In fact, they are not the same in nature. The reserve funds bear interest, but they do not cost it. Thus, such accounts expand the denominator of the rate of return formula without affecting fixed charges items of the numerator. This is not so for the other industries. Therefore, the comparison of profitability between the property-liability insurance industry and other industry using "return on total investable funds" measure would necessarily make the return of the property-liability insurance industry appear low.

Following the release of the ADL report, increasing attention is being focused on the return on net worth concept as a device to measure the profitability of the industry. But even with the confines of this concept there exist a multitude of variations. 82

The number of conclusions reached and the techniques employed present a seemingly bewildering array to the world. In short, unanimity is not yet a fact of

82 For example, the following studies used basically the concept of return on net worth: Professor Norgarrd's "Unorthodox" measurement reported in Norgarrd and Schick Study, op. cit.; The Goddard Approach reported in R. P. Goddard, "Total Earnings from Insurance Operations--The Investor's Viewpoint," Proceedings of Casualty Actuarial Society, 110, 135 (1968); The modified Goddard Formula; and The Dean Sharp Method, etc.
life in the area of measuring profitability of the property-liability insurance industry.

Although there are many unresolved and conflicting issues in measuring the profitability of the industry, it does not necessarily imply that it is impossible to measure the profitability of the industry. The present study attempts to rest the profitability of the industry in the framework of general equilibrium risk-return relationship, more precisely, in the framework of the modified capital asset pricing model developed in Chapter IV.

Theoretical Background of the Test

In the general market equilibrium capital asset pricing theory, the required rate of return on equity of a firm (or expressed otherwise, the cost of equity capital) is determined in the market risk-return relationship. Since the investors in the capital market invest their funds to the equity capital of firms in expectation of earnings as much as the required rate of return on the equity capital, corresponding to its risk, firms which fail to yield the required rate of return on their equity capital may not be able to attract capital from capital market in the future. In other words, if a firm or an industry could not provide their equity shareholders with the yield more than or equal to the required rate of
return, then the firm or the industry cannot be considered profitable.

Therefore, the required rate of return on equity capital determined in the general equilibrium market risk-return relationship can be used as a criterion against which the profitability of firms or industries can be effectively and objectively evaluated.

Companies Included in the Test

The same sixty companies used in the previous sections are included in this test. Since the companies included in the test are mostly large and have been existing relatively a long period, any results of this test must be interpreted accordingly in consideration of the sample.

Information Required for the Test

The following information was required to test the profitability of the property-liability insurance industry in the framework of modified capital asset pricing model:

1. Individual Firm's Systematic Risk: In the modified capital asset pricing model the risk of the policyholders' surplus is measured by the market beta estimated via accounting earnings variability (\( \hat{\beta}_j \)). In the present test, \( \hat{\beta}_j \) for each company was calculated by the following equation:
\[ \hat{B}_j = .333 + 2.768S_j \quad \ldots \ldots \ldots \ldots \ldots \ldots (55) \]

2. Required Rate of Return on Policyholders' Surplus (Cost of Policyholders' Surplus): The required rate of return on policyholders' surplus for each firm was estimated by the following equation:

\[ E(R_j) = 4.168 + 3.864\hat{B}_j \quad \ldots \ldots \ldots \ldots \ldots (56) \]

The required rate of return on policyholders' surplus for each company were calculated in section two. The equation (56) is the security market line (SML) obtained in the framework of the modified capital asset pricing model for the base period from 1956 to 1975.

3. Average Rate of Return on Policyholders' Surplus for Individual Firms: In order to obtain average rate of return on policyholders' surplus for each firm, the annual rate of return on policyholders' surplus is defined as below:

\[
ARR_t = \frac{\text{statutory underwriting gain (loss)}_t + \text{net investment} + \text{income}_t + \text{realized and unrealized capital gain (loss)}_t - \text{taxes paid}_t}{\text{policyholders' surplus}_{t-1}}
\]
The average rate of return on policyholders' surplus for each firm is the arithmetic mean of the annual rate of return over the period from 1956 to 1975. Accordingly, every data required in the test was obtained on the same 20-year period.

Test Period

The base period for the test of profitability is the 20-year from 1956 to 1975. Accordingly, every data required in the test was obtained on the same 20-year period.

Test Design

The following three types of analyses are employed to test the profitability of property-liability insurance industry.

Analysis No. 1:

The required rate of return determined in the framework of the modified capital asset pricing model and the average rate of return on individual firms are compared.

Analysis No. 2:

The required rate of return determined in the framework of the modified capital asset pricing model
and average rate of return are compared in terms of average of the sample of sixty firms.

Analysis No. 3:

By plotting the individual firms' risk-return points against the security market line on the risk-return space, the profitability of the industry is graphically analyzed.

Results of the Test

A. Result of Analysis No. 1

The result of Analysis No. 1 is summarized as shown in Table 14. Also shown in Table 14, for 75% of the sample of sixty companies, the average rate of return on policyholders' surplus is greater than or equal to the required rate of return on policyholders' surplus. Only 25% of the sample companies show that their average rate of return is less than their required rate of return. More than 50% of the sample companies earned greater than their required rate of return by more than 1% margin during the test period. Only less than 3.5% of the sample companies earned less than required rate of return by margin of more than 3%.

The results indicate that most of the companies tested in the present study earned, in average rate of
TABLE 14

The Result of Comparison Between Required Rate of Return and Average Rate of Return: Individual Company Basis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R.R. A.R. (5% over)</td>
<td>1</td>
<td>1.66%</td>
</tr>
<tr>
<td>R.R. A.R. (3% - 5%)</td>
<td>1</td>
<td>1.66%</td>
</tr>
<tr>
<td>R.R. A.R. (1% - 3%)</td>
<td>8</td>
<td>13.33%</td>
</tr>
<tr>
<td>R.R. A.R. (0% - 1%)</td>
<td>5</td>
<td>8.33%</td>
</tr>
<tr>
<td>Sub-Total (R.R. A.R.)</td>
<td>15</td>
<td>25.00%</td>
</tr>
<tr>
<td>R.R. A.R. (0% - 1%)</td>
<td>6</td>
<td>10.00%</td>
</tr>
<tr>
<td>R.R. A.R. (1% - 3%)</td>
<td>21</td>
<td>35.00%</td>
</tr>
<tr>
<td>R.R. A.R. (3% - 5%)</td>
<td>7</td>
<td>11.66%</td>
</tr>
<tr>
<td>R.R. A.R. (5% - 8%)</td>
<td>6</td>
<td>10.00%</td>
</tr>
<tr>
<td>R.R. A.R. (8% over)</td>
<td>5</td>
<td>8.33%</td>
</tr>
<tr>
<td>Sub-Total (R.R. A.R.)</td>
<td>45</td>
<td>75.00%</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>60</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

*R.R. = required rate of return determined in the framework of the modified capital asset pricing model

A.R. = average rate of return for individual firms

R.R. A.R.: this means required rate of return is greater than average rate of return

R.R. A.R.: this means required rate of return is less than average rate of return.

**

\[
\text{percentage} = \frac{\text{no. of companies belonging to each range}}{\text{total number of the sample (60)}} \times 100
\]
of return over the past 20-year period from 1956 to 1975, greater than or equal to their required rate of return on their policyholders' surplus.

B. **Result of Analysis No. 2:**

The average of the required rate of return for the sample of sixty companies is 7.64%. On the one hand, the average of the average rate of return for the sample companies is 10.13%. This result implies that property-liability insurance industry earned, in average, more than the required rate of return on policyholders' surplus over the past 20-year period from 1956 to 1975.

C. **Result of Analysis No. 3:**

Figure 2 shows the result of graphical comparison between the required rate of return on policyholders' surplus and the average rate of return on policyholders' surplus. In Figure 2, the vertical axis denotes rate of return on policyholders' surplus and the horizontal axis denotes the riskiness of policyholders' surplus, as measured by the market beta estimated via accounting earnings variability \( \hat{\beta}_j \).

As shown in Figure 2, most the risk-return points of the sample of sixty companies fall above the security market line. Many companies fall far above the security market line. There are several companies whose risk-return
points fall far below the security market line. Except these several companies, the risk-return points of most of the sample companies are close to or far above the

\[ E(R_j) = 4.168 + 3.864 \beta_j \]

Figure 2. Graphical Comparison between Required Rate of Return and Average Rate of Return of Individual Firms on Risk-Return Space
security market line. The point indicated by I is the industry average risk-return point. This point also falls far above the security market line.

Conclusion

In view of the results of the present test, it can be concluded that property-liability companies earned, by and large, more than or equal to their required rate of return on their policyholders' surplus over the past 20-year period from 1956 to 1975. In other words, from the standpoint of the general equilibrium market risk-return relationship the profitability of the property-liability insurance industry for the same period could be considered very good. Therefore, the null-hypothesis stated in the beginning can be rejected.

Other Findings

The purpose of this section is to report some of other results obtained in the course of the empirical study and discuss the implications of the results to further study of financial aspects of the property-liability insurance companies and to rate regulation of property-liability insurance.
What Was the Major Source of Income for Property-Liability Insurance Companies?

Over the 20-year period studied, the sample of sixty companies earned, in average, 16% rate of return on policyholders' surplus on the basis of earnings before income tax. What was the major source of these earnings for these companies? In terms of average of the sample companies, the rate of underwriting earnings to policyholders' surplus was -.6%, while the rate of investment earnings to policyholders' surplus was 16.6%. In other words, most of the earnings for the property-liability insurance companies came from investment operation, and underwriting operation actually made a negative contribution to the total earnings. Many companies have been heavily relying on investment earnings for their survival and growth. Not a single company of the sample companies experienced a negative average rate of investment earnings to policyholders' surplus over the 20-year period. In contrast, more than 60% of the sample companies showed negative rates of underwriting earnings to policyholders' surplus.
What Was the Major Source of Total Earnings Variability for Property-Liability Insurance Companies?

The average standard deviation of the total rate of return on policyholders' surplus over the sample of sixty companies was 21%. The average standard deviation of the rate of underwriting earnings to policy holders' surplus was 10.8%, while it was 19.7% for investment earnings.

The variability of investment earnings was almost twice the variability of underwriting earnings. Since the exact relative contribution of each earnings variability to the total variability can be determined only after the relative proportion of each earnings to total earnings is known, it cannot be precisely determined how each operation contributes to the variability of total earnings without the data. However, it is apparent that the total variability in earnings has been largely attributed to the variability in investment earnings. It does not necessarily imply that the variability in underwriting earnings is not important at all in determining the variability of total earnings. For some companies, the variability of underwriting earnings was greater than that of investment earnings.
Implications of the Results

The results discussed in the above carry several important implications to the study of financial aspects of the property-liability insurance industry and its rate regulation. First, if the investment activities of property-liability insurance companies had not been subject to the relatively conservative state regulation, the profitability and the riskiness of the industry might have been different. Since the investment operation has been and will be the major source of income for property-liability insurance companies, any major changes in state investment regulation or major changes in investment policies of companies would have great influence on profitability and riskiness of the industry.

Second, the facts, that the property-liability insurance companies are heavily relying on the investment income and that the variability of the total variability in earnings is largely attributed to the variability of investment earnings, suggest some important implications to the study of rate regulation of property-liability insurance. If rate of property-liability insurance is to be regulated on the basis of risk-return relationship of policyholders' surplus, the risk and return associated with investment operations should be properly reflected in ratemaking and rate regulation process.
Underwriting risk for a certain line of insurance can be assumed to be the same regardless of insurers. On the other hand, investment risk varies with investment policy of each company. This implies that even if the loss characteristics of two insurance policies sold by two different companies are the same, the prices of the two policies may be different from each other because of differences in the effect of investment return and risk on the prices. However, if the risk and return associated with investment activity are properly reflected in the ratemaking process, there should not be difference in prices due to differences in investment policies. In the real world, there will be actually difference in prices, but it will be negligible.

It will be up to individual preferences of insurance customers as to which policy they will buy, either a policy sold by the company oriented to high risk investment or a policy sold by the company oriented to low risk investment.

In the case that rates of property-liability insurance are determined and regulated in the framework of risk-return relationship of policyholders' surplus, the primary and most important duty of rate regulatory authorities is to make sure that the required rate of return and the expected yield on investment to be reflected in
the ratemaking process are properly and accurately determined.

If the rate regulatory authorities would make their investment regulations in such a way that every property and liability insurance company should follow a uniform investment policy in terms of risk and return for a particular line of insurance, their job would be simplified. In this case, the primary factors to make different the prices of insurance policies sold by different companies will be the expected amount of loss and expense, its underwriting risk nature, and the amount of policyholders' supporting the particular line of insurance.
CHAPTER VII

SUMMARY AND CONCLUSIONS

Introduction

The prices of many types of property-liability insurance contracts are subject to statutory rate standards, i.e., adequacy, in excessiveness, or fair discrimination. However, lack of uniformity in the interpretation of these rate standards has caused many practical problems in the process of rate regulation and ratemaking. Because of the absence of clear-cut definitions of the standards provided by statutes, regulatory authorities have had to exercise their subjective judgment in reviewing proposed rates. Under the circumstances, it has not been easy for the P-L industry and regulatory authorities to determine proper rates which will satisfy the rate standards.

In addition to the problems due to lack of uniform interpretation of the rate standards, regulatory authorities and the P-L industry have been plagued for many years with the question of whether or not investment income should be considered formally in property-liability insurance ratemaking. Furthermore, the current method of rate regulation of property-liability insurance has been
criticized because it does not properly recognize the risk associated with underwriting operation in ratemaking. It appears that each of the problems in the current rate regulation is due to the fact that there has not been developed an appropriate theory for rate regulation of property-liability insurance.

The primary objective of the study has been to apply certain financial theories to rate regulation of property-liability insurance in order to solve some of the problems in the current rate regulation.

The study consists of three major parts: 1) development of a theoretical rate regulation model based on the concepts fair rate of return and total rate of return, 2) development of a modified capital asset pricing model for property-liability insurance companies, which will be used to determine cost of policyholders' surplus of property-liability insurance companies, and 3) a series of empirical studies, including: a) the test of relationship of cost of policyholders' surplus with company size and insurance leverage, b) profitability of property-liability insurance industry, c) measurement of cost of policyholders' surplus for a sample of sixty property-liability insurance companies, and d) the test of relationship between market beta and accounting earnings variability of property-liability insurance companies.
Development of A Theoretical Rate Regulation Model

The model developed in the study is supposed to solve some of the problems in the current rate regulation, that is, problems attributed to ambiguity of rate standards, investment controversy, and inappropriate recognition of underwriting risk.

The model has been developed based on the two basic premises, that is, the concept of fair rate of return and the concept of total rate of return. These two concepts are embodied in the model by means of the concept of cost of policyholders' surplus derived from the general equilibrium market risk-return relationship.

The concept of fair rate of return is understood in terms of competitive standard in the capital market. The equilibrium expected rate of return on assets is positively related to risk, and the expected rate of return on assets with same risks should be the same. In other words, the expected rate of return on an investment should be commensurate with the risk assumed. Since investors in the stock-property insurance business, like those in any other business, should be able to earn a competitive rate of return on their capital, insurance rates should be set so as to provide the competitive rate of return on
their capital. An operational meaning of the fair rate of return on the invested capital is the cost of policyholders' surplus determined in the framework of general equilibrium market risk-return relationship. The model developed in the study is to specifically achieve the following aims of rate regulation: 1) to prevent the property-liability insurance industry from extracting an excess economic profit (earning more than fair rate of return), 2) to prevent the property-liability insurance industry from suffering lack of capital supply because of low profitability earning less than fair rate of return, and 3) to prevent property-liability insurance companies from becoming insolvent as a result of cut-throat competition in price.

If one is to regulate rates of property-liability insurance on the basis of fair rate of return, he has to consider total income for property-liability insurance companies in generating rate of return on policyholders' surplus. This means that in the framework of fair rate of return regulation, underwriting income as well as investment income should be formally considered in ratemaking.

The cost of policyholders' surplus is determined by the modified capital asset pricing model which incorporates explicitly and jointly the risks associated with underwriting and investment activities.
The model developed in the study takes the following form:

\[ P = \frac{ps((E(R_i) - E(I_p)) + \bar{L}}{1 + a \cdot E(I_p)} \]

Some of the important features of the model include:
1) premiums can be determined in an objective manner;
2) investment income as well as underwriting income is properly reflected; 3) the risks associated with underwriting and investment operations are adequately recognized; and
4) premiums determined by the model are expected to cover all losses and expenses, and to provide fair rate of return to the policyholders' surplus.

The validity of the model depends on the validity of the general market equilibrium capital asset pricing theory. Therefore, should any question about the validity of the capital asset pricing theory arise in the future, the model should be amended accordingly.

**Development of A Modified Capital Asset Pricing Model**

The rate regulation model developed in the study requires the information on the cost of policyholders' surplus to be determined in the framework of the capital
asset pricing model. In the meantime, the conventional capital asset pricing model has some limitation in its applicability to certain situations. It is not practically applicable to the situations where market data do not exist. This problem is serious particularly in the property-liability insurance industry, for the majority of property-liability insurance companies are non-traded firms. In order to solve the problem in application of the conventional capital asset pricing model, and to incorporate unique nature of operations of property-liability insurance companies, the study developed a modified capital asset pricing model for property-liability insurance companies.

The modified capital asset pricing model is expressed as below:

\[
E(R_i) = R_f + (E(R_m) - R_f) \cdot \{a_o + a_1 \left[ \sigma^2 (1-L_{R_i}) \cdot (P/ps)_i \right. \\
+ \sigma^2 (I_p)_i \cdot (F/ps)_i^2 \} \}
\]

The unique feature of the modified model lies in the facts that the systematic risk of policyholders' surplus is not measured based on market data, but it is measured by accounting data, more precisely, market beta estimated via accounting earnings variability, and that the market beta
estimated via accounting earnings variability explicitly and jointly incorporates the risks associated with underwriting and investment operations of a firm. The basic theoretical background of modification is the proposition that there is a significant relationship between the market beta and the accounting earnings variability of property-liability insurance companies. This proposition has empirically been proved in the present study, and explained as well as in the previous studies.

**Empirical Study**

A series of empirical studies have been performed on the following subjects.

**Association Between Market Beta and Accounting Earnings Variability of Property-Liability Insurance Companies**

The test has been performed based on a sample of 20 property-liability insurance companies by means of cross-section regression analysis in which market beta was used as dependent variable and accounting earnings variability as independent variable. The market beta was obtained from the market model, and accounting earnings variability was defined as the standard deviation of net
income before tax over policyholders surplus at end of immediate previous year.

The result of the test showed that there is a significant association between the market beta and accounting earnings variability of property-liability insurance companies.

In a pilot study, the relationship between the market beta and the covariability of earnings (accounting beta) was also tested. The result of the test showed that there is not a significant relationship between the two variables.

Effect of Company Size on The Cost of Policyholders' Surplus

The test has been performed based on a sample of 60 companies by means of both cross-sectional regression analysis and difference between means test. In the regression analysis, the market beta estimated via accounting earnings variability was used as dependent variables and natural logarithm of the average of total asset over the 20-year period from 1956 to 1975 was used as independent variable.

The results from both analysis showed that there is not a significant relationship between the size and the market beta estimated via accounting earnings variability. Accordingly, it was concluded that there is not a significant relationship between the size and the cost
of policyholders' surplus, for the cost of policyholders, surplus is positively and linearly related with the market beta estimated via accounting earnings variability.

Effect of Insurance Leverage on the Cost of Policyholders' Surplus

The test was performed by means of cross-sectional regression with insurance leverage as independent variable and market beta estimated via accounting earnings variability as dependent variable. Differences between means test was also supplemented to the regression analysis.

The insurance leverage was defined as the average of annual net premium written over the amount of policyholders' surplus at end of immediate previous year for the 20-year period from 1957 to 1975.

As expected, the results of the tests showed that there is a positive relationship between the insurance leverage and the market beta estimated via accounting earnings variability. Accordingly, it was concluded that there is a positive relationship between the insurance leverage and the cost of policyholders' surplus.

Profitability of the Property-Liability Industry

In the test, profitability was defined in such a way that if a firm earned, an average over a certain period,
more than or equal to the cost of policyholders' surplus (required rate of return determined by the general equilibrium market risk-return relationship in the same period), the firm would be considered profitable, and vice versa.

The cost of policyholders' surplus (required rate of return) was obtained by the modified capital asset pricing model on the basis of 20-year period data. The average rate of return was defined as arithmetic mean of annual rate of return and the annual rate of return was defined as statutory underwriting gain (loss) plus net investment income plus realized and unrealized capital gain (loss) minus taxes paid over policyholders' surplus at end of immediate previous year.

From the analysis, it was shown that 75% of the sample of 60 companies earned more than or equal to the cost of policyholders' surplus (required rate of return). More than 50% of the sample companies earned greater than the cost of policyholders' surplus (required rate of return). More than 50% of the sample companies earned greater than the cost of policyholders' surplus by more than 1% margin. Only less than 3.5% of the sample companies earned less than the cost of policyholders' surplus by margin of more than 3%.

The average of the cost of policyholders' surplus for the sample of 60 companies was 7.65%, while the average of the sample companies in average annual rate of
return was 10.13%. This indicated that property-liability insurance companies studied in the test, in average, earned more than the required rate of return.

The results led the writer to conclude that in the framework of general equilibrium market risk-return relationship the profitability of the property-liability insurance industry during the past 20-year period from 1956 to 1975 was very high.

In addition to the above findings, the empirical study showed that the major source of earnings for property-liability insurance companies in the past was investment earnings and actually the underwriting operation made negative contribution to the total earnings in general. Total variability in total earnings had been largely attributed to the variability of investment earnings.

**Implications of the Study**

**Implications to the Management of Property-Liability Insurance Companies**

The study carries two important implications to the management of the property-liability insurance companies in the following two areas: application of cost
of equity capital to financial decision making and ratemaking of property-liability insurance.

Even though there has been a well established finance theory which deals with application of cost of equity capital, derived in the framework of the capital asset pricing model, to financial decision-making, this theory has not been generally useful and therefore, not applied to financial decision-making for property-liability insurance companies. This is mainly because of difficulties involved in determining the cost of equity capital of property-liability insurance companies in the framework of the conventional capital asset pricing model.

In the conventional capital asset pricing model, the cost of equity capital of a firm is determined by the systematic risk of the equity capital, and the systematic risk has been customarily determined based on market data. Therefore, for those property-liability companies for which market data do not exist, such as, wholly-owned firms by conglomerates, privately-held firms, and property-liability division of all-line insurance companies, it is not possible to determine the cost of equity capital by applying the conventional capital asset pricing model.

This problem is now solved by the development of the modified capital asset pricing model which requires only accounting data. In other words, the study enables
the management of property-liability insurance companies to determine the cost of equity capital, regardless of whether the companies are wholly-owned firms, privately-held firms or even division of all-line insurance companies, in the framework of the capital asset pricing theory. This implies that the management of property-liability insurance companies can apply the cost of equity capital to their financial decision-makings.

Another important implication of the modified capital asset pricing model to the management is that the modified model enables the management to analyze the effect of their policies on underwriting and investment operations upon the cost of equity capital.

In sum, the modified capital asset pricing model provides the management with an opportunity to apply the modern finance theory in their management. This opportunity will enhance the effectiveness and efficiency in the management of property-liability insurance companies.

As to ratemaking of property=liability insurance, the rate regulation model developed in the study can be used as an objective tool to determine rates of insurance. Therefore, the management will no longer have to rely on their subjective judgment in ratemaking, and also no longer have to debate with regulatory authorities about the reasonableness of proposed rates. This will save time and money involved in rate filings.
Since the regulation model has been developed in such a way that premiums determined by the model are expected to cover the loss and expense and provide fair rate of return to policyholders' surplus, the only thing they have to do in ratemaking is to follow properly the procedures specified in the model.

Implication to Regulatory Authorities

The rate regulation model developed in the study provides regulatory authorities with an objective and clear-cut method of reviewing proposed rates. Since the model has been developed in such a way that rate determined by the model will satisfy the statutory rate standards, particularly adequacy and inexcessiveness, they will no longer have to exercise their subjective judgment in the process of reviewing proposed rates. The only thing they have to do is to mechanically check whether or not proposed rates are properly determined in accordance with the model, and to check whether or not the assumptions made by the company management in determining input variable are theoretically and practically appropriate. However, in order to properly apply the model, regulatory authorities are required to make themselves familiar with the modern finance theory, particularly portfolio theory and capital market theory. This may imply that there should be at
least one or more experts in modern finance theory in each state insurance department.

**Directions for Future Research**

Suggestions made here are those which have occurred to the writer as the study progressed. Each distinct question believed worthy of investigation is numbered.

1. The regulation model has been developed for the case where a property-liability insurance company sells only one line of insurance to a group of customers with homogeneous loss of characteristics. Therefore, it may be worthwhile to extend the model for the case where a firm sells more than one line of property-liability insurance to different groups of customers with heterogeneous loss of characteristics.

2. A much larger sample of firms (including many small firms) could be employed to examine the relationship between the cost of policyholders surplus and the size of the firm. This would increase the generality of the results.

3. A new sample—containing relatively small firms—might be utilized in order to test the difference in profitability between large firms and small firms and to increase the generality of the results.
APPENDIX A

THEORETICAL DEVELOPMENT

OF CAPITAL ASSET PRICING MODEL
The modern capital market theory is concerned with the determination of general equilibrium prices of capital assets under conditions of uncertainty. There are two main approaches to this problem: the mean variance models following the Markowitz tradition, and the state preference models due originally to Arrow and Debreau. 83

The capital asset pricing model was originally developed by Sharpe and Lintner. 84 The Sharpe-Lintner Capital asset pricing model is the mean-variance approach to the problems of valuation of risk assets in the market equilibrium. This model is a natural extension of the one-period portfolio models of Markowitz (1959) and Tobin (1958), which in turn built on the expected utility model of Von Newmann and Morgenstern (1953) and others.


84 W. Sharpe (1964), op. cit.; J. Lintner (1965), op. cit.
The fundamental questions which Sharpe and Lintner were concerned with are: a) What is the appropriate measure of the risk of a capital asset? b) What is the equilibrium relationship between this measure of the asset's risk and its one-period expected return?\textsuperscript{85}

The model rests on the following assumptions:

1. All investors are single-period expected utility of terminal wealth maximizers who choose among alternative portfolios on the basis of mean and variance (or standard deviation) of return.

2. All investors can borrow or lend an unlimited amount at an exogenously given risk-free rate of interest.

3. Capital markets are perfect in the sense that all assets are infinitely divisible; there are no transaction costs or taxes, information is costless and available to everybody.

4. All investors have the same decision horizon, and over this common horizon period the means and variances of the distribution of one period returns on assets and portfolio exist.

5. All investors have identical subjective estimates of the means, variances and covariances of returns among all assets.

6. All investors are price takers.

7. The quantities of all assets are given. Given the assumptions, the general equilibrium market risk-return relationship of any asset \( j \) is given by

\[
E(R_j) = R_f + \lambda \text{Cov}(R_j, R_m) \quad . . . . . . . \quad (A1)
\]

where \( E(R_j) \) = the equilibrium expected rate of return on asset \( j \).

\( R_f \) = the risk-free rate of interest

\( \lambda = (E(R_m) - R_f)/\sigma_m^2 \), the market risk premium per unit of risk,

\( E(R_m) \) = the expected rate of return on market portfolio

\( \sigma_m^2 \) = the variance of return on market portfolio

\( \text{Cov}(R_j, R_m) \) = the covariance between the return on asset \( j \) and the return on market portfolio.

Thus, the equilibrium expected return on any asset is equal to the risk-free rate of interest plus a risk premium given by the product of the market risk premium, \( \lambda \), and the risk of the asset as measured by \( \text{Cov}(R_j, R_m) \).
The capital asset pricing model shown as equation (A1) has two major implications. First, in equilibrium, the rate of return on individual assets will reflect only their systematic risk component, that is, that portion of the variability resulting from the association between the asset's return and that of market portfolio, measured by $\text{Cov}(R_j, R_m)$. The second implication of the capital asset pricing model is that in a market of risk-averse investors, high risk should always be associated with high expected return. Stated otherwise, investors must be paid to assume additional degrees of risk.

The equilibrium relationship between risk and expected return on individual assets, shown by equation (A1), is a logical extension of the general relationship in the market for risky assets that we call the capital market line (CML). The capital market line (CML) is expressed as equation (A2)

$$E(R_p) = R_f + \left[ (E(R_m) - R_f)/\sigma_m \right] \cdot \sigma(R_p) \ldots \ldots (A2)$$

where $E(R_p)$ = expected rate of return on an efficient portfolio $p$

$\sigma(R_p)$ = standard deviation of return on an efficient portfolio $p$.

The capital market line provides the equilibrium relationship for efficient portfolios, but does not
directly say anything about the expected returns on inefficient portfolios or individual securities.

The equilibrium conditions for securities and inefficient portfolios can be determined from the mathematical relationship between the market portfolio (M) which lies on the capital market line and the securities that comprise the portfolio. The CML is tangent to the efficient frontier (FMT) of risk portfolios at point M, the market portfolio, as is shown in Figure A1.

Let us take any asset j with \( E(R_j) \) and \( \sigma_j^2 \) at point Q in Figure A1. Consider the combinations that result from putting a fraction \( x_j \) of funds into asset j and the rest \( (1 - x_j) \) into the market portfolio, M. The expected return, \( E(R_p) \), and variance of return, \( \sigma_p^2 \), of the portfolios along QMS can be expressed as

\[
E(R_j) = x_j E(R_j) + (1-x_j)E(R_m) \quad \ldots \quad \ldots \quad (A3)
\]

\[
\sigma_p^2 = x_j^2 \sigma_j^2 + (1-x_j)^2 \sigma_m^2 + 2x_j(1-x_j)\sigma_m \sigma_j \quad \ldots \quad (A4)
\]

Since QMS must touch but not pass through FMT, QMS must be tangent at point M. This fact enables us to derive the equilibrium expected rate of return on asset j.

Since both the capital market line (CML) and QMS are tangent to FMT at point M, the slope of the capital market line must equal to the slope of QMS at point M.
From equation (A2), we know that the slope of the capital market line is \( \frac{E(R_m) - R_f}{\sigma_m} \). The slope of QMS at point M is the derivative of \( E(R_p) \) with respect to \( \sigma_p \cdot \frac{dE(R_p)}{d\sigma_p} \).

By the chain rule of differentiation

\[
\frac{dE(R_p)}{d\sigma_p} = \frac{dE(R_p)}{dx_j} \cdot \frac{dx_j}{d\sigma_p}
\]

From equation (A3).

\[
\frac{dE(R_p)}{dx_j} = E(R_j) - E(R_m)
\]
From equation (A4)

$$\frac{d\sigma_p}{dx_j} = \frac{x_j(\sigma_j^2 + \sigma_m^2 - 2\sigma_j\sigma_m) + \sigma_j\sigma_m - \sigma_m^2}{\sigma_p} \quad \ldots \quad (A7)$$

At point M, $\sigma_p = \sigma_m$ and $x_j = 0$; therefore,

$$\left(\frac{d\sigma_P}{dx_j}\right)_{x_j=0} = \frac{\sigma_j\sigma_m - \sigma_m^2}{\sigma_P} = \frac{\sigma_j\sigma_m - \sigma_m^2}{\sigma_m} \quad \ldots \quad (A8)$$

By substituting equation (A6) and (A8) into equation (A5) we can derive the slope of QMS at point M;

$$\frac{dE(R_p)}{d\sigma_p} = \frac{[E(R_j) - E(R_m)]\sigma_m}{\sigma_j\sigma_m - \sigma_m^2} \quad \ldots \ldots \quad (A9)$$

The slope of the capital market line and the slope of QMS at point M should be equal; that is

$$\frac{[E(R_j) - E(R_m)]\sigma_m}{\sigma_j\sigma_m - \sigma_m^2} = \frac{[E(R_m) - R_f]}{\sigma_m} \quad \ldots \quad (A10)$$

Solving equation (A10) for $E(R_j)$,

$$E(R_j) = R_f + \frac{E(R_m) - R_f}{\sigma_m^2} \cdot \sigma_j\sigma_m \quad \ldots \quad (A11)$$
and the equation (A11) is exactly the same as the equation (A1), which shows the equilibrium expected rate of return of any asset j.

It should be noted that although investors take the variance of their portfolio return as an appropriate measure of risk, the above results imply that the appropriate measure of risk of any individual asset is its covariance with the return on the market portfolio and not its own variance. This is because diversification can eliminate most of the effects of an asset's variance on the variance of a portfolio, but cannot eliminate the effects of an asset's covariance with all others in the portfolio.

The covariance, \( \text{Cov}(R_j, R_m) \), is proportional to the marginal impact of asset j on the standard deviation of the market portfolio, i.e., \( \alpha \sigma_m/\alpha x_j = \text{Cov}(R_j, R_m)/\sigma_m \), where \( x_j \) is the weight that asset j receives in the market portfolio. Thus rewriting equation (A1) in terms of \( \alpha \sigma_m/\sigma x_j = \text{Cov}(R_j P_m)/\sigma_m \) and defining \( \lambda \) as \( (E(R_m) - R_f)/\sigma \) we see that in equilibrium the expected return on asset j is linearly related to its marginal contribution to the total risk to be borne by the market portfolio.
APPENDIX B

LIST OF SAMPLE COMPANIES AND
COST OF POLICYHOLDERS' SURPLUS
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APPENDIX C

LIST OF VARIOUS RATE OF RETURN AND VARIABILITY OF SAMPLE COMPANIES
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1. Average Rate of Return (Before taxes paid)
2. Investment Rate of Return on Policyholders' Surplus
3. Underwriting Rate of Return on Policyholders' Surplus
4. Total Accounting Earnings Variability
5. Investment Earnings Variability
6. Underwriting Earnings Variability
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