THE CAPITAL ASSET PRICING MODEL AND REAL ESTATE INVESTMENT ANALYSIS

by

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Statement As To Originality Of Contents:

This dissertation contains no material which has been accepted for the award of any other higher degree or graduate diploma in any tertiary institution and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due reference is made in the text.

Stuart Murrin Locke

Abstract:

The research reported upon in this thesis consists of two parts. First, a discussion of the theoretical development of the capital asset pricing model and its applications, as reviewed in the finance literature, is presented. Second, a detailed empirical investigation into the applicability of the model to various aspects of the analysis of real estate investment is undertaken.

CAPM is presented as a framework for the analysis of competing investment choices in an uncertain world. The theoretical development is traced from a single period consumption or defer consumption problem in state preference theory, through to the obtaining of maximum utility from a portfolio of assets in a world of uncertainty. The model is next demonstrated with regard to its use for tests of information efficiency in the market, the evaluation of investment projects and the assessment of investment performance.

Extensive testing of the capital asset pricing model has been undertaken in the financial securities markets. It is also included as a fundamental component of most corporate finance texts concerned with project investment analysis and the monitoring or assessment of the performance of portfolios of financial securities. Developments, refinements and alternative models discussed within the literature, which result from the ongoing research efforts in these areas, are summarized.

Almost all of the empirical testing and applications of the capital asset pricing model discussed in the finance literature are concerned with financial securities. This is a little surprising in the light of the generality of the model in its theoretical form. However, data availability, in the form of share price files for various stock markets, is very likely a major contributing factor for the predominant concentration of research in the equities section of the asset market.

Applicability of the capital asset pricing model to the property market is considered next. Real estate transaction information is reviewed and a number of simplifications and abstractions from what is conceptually desirable are explained. Data files for the empirical experiments undertaken are compiled from a number of sources.

While the lack of price and return information may have inhibited earlier research into the usefulness of the capital asset pricing model for real estate investment analysis, it may also result in the model being inappropriate. This possibility is considered in detail.

The link between the capital asset pricing model and information is examined by empirical tests of the three forms of the efficient market hypothesis. First, the weak-form and the distributional properties of the returns are analysed. Second, the semi-strong form is investigated with an announcement effect study. Third, the strong-form is considered with an examination of portfolio performance. The theoretical justification for applying the model to specific applications is dependent upon the level at which the efficient market hypothesis is accepted.

Real estate provides a new area for considering the relative pricing of an asset in an equilibrium framework known as the capital asset pricing model. The research reported makes a useful contribution to capital market finance by empirically testing, in a thorough statistical manner, the applicability of a general theory to a significant submarket of the Australian asset market viz. the real estate (property) market.

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CHAPTER ONE

INTRODUCTION

Introduction

The research presented in this thesis is, as the title indicates, concerned with both the capital asset pricing model and real estate investment analysis. Specifically, the aim is to consider the applicability of this particular model of equilibrium asset pricing to the analysis of real estate valuation and to the assessment of real estate performance.

First, the theory of the capital asset pricing model and how it may be applied in the analysis of real estate is discussed. Second, extensive empirical research into how well the model fits the data is undertaken. Before proceeding directly to examine these two aspects of this study it will be useful to consider why the issue is of interest. Accordingly, the motivation for this research is explained.

1. Motivation

Motivation underlying the research reported in this thesis arose from observations of apparent dissimilitude in the real estate and share markets. Differences in the manner in which the markets operate, physical differences in the assets traded, and differences in the terminology employed are readily apparent. Although such aspects may be interesting to explore, it is the irreconcilable divergence between valuations determined in the real property market and the financial property market which became the primary point of focus. In particular, the widespread phenomena of shares in property trusts selling at a discount on the appraised valuation of their net tangible assets prompted further investigation.

It is revealing to compare the capitalized value of the shares in listed property trusts, namely the market price of the shares multiplied by the number of issued shares, with the net tangible assets (NTA) of the trusts for the early 1980s when this research commenced. The ratio of NTA, which are appraised market values, to capitalized share price is presented in Table 1.1. It is apparent that in the majority of instances these property trusts are selling at a discount and this is consistent with the pattern observed in Britain and the United States.

TABLE 1.1

NET TANGIBLE ASSETS TO CAPITALIZED VALUE:
PROPERTY TRUST INDUSTRY

Trust	December 31 1983 (TIMES)	December 31 1982 (TIMES)	December 31 1981 (TIMES)	December 31 1980 (TIMES)
ASC Property	1.05	1.35	1.00	1.22
Canberra Commercial	1.13	1.27	1.25	1.48
Canberra Commercial #2	0.95	1.08	1.11	1.26
PML Property	1.07	1.18	0.96	0.88
Stocks & Holdings Property	1.15	1.31	1.40	1.33
General Property	0.95	1.29	1.02	1.13
National Property	1.42	1.50	0.83	1.11
Schroder Darling Property	0.90	1.09	1.07	1.10
Equitable Property #1	1.42	1.74	1.41	1.43
Equitable Property #3	1.36	1.68	1.47	1.24
IEL Property	1.41	2.07	1.74	1.61
PA Property	1.36	1.50	1.22	0.80
Industry Median	1.14	1.33	1.17	1.23

Source: Sydney Stock Exchange Research Service

Mayo (1983, p.567.) comments on this fact in relation to Real Estate Investment Trusts (REIT) in the United States:

> Since REIT shares may sell below their equity per share, should investors consider the REITs attractive? The answer is 'Not necessarily'. If a REIT's shares are selling for less than the equity per share that

> alone is insufficient justification to purchase the stock. The investor should seek to determine the cash flow (profits plus depreciation) generated by the properties. If the properties are generating sufficient cash flow, then the REIT may be considered attractive. However, if the cash flow is insufficient, the shares are unattractive even if they sell at a discount from equity per share.

Malkiel (1985, p.286.) offers a similar view.

Property trusts in Australia, property companies in the United Kingdom, and REITs in the United States of America are corporations which invest in a portfolio of properties. The shares in these corporations are in some instances listed on the stock exchange and traded like any other share. Determination of the intrinsic value of shares in a company is an exercise in establishing the present value of future cash flows associated with holding the shares. The fundamental rule of economic value applies in principle. The practical issue is a problem of estimating the magnitude and timing of the net cash flows and the appropriate discount rate to be used. Intrinsic values determined according to the economic value theorem should, in a competitive market, equal the market price of the share.

Valuation of properties in a portfolio is undertaken periodically by qualified valuers or appraisers, as they are known, in order to estimate the "market value" of the individual properties. Millington (1982, p.35.) defines this term "as the money obtainable from a person or persons willing and able to purchase an article when it is offered for sale by a willing seller." It appears reasonable therefore to assume that the total value of the portfolio will be the total value of the corporation if no other assets or liabilities are involved. The total market value of the properties held by the trust should be the same as the total market value of the trust. However, as is apparent in Table 1.1, this is not necessarily the case.

Differences in share price and asset backing are also apparent in closed-end mutual funds. Malkiel (1977) discusses three variables which help explain the discount. The tax liability associated with unrealized capital gains, fund policy as to how capital gains are to be distributed and the liquidity of the holdings are thought to be important. After taking these factors into account there still remains an unexplained discount which Malkiel (1977), and Thompson (1978) attribute to market inefficiency. Evidence in the United Kingdom reported by Woodward and Matatko (1980, p.505.) "reinforce the earlier pessimistic results of Malkiel (1977)." Further discussion by Brauer (1984) suggests that abnormal returns are available when closed-end funds are to be opened. The possibility of inefficiency warrants attention in the property trust context.

The British property consultant firm, Simon and Coates (1982, p.2.), suggests a number of reasons why discounts exist for property companies. "The explanation for this lies in the nature of the real estate market which is, of necessity, a much slower and more imperfectly reacting animal than the stock market." The firm proposes that "An investor might be absolutely convinced that logically yield ought to rise and hence that capital values should fall, but this does not necessarily mean that he will withdraw from the market and hence that capital values will fall anything like as far as logic might dictate they should." Immediately following this quote an example is provided:

> As an example of the illogical (or non-mathematical) way in which the real estate market can react to events, we may take the last quarter of 1976 when

> there was a major sterling crisis; MLR rose from 9% to 13% to 15%; the yield on undated gilts rose from 14% to over 16%. Property share prices fell sharply and many shares were left standing on discounts to their net asset values of 50%.

An obvious first explanation is that this is just a timing problem. Valuations were not written down in subsequent periods and the gap remained large.

This last suggestion and several other factors, such as those suggested in the context of closed-end mutual funds, may contribute to the distortion. Whiting (1982) considers such issues in an analysis of the potential information content of discounts. Unfortunately, he reports in respect of the basic anomaly that "No advance has been made here" (p.77.) in terms of developing a plausible explanation. Blandon (1983, p.117.) also investigates this discrepancy and he believes the problem arises from valuations which are inappropriate, having regard to the appraisers involved. "The property valuers are themselves trained more in the law, technology and institutions regarding property than in the theories of financial economics that are relevant to the rigorous analysis of the investment potential of property."

Cole, Guilkey, and Miles (1986) provide empirical evidence for a sample of property sales in the United States of America showing the mean absolute difference between actual selling price and an appraised market value, conducted in the preceding quarter to be 9.1%. As pointed out by Locke and Langfield-Smith (1986a) the choice of an alternative error metric capable of detecting bias is desirable. The property share discount phenomena and the observation of property trust crashes in the US [Hall (1974) and Rudnitsky (1977)] and in Australia, as reflected in the 1984 demise of the Telford and Balanced property trusts, indicates that valuations are likely to be above price.

The fundamental issue which emerges from these apparent differences in the market value of real estate property and real estate shares is the question of whether the assets are substitutes. If real estate is another security which investors may choose to place in their portfolios then the underlying asset pricing equilibrium model should be the same as for the shares. Francis and Archer (1979, p.3.) claim that the modern approach to portfolio theory, which is at the core of modern finance, "is adaptable for any decision involving risk, such as selecting an automobile, a home, a career, or even a spouse."

2. Approach

Portfolio theory provides a framework in which to investigate the issue as to whether real property assets and financial property assets are substitutes for one another in investors' holdings of securities. The requirement to choose between alternative investment instruments under conditions of uncertainty requires the development of a model which is capable of explaining the relative price of assets when a state of equilibrium prevails.

The capital asset pricing model (CAPM) is chosen as the specific paradigm in which the research question is to be investigated. Selection of CAPM rather than some alternative model is based on a number of grounds. First and foremost it is the most widely discussed and tested model of equilibrium pricing. The vast volume of material written about this model may be due to it preceding more recently developed alternatives. Nevertheless, it continues to be widely utilized.

Simplicity in use is the second important reason for selecting CAPM. It is now appearing more frequently in the real estate valuation and appraisal literature. As the model is currently being recommended for use in real estate analysis, research into its applicability is particularly timely and worth pursuing.

The initial step in the investigation is to explain how CAPM is consistent with the choice of alternative investments in a world of uncertainty. This task is undertaken in the next chapter i.e. Chapter 2. A single period choice problem of consumption versus deferred consumption is expanded upon to introduce the concepts of return and risk. Choice under risk is demonstrated to be a relatively simple matter when certain statistical requirements concerning the probability density functions of the choice variables exist. CAPM simplifies the relative pricing of assets to a linear relationship between the risk-free interest rate and the rate of return on the market portfolio.

Application of CAPM to the analysis of real estate is relatively new. In Chapter 3 a discussion is provided of the major possible uses. Within the valuation and appraisal literature recurring reference is made to CAPM but few conceptual explanations are provided. The unfortunate consequence of this somewhat ad hoc adoption of CAPM, or a misunderstood CAPM, is that there are errors in procedures which have been recommended.

The remainder of the thesis is primarily empirical. Two aspects concerning the use of data are addressed in Chapter 4. First, what are the desirable qualities for data to exhibit to be readily useful in estimations of CAPM? Second, what data are available and how do they measure up against the desired characteristics?

Design of the empirical analyses to address the question of whether CAPM is appropriate for real estate data is determined by the assumptions of the model. The approach pursued is based on the understanding that the empirical estimation of CAPM cannot be undertaken in the absence of assumptions regarding the security market. In particular the requirements of the model, as discussed in Chapter 2, make any direct estimation of the model a joint test of the efficiency of the market.

Two possible designs present themselves as alternatives. Either directly estimate the model, or test that the necessary conditions of market efficiency are present. The latter method is chosen. Adoption of the former approach may obtain good results from the data but these may be just a statistical anomaly. A wiser course of action is to deduce from the model the necessary conditions for the model to operate and test that these are satisfied. If the necessary conditions are met, then the model may be estimated with greater certainty attributable to the results. This idea is discussed further in Section 6 of Chapter 2 and in the empirical Chapters numbered 5, 6 and 7.

3. Limitations

Sample size and data reliability are the two major factors which serve to limit the generality of this research. Ball and Foster (1982, pp.170-171.) suggest that data availability has played a central role in shaping the direction and development of empirical research in accounting. If the data were readily available the extensive testing of CAPM conducted in the financial securities market would have been duplicated in other asset markets.

However, data are not readily available and this poses several difficulties.

Available length of the time series and the range of assets covered in these series constrain the analysis in regard to the methods which may be utilized. Further, there is very little information concerning the actual components of the data series provided by the various organizations which are responsible for publishing the numbers. A number of visits to industry sources in order to obtain more details on returns and indexes which they published, proved to be frustrating. Very few particulars as to sample size, sampling methods and distributions were available. While every endeavor is made to ensure the numbers used are the best available there still remains a high degree of uncertainty regarding the real asset returns. The insights into the real estate industry gained during this lengthy data gathering exercise are, nevertheless, useful background for the overall study.

An extensive discussion, focusing on the theoretically desirable properties of data inputs and the actual data employed, is provided in Chapter 4. Of particular significance, in terms of the possible limiting effect on the generality of the research, is the number of observations available for statistical analysis. Specifically, there are few published real estate price indexes which are suitable for the calculation of returns. Coverage is confined to broad categories of asset type, such as housing in a particular city or vacant land. The aggregation of assets into these broad groupings is likely to result in losses of information bearing on the behavior of finer classifications of assets. There are potentially offsetting movements in each category between assets which are not perfectly positively correlated. The average outcomes observed may not be representative of any of the assets within the group.

As discussed in Chapter 4, several of the returns series used are calculated from various indexes. These indexes are prepared by property consultant sources based on portfolios of assets under their control. The actual size and representativeness of these portfolios are unknown. Information regarding the geographical composition of the index and the extent to which the value is unique because of the given location of the assets held, is limited for Australian portfolios. If alternative indexes purporting to measure the same or very similar factors were available then the opportunity to measure their comparability would be useful. Unfortunately no verifying procedure along these lines is possible.

Insufficient time-series length poses problems in terms of the statistical analysis undertaken. Some methods used in share market studies to estimate correlations, such as spectral analysis, are not feasible since there are too few observations. The approaches pursued and reported on are limited by the availability of data. Inferences as to the statistical significance attributable to several results are affected by the small number of degrees of freedom.

A further limitation, with respect to the equilibrium asset pricing model used in this research is the predominant emphasis upon the capital asset pricing model. This restriction is deliberate and the form of CAPM considered is very much the conventional or standard form. This is compatible with the model currently appearing in the real estate valuation and appraisal literature. Although various modifications and extensions to the basic model are noted in the theoretical discussion contained in Chapter 2 they are not implemented in the empirical analysis. Similarly, alternative models of equilibrium, such as the arbitrage pricing theory framework attributed to Ross (1976), are not incorporated in this study. Emphasis is limited to the original form of CAPM as this study is primarily concerned to establish whether or not it is applicable. Tests of various modified forms of CAPM and/or alternative equilibrium models of the relative prices for assets are potential topics for further research. The desirability of such research is likely to be heavily influenced by the outcome of this initial enquiry. Perhaps CAPM will appear as a highly probable contender for the most parsimonious model.

4. Contribution

An apparent anomaly in the valuation of property trusts provided the initial motivation for this study. Likely explanations as to why these observable differences exist relate to imperfections in the market. It appears that either the share market or the appraised value of the real estate asset is wrong. However, this may not necessarily have to be the case. If the property valuations purport to measure something other than market selling price at that specific point in time, then the differences may be explained. Similarly, the striking differences in techniques between those used by valuers and the net present value approach to economic valuation may not represent a problem.

The primary contribution of the research reported in this thesis is in terms of the light it sheds upon the differences between the share market and the property market. There are, of course, readily distinguishable differences in institutional form, but the underlying issue of what determines value is more important. Hence, the central focus of the enquiry is to examine the extent to which a common, tried and true stockmarket model of equilibrium relative price setting, is applicable to real estate.

If CAPM fits the real estate data well, then it is not difficult to argue in favor of valuation methods based on CAPM. The readily observed differences between real estate property and real estate share valuations can be explained in terms of inappropriate methodology on the part of valuers in their appraisal work. Differences in the two forms of market value are then attributed to poor valuations. However, if CAPM does not fit the data, this argument based on a requirement of consistency of technique with the underlying equilibrium model founders.

Empirical evidence reported in this thesis addresses the issue of the propriety of applying CAPM derived methods of valuation and performance evaluation to real estate. Considerable evidence regarding the efficiency of the property market and a comparison with the findings in the share market is reported. The major contribution of this research is in the evidence it provides on the efficiency of the real estate market and the applicability of the widely accepted capital asset pricing model to this group of assets.

A minor contribution stems from empirical research methods used. The comprehensive, and at times exhaustive, testing of hypotheses utilizes several new approaches. The issue as to whether returns from taking a short position should be included in a filter test, and the treatment of random coefficient regressions, improves the general level of debate in those areas.

In summary, the most significant contribution of the thorough empirical investigations reported in this thesis is twofold. First, it provides a reason for the existence of differences in the market price of real estate property and real estate shares. Second, it presents support for valuers not using the same approach as that adopted in the corporate securities market.

CHAPTER TWO

CAPITAL ASSET PRICING

Introduction

This Chapter describes the development of an equilibrium asset pricing framework, known as the capital asset pricing model (CAPM), which is to be applied in a number of real estate evaluation contexts. An understanding of the issues which culminated in the formulation of CAPM enhances an appreciation of both its simplicity and its limitation. The ensuing discussion develops a theoretical formulation of the model from a simple investment choice starting point through to a consideration of various extensions and adaptations of CAPM.

The exposition proceeds in seven sections, each focusing on different aspects of the equilibrium asset pricing framework. It is apparent, in the following sections, that the distinction between theory, empirical estimation and application is not completely maintained. Research into the estimation of models has resulted, as discussed below, in the hypothesising of new models and amendments to the then existing theory. Similarly, attempts at applying the theory in various problem solving roles resulted in the modification of the model employed and alterations to the underlying theory. Both estimation and application not only use the contemporary theory of that time but are observed also as driving theory development. Accordingly, the distinction between these three aspects is not always clear cut and a more subtle delineation is required in selecting material for inclusion under specific headings.

Section 1 commences with a two period model of consumption/saving choice in a perfect certainty setting. The strong assumption of perfect certainty is then relaxed and a consideration of risk, an important parameter in more realistic asset choice models, commences. Further elaboration occurs in Section 2 where both the qualitative notion of risk and the need for a quantitative measure are addressed. Investment is seldom directed entirely toward a single asset and it is more likely that funds are spread over a set of assets known as a portfolio. Section 3 discusses the return and risk characteristics of portfolios and the relevant risk and return characteristics of individual securities viewed as a component or potential component of a portfolio of assets.

A model of individual asset return and risk parameters, known as the market model or single index model, is presented in Section 4. This linear model provides not only a practical simplification of the complexities involved in attempting to apply portfolio theory in practice but it also leads into the development of CAPM. Section 5 explains the standard form of CAPM and examines its relationship to asset choice under conditions of uncertainty. The assumption of perfect markets and the implications of this requirement for market efficiency are noted. This is the central pivot for the empirical research of Chapters 5, 6 and 7 follows. A full treatment of the potential applications of CAPM to the areas of asset selection and performance evaluation is left to Chapter 3.

Empirical testing of CAPM is examined in Section 6. Published studies which analyze the empirical validity of this model do so in several different ways. The apparent failure of CAPM to fit the data is the subject of Section 7. Various modifications and extensions of CAPM directed toward redressing the confounding empirical evidence are reported in numerous research papers. Those aspects considered to have a direct bearing on the application of CAPM to real estate, as detailed in subsequent chapters, are reviewed.

Chapter 2 concludes with a summary of the major issues discussed in Sections 1 - 7. Further, the main points regarding the relevance of CAPM developed in subsequent chapters are briefly stated.

1. Investment Choice

The development of a model for analyzing the optimum investment in assets commences in a two period perfect certainty framework. All individuals start with an initial endowment of wealth and they attempt to maximize their utility defined over immediate consumption (C_0) and end of period consumption (C_1). If it is assumed that individuals have a positive rate of time preference, then present consumption is preferred to future consumption. Further, if it is assumed there exists a real risk-free rate of interest (r_f), representing the consensus view of the rate of time preference, then the problem may be formally stated as a constrained maximization formulation from which decision choice formulas are derivable.

The optimal consumption/saving choice, referred to in some finance texts as investment/consumption choice [Levy and Sarnat (1984, ch.3.), Copeland and Weston (1983, ch.1.)], is expressed as:

$$\text{Max } U(C_0, C_1), \quad \text{when } U' > 0,\ U'' < 0$$
$$\text{s.t. } W_0 = C_0 + C_1/(1 + r_f), \quad \text{and } W_1 > 0. \tag{2.1}$$

The original wealth may be interpreted as the present value (PV) of the consumption set:

$$PV(C) = C_0 + C_1/(1 + r_f). \tag{2.2}$$

The decision models for initial and terminal consumption are formulated accordingly over wealth and interest rate:

$$C_0 = C_0(W_0, r_f)$$

$$C_1 = C_1(W_0, r_f) \tag{2.3}$$

Individuals will save some portion of their initial wealth and invest this amount. In a perfect certainty world all investment will occur in the asset which will yield the highest return. No funds will flow to assets which offer a lesser rate of return. As the demand for the highest yielding asset is bid up and the price of all lower yielding assets fall, an equilibrium rate of return for all assets, in this perfect certainty world, of r_f is obtained.

Casual observation of the returns afforded by securities as listed in the financial press clearly indicates this is not the current state of the financial markets. To improve the efficacy of this model of consumption/saving choice, further development is required by the relaxation of the perfect certainty assumption. Risk must explicitly be accounted for and entered directly into the choice model.

Consideration of risky returns where there is a probability density function for each instrument, has been a matter of interest for a long time. The well known St Petersburg Paradox, formulated by Nikolaus Bernoulli around 1733, [Bernoulli (1738)] provides a clear illustration of the inappropriateness of the maximum return criterion for choices involving risk. The principle of utility maximization was devised as an approach to overcome the problem. Utility theory became the subject of considerable debate and further refinement, culminating in the axiomatic approach of Von Neumann and Morgenstern (1947, ch. 1.).

Axiomatic approaches to utility functions following the work of Von Neumann and Morgenstern provide a number of useful insights into the general concept of risk premiums. The proof of the existence of continuous utility functions under various conditions by Debreu (1959) and Fishburn (1969) among others impacts upon the central notion of the core in economic equilibrium [Klein, (1973)]. Individuals' attitude toward risk is embodied in their utility functions and thus it is possible to derive definitions of risk aversion. Fama and Miller (1972, ch. 5.) and Copeland and Weston (1983, ch. 4.) provide, in more detail, an exposition along similar lines to the remainder of this Section.

Pratt (1964) and Arrow (1971) suggest a general formulation. If an individual has current wealth W_0 and is presented with an actuarially neutral gamble of $\overset{*}{Z}$ dollars, it has an expected value of zero, then the question may be asked as to what risk premium $q(W_1\overset{*}{Z})$ is required in addition to the gamble to induce indifference between it and the actuarial value of the gamble. The risk premium is the difference between U[E(W)] and E[U(W)] which Markowitz (1959) defines as describing an attitute toward risk such that:

$U[E(W)] > E[U(W)]$ implies risk aversion;

$U[E(W)] = E[U(W)]$ implies risk neutrality; and

$U[E(W)] < E[U(W)]$ implies risk seeking.

The expected utility of the current level of wealth given the gamble is equal to the utility of the current level of wealth plus the utility of the actuarial gamble minus the risk premium:

$$E[U(W + \overset{*}{Z})] = U[W + E(\overset{*}{Z}) - q(W,\overset{*}{Z})]$$

$$E(\overset{*}{Z}) = 0$$

$$\rightarrow \quad U[W + E(\overset{*}{Z}) - q(W,\overset{*}{Z})] = U[W - q(W,\overset{*}{Z})]. \tag{2.4}$$

A Taylor's series expansion of both sides of Equation (2.4) yields: left hand side,

$$E[U(W + \overset{*}{Z})] = E[U(W) + \overset{*}{Z}\, U'(W) + \tfrac{1}{2}\overset{*}{Z}{}^2 U''(W)$$
$$+ \text{ terms of order at most } (\overset{*}{Z}{}^3)]$$
$$= U(W) + \tfrac{1}{2}\, VAR(\overset{*}{Z})U''(W)$$
$$+ \text{ terms of smaller order than } VAR(\overset{*}{Z})$$

right hand side,

$$U(W - q) = U(W) - q(W)$$

solving for the risk premium,

$$q = \tfrac{1}{2}VAR(\overset{*}{Z})\ (-\frac{U''(W)}{U'(W)}) \tag{2.5}$$

and as $\frac{1}{2}VAR(Z)$ is always positive the sign of the risk premium is determined by the sign of the expression in the bracket. This is known as the Arrow-Pratt measure of local risk premium called absolute risk aversion (AR):

$$AR = -\frac{U''(W)}{U'(W)} \tag{2.6}$$

Multiplication of AR by the level of wealth gives a measure of relative risk aversion (RR):

$$RR = -W\frac{U''(W)}{U'(W)} \tag{2.7}$$

The utility formulation is also used as a rule for investment choice under uncertainty. The property of stochastic dominance founded on the concept of expected utility maximization applies to any probability distribution. Bawa (1975) provides a discussion of the approach, summarized below, which is typical of the growing literature supporting its use. Three levels of stochastic dominance provide criteria for selecting between alternative assets x and y, where $F_x(W)$ and $G_y(W)$ are the respective cumulative probability distributions:

First Degree Stochastic Dominance:

Assumption: $U'(W) \geqq 0$

$F_x(W) < G_y(W)$ for all W and $F_x(W) < G_y(W)$ for at least one W_i

$\rightarrow$ x dominates y. (2.8)

Second Degree Stochastic Dominance:

Assumptions: $U'(W) \geqq 0$ and $U''(W) \leqq 0$

$F'_x(W) < G'_y(W)$ for all W and $F'_x(W) < G'(W)$ for at least one W_i

where $F'_x(W) = \int_{\infty}^{W} F(W)\, dW$, and

$G'_y(W) = \int_{\infty}^{W} G'(W) dW$

$\rightarrow$ x dominates y. (2.9)

Third Degree Stochastic Dominance:

Assumptions: $U'(W) \geqq 0$, $U''(W) \leqq 0$, and $U'''(W) \geqq 0$

$F''_x(W) \leqq G''_y(W)$ for all W and $F''(W) < G''_y(W)$ for at least one W_i

and $E_x(W) \geqq E_y(W)$

where $F''_x(W) = \int_{\infty}^{W} F'_x(W)\, dW$ and

$G''_y(W) = \int_{\infty}^{W} G'_y(W)\, dW$

$\rightarrow$ x dominates y. (2.10)

The stochastic dominance approach provides the basis for a complete theory of choice for risky assets by risk averse individuals. If the probability density function for the returns on assets are normal and the interrelationships between such assets also obey normal probability laws, then considerable simplification is achievable. Expected utility can be maximized by reference to the best combination of the mean and variance of the returns on securities. Discussion of a theory founded on these first two moments and extensive empirical testing of the underlying assumptions constitute the major component of the research reported in the following pages.

2. Risk And Return

Consistent with the view of investors as utility maximizers is the assumption that they attempt to hold an efficient set of assets known as a portfolio. A portfolio consists of one or more assets. Efficient in this context implies that given a specific risk level there is no other combination or mix of the assets which will yield a higher return, or alternatively given a specific return level there is no other mix of the assets in the portfolio which will yield this return for less risk. Return in this context, in the majority of instances, is an ex ante concept. The expected return for the ith asset $E(R_i)$ is the product of the probability P of each of the N possible events and corresponding return outcome:

$$E(R_i) \quad = \quad \sum_{n=i}^{N} P_{in} \, R_{in}. \tag{2.11}$$

Where it is deemed appropriate to use the arithmetic average of performance in past periods as a guide to likely future returns then the mean return $\bar{R}_i$ is computed:

$$\bar{R}_i \quad = \quad \sum_{t=1}^{T} R_{it}/T \tag{2.12}$$

where R_{it} is actual return in period t.

Risk must be quantified for use in formal models. Libby and Fishburn (1977) review the evidence from experimental studies on the merit of various normative risk measures when applied in business decision contexts. Potential differences in outcome from the expected result is a widely accepted definition of risk in the finance area. Keynes (1937) identifies risk with dispersion of returns and Hicks (1946) accepts the variance of returns (VAR) as a risk measure. While noting the potential role of higher order moments for decisionmaking in conditions of uncertainty Marschak and Radner

(1972) suggest the coefficient of variation (standard deviation divided by mean) as sufficing for a statistic in most instances. Baumol (1963) does not accept the symmetrical notion of risk and prefers to consider it as relating to potentially large downside outcomes. The primary concern is with situations where the expected return is large when compared to the standard deviation (SD). In this context E(R) - k SD is suggested as a superior risk index. Chebyshev's inequality suggests that the probability of a random variable having a value less than k SD from the mean is bounded by $1/k^2$.

The variance or standard deviation are typically used and these are defined as:

$$VAR(R_i) = \sum_{j=1}^{N} P_{ij} (R_{ij} - E(R_i))^2, \text{ and}$$

$$SD(R_i) = VAR(R_i)^{\frac{1}{2}} \tag{2.13}$$

A historical time series of returns is often used to estimate the sample variance (S^2) and sample standard deviation (S):

$$S_i^2 = \sum_{t=1}^{T} (R_{it} - \bar{R}_i)^2/T, \text{ and}$$

$$S_i = (S_i^2)^{\frac{1}{2}}. \tag{2.14}$$

Implicit in the acceptance of variance as a surrogate for risk is the assumption that the probability distribution is approximately normal. In such situations there is no gain to be made by working only with less favorable than expected results, downside risk, as measured by the semivariance (h^2) and semistandard deviation (h) of returns:

$$h^2 = \sum_{n=1}^{N} P_{in} [R'_{in} - E(R_i)]^2, \text{ and}$$

$$h_i = (h_i^2)^{\frac{1}{2}}. \qquad (2.15)$$

where R'_i are rates of return less than $E(R_i)$. Cooley (1977) explains the use of semivariance analysis and measures of skewness to deal with assymetric distributions.

The discussion in this Section dealing with return and risk focuses, to this point, on measures appropriate for single assets. As noted in the opening paragraph, investors will primarily be involved with a portfolio of more than one security. Hence it is, necessary to develop return and risk measures for those cases. Markowitz (1952) provides a major break-through in the understanding of the relationship between the fundamental variables of risk and return when assets are combined to form portfolios. The expected return for a portfolio $[E(R_p)]$ consisting of M securities is the sum of the expected value of each security weighted (x_i) according to its proportion of the total value of the portfolio. This follows directly from the properties of the expectation operator [Hoyle (1971, p.118.)]:

$$E(R_p) = \sum_{i=1}^{M} E(R_i)\, x_i \qquad (2.16)$$

$$\text{s.t.} \quad \sum_{i=1}^{M} x_i = 1.$$

Portfolio risk, as measured by the portfolio variance, is not, in general, the weighted sum of the variances of each security in the portfolio. This is apparent when the definition of variance and covariance $[COV(R_iR_j)]$ are combined to reexpress the variance of a portfolio as:

$$VAR(R_p) = E[R_p - E(R_p)]^2 \tag{2.17}$$

$$COV(R_iR_j) = E[(R_i - E(R_i))(R_j - E(R_j))]. \tag{2.18}$$

Rewriting (2.17),

$$VAR(R_p) = E[\sum_{i=1}^{M} R_i x_i - \sum_{i=1}^{M} x_i E(R_i)]^2$$

$$= E[\sum_{i=1}^{M} x_i (R_i - E(R_i))^2]$$

and substituting (2.18),

$$VAR(R_p) = \sum_{i=1}^{M} x_i^2 E(R_i - E(R_i))^2 + 2 \sum_{i=1}^{M} \sum_{\substack{j=1 \\ i \neq j}}^{M} COV(R_iR_j)$$

$$= \sum_{i=1}^{M} x_i^2 VAR(R_i) + 2 \sum_{i=1}^{M} \sum_{\substack{j=1 \\ i \neq j}}^{M} x_i x_j COV(R_iR_j)$$

$$= \sum_{i=1}^{M} \sum_{j=1}^{M} x_i x_j COV(R_iR_j). \tag{2.19}$$

The extent to which securities covary determines the magnitude of the risk reduction attributable to diversification. Portfolio variance is a function of individual security variances and the covariance between each pair of different securities s.t. $i \neq j$.

3. Portfolio Theory

Markowitz (1952) makes four assumptions regarding investors and the assets they may hold:

(1) An investment's return fully describes the outcome of the investment over the period in question, and investors think in terms of a probability function for returns;

(2) An investor's perception of risk is directly proportional to the variance of return on the portfolio;

(3) Investment decisions are founded on return and risk parameters in the probability density function; and

(4) Investors' utility functions are of a form which enables them to choose portfolios on the basis of the estimated risk and expected return of the portfolios, and the investors display risk aversion.

These assumptions imply that investors will only hold efficient portfolios. Accordingly, investors seek to maximize returns for a given level of risk or for a given level of return to minimize the risk which must necessarily be borne.

The strength of the covarying relationship between securities is measured by the correlation coefficient (COR) which has the convenient property of having a range from -1 to 1 whereas the covariance is unbounded. The correlation coefficient is defined as:

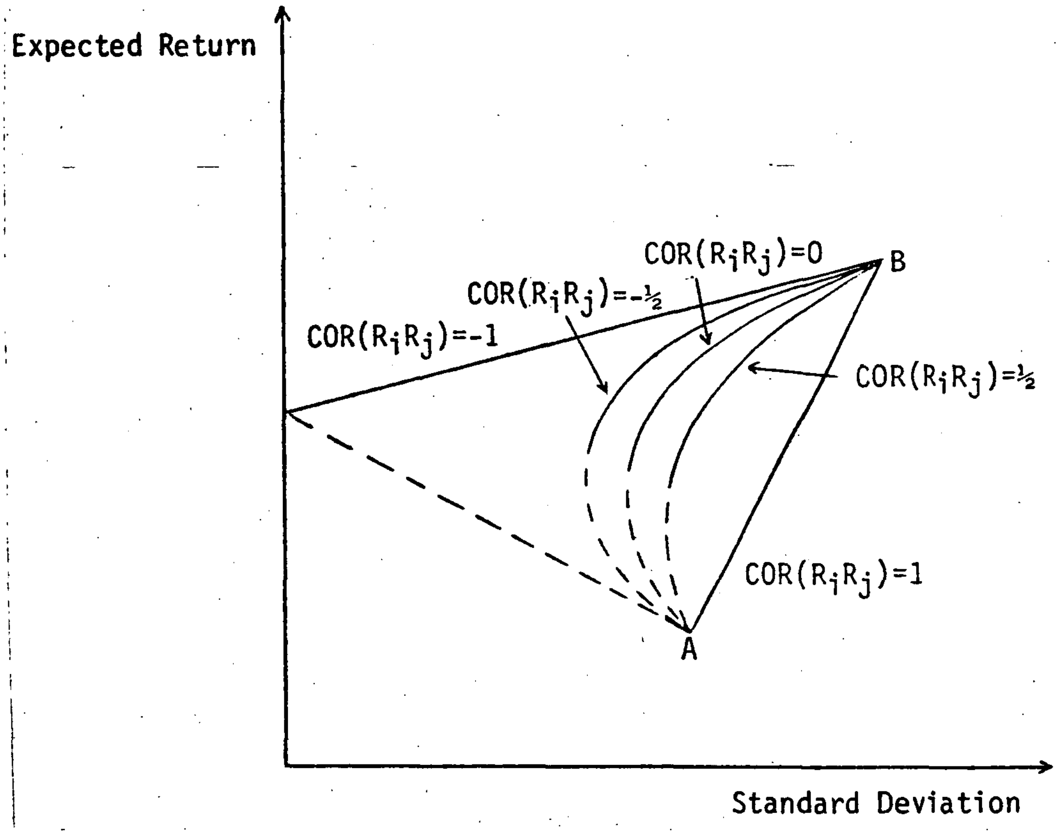
$$COR(R_iR_j) = COV(R_iR_j)/SD(R_i)\ SD(R_j) \tag{2.20}$$

$$VAR(R_p) = \sum_{i=1}^{M} x_i^2\ VAR(R_i) + 2 \sum_{i=1}^{M} \sum_{\substack{j=1 \\ i \neq j}}^{M} x_i\ x_j\ COV(R_iR_j).$$

The impact of the correlation coefficient on the return-risk characteristic of a portfolio comprising two securities i and j is presented in Figure 2.1. As COR takes values from +1 to -1 the transformation curve bows more and more to the left, indicating the same return for a specific proportion of assets i and j is obtained at lower levels of risk.

FIGURE 2.1

CORRELATION COEFFICIENTS AND PORTFOLIO RISK



In the derivation of Equation 2.19 it is shown that:

$$COR(R_iR_j) = COV(R_iR_j)/SD(R_i)\ SD(R_j)$$

$$\rightarrow COV(R_iR_j) = COR(R_iR_j)\ SD(R_i)\ SD(R_j), \text{ and}$$

$$VAR(R_p) = \sum_{i=1}^{M} x_i^2\ VAR(R_i)^2 + 2 \sum_{\substack{i=1 \\ i \neq j}}^{M} \sum_{j=1}^{M} x_i x_j\ COR(R_iR_j)\ SD(R_i)\ SD(R_j) \quad (2.21)$$

From Equation 2.21 it is apparent that the transformation frontier is linear when COR = 1 and COR = -1 and for all values -1 < COR < 1 the locus is curved.

As any two securities may be combined, with different weightings, to obtain various risk and return positions along a transformation locus this is also the case for portfolios. An efficient set of portfolios can be generated and this will trace an efficient frontier in risk and return space. The efficient set is found by selecting the investment proportion in each asset, x_i, so as to minimize the variance for a given expected return. This may be expressed as minimizing the Lagrange function:

$$C = \sum_{i=1}^{M} x_i^2 \ VAR(R_i) + 2 \sum_{i=1}^{M} \sum_{j=1}^{M} x_i x_j \ COR(R_i R_j) \times SD(R_i) \times SD(R_j)$$

$$+ \lambda_1 (1 - \sum_{i=1}^{M} x_i) + \lambda_2 \ (E(R_p) - \sum_{i=1}^{M} x_i \ E(R_i))$$

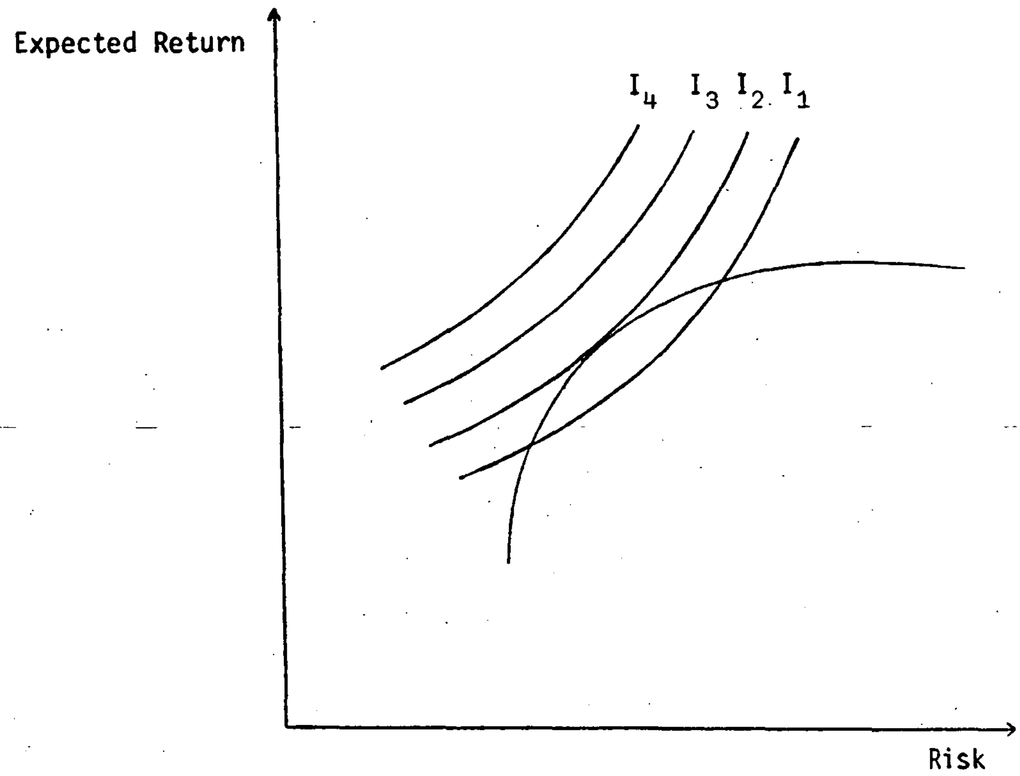
$$\text{s.t.} \quad \sum_{i=1}^{M} x_i = 1 \qquad (2.22)$$

where λ_1 and λ_2 are Lagrange multipliers [see Chiang (1984, pp.376-382.) for examples].

The choice of which position on the efficient frontier, as depicted in Figure 2.2, an individual investor wants, is a matter of taste. In the earlier discussion regarding consumption in two periods there was perfect certainty. Now a utility function is defined over expected return and risk. If it is assumed that all individuals prefer the greatest possible expected return for a given level of risk, then the indifference map rises from left to right in Figure 2.2. The preferred position is the point of tangency of the indifference curve and the efficient frontier.

FIGURE 2.2

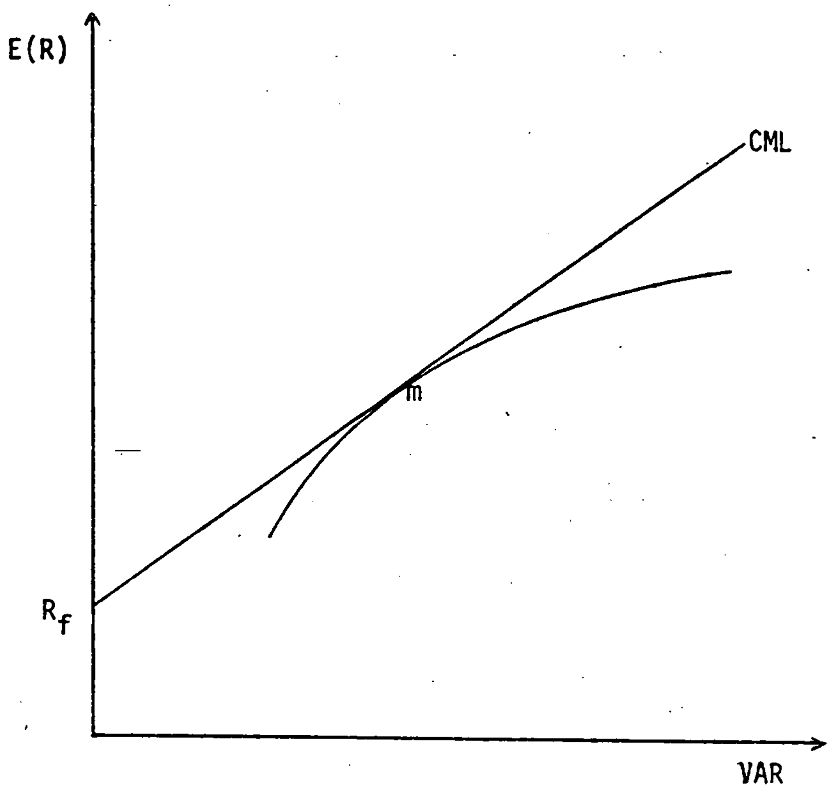
PORTFOLIO CHOICE FOR THE INDIVIDUAL



Tobin (1958) applies portfolio theory to the analysis of the demand for cash balances and in that discussion introduces the notion of a nominal risk-free rate of interest (R_f). The notion of R_f when introduced into the portfolio choice problem confronting an individual considerably simplifies the analysis. If it is assumed that there exists a risk-free asset which returns R_f and that borrowing and lending occurs at this rate, then there exists a linear function of R_f and a portfolio m, on the efficient frontier, which dominates all other combinations of risk-free asset and risky assets. Figure 2.3 illustrates the relationship diagramatically. A combination of the set of efficient portfolios of risky assets, enlarges the choice set available to individuals. The new transformation locus from R_f through m is known as the capital market line (CML).

FIGURE 2.3

EFFICIENT SET WITH ONE RISK FREE ASSET



By forming a portfolio of m and R_f individuals can move to a higher indifference curve than is the case achievable in Figure 2.2. A levered portfolio, borrowing at R_f, allows an individual to achieve a position on the extension of the line R_fm above m, whereas investing in the risk free asset, lending at R_f, obtains a position bounded by R_f and m.

The option to borrow or lend at the risk-free rate permits investors to choose where along the CML they may wish to invest, i.e. what level of risk they are prepared to bear. The desired position is reached in a two stage process which demonstrates the separation theorem attributed to Tobin (1958). First, choosing the securities to be included in the portfolio is independent of an investor's taste. There is only one efficient portfolio. Second, the choice of the level of lending or borrowing at R_f is determined according to the investor's taste.

The optimum portfolio m, termed the market portfolio, includes all assets in the capital market. Every security which has a price is included in m and accordingly its weighting in the market portfolio x_i^m is:

$$x_i^m = P_iQ_i / \sum_{i=2}^{M} P_iQ_i \tag{2.23}$$

where P_i and Q_i are respectively the equilibrium price and quantity outstanding of the ith security. The risk-free asset (security 1) is excluded by definition.

Risk is now seen as having a price. Each small increase in risk, a movement along the horizontal axis, ensures an increase in return. Any combination, x, of R_f and m will yield an expected return calculated as:

$$E(R_p) = x\ R_f + (1 - x)\ E(R_m). \tag{2.24}$$

Accordingly, the risk is:

$$VAR(R_p) = (1-x)^2 VAR(R_m).$$

$$VAR(R_f) = 0$$

$$\rightarrow \quad SD(R_p) = (1 - x)\ SD(R_m). \tag{2.25}$$

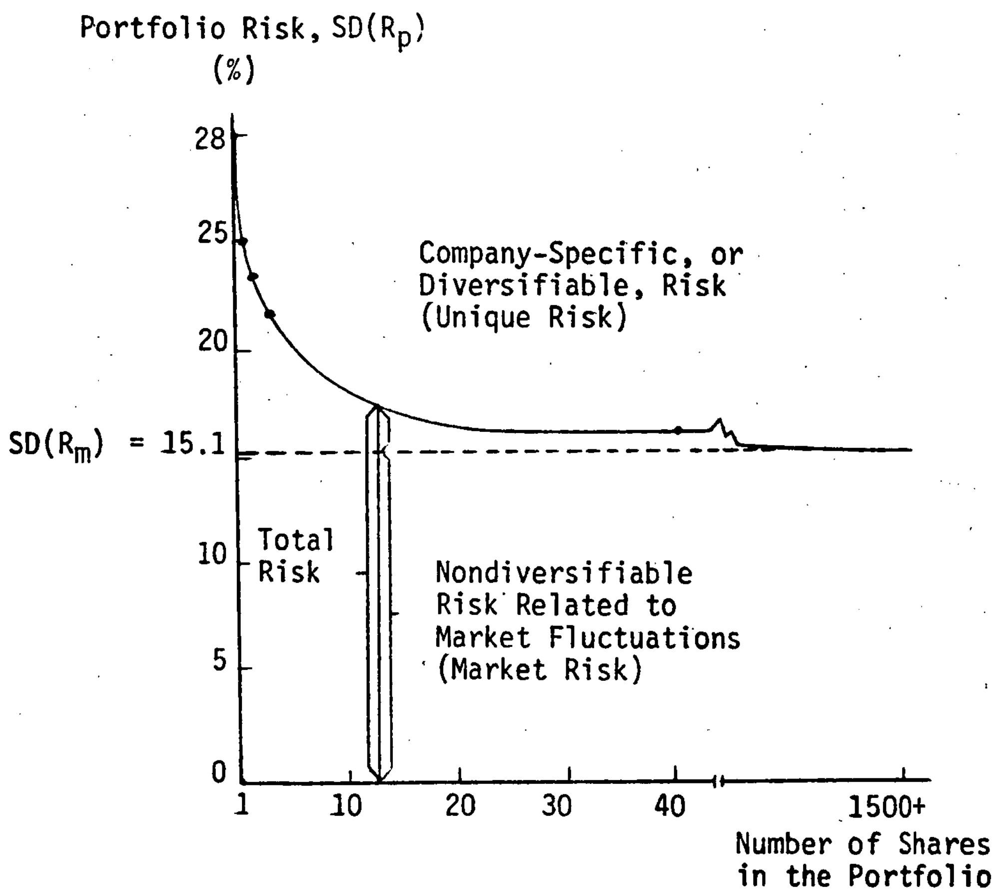
Equation (2.24) may now be rewritten as:

$$E(R_p) = R_f + [E(R_m) - R_f]\ VAR(R_p)/VAR(R_m) \tag{2.26}$$

Further discussion of the market portfolio is provided in Chapter 4. At this point it is worth recalling that when securities are less than perfectly positively correlated a reduction in risk is achieved through the combining of the securities to form a portfolio. Considerable risk reduction for a portfolio formed by selecting random securities, known as naive diversification, is achieved with a small number of securities. Brigham and Gapenski (1985, p.55.) present Figure 2.4 as an illustration of the reduction in risk achievable through naive diversification. The terminology used to refer to components of risk as depicted is discussed shortly. Bird and Tippett (1986, p.250.) show that a use of standard deviation in place of variance as a measure of risk results in "an over-estimation of the rate at which diversifiable risk is eliminated as the portfolio size is increased". While the general pattern of risk reduction as a result of naive diversification holds, it is at a slower rate and there will be considerable risk reduction occurring beyond the 12 securities as drawn.

FIGURE 2.4

RISK REDUCTION THROUGH NAIVE DIVERSIFICATION



The Markowitz formulation for the determination of the efficient frontier involves the minimization of an objective function as shown in Equation 2.22. Markowitz demonstrates that solutions to this portfolio selection problem are obtainable through geometric analysis, calculus and quadratic programming. The practical aspects of attempting to solve for the efficient frontier when there are more than a very few securities to be considered, gives rise to significant computational and data collection exertion. Calculation of the efficient transformation locus, as is apparent from Equation 2.22, first requires that all elements of the variance-covariance matrix are known. If there are M securities in the set, then there are M individual variance terms and M^2-M individual covariance terms of which one half, due to the symmetrical nature of the matrix, are required. Second, there is a need for M expected return estimates. As M increases the number of data are subject to rapid expansion as shown in Table 2.1.

TABLE 2.1

NUMBER OF DATA TERMS IN MARKOWITZ PORTFOLIO ANALYSIS

Securities	Return Terms	Variances Terms	Half the Covariances Terms	Total Terms
1	1	1	-	2
2	2	2	1	5
5	5	5	10	20
10	10	10	45	65
20	20	20	190	230
50	50	50	1225	1325
100	100	100	4950	5150
150	150	150	11750	12050
500	500	500	124750	125750

It is apparent that full covariance estimation demands many data points. The estimates of the covariance matrix are also subject to error. The practical difficulties raised in dealing with the large number of computations required are a further major problem. Cohen and Pogue (1967) empirically examine alternative portfolio selection methods and note the unwieldiness of the model, resulting from the large workload of computations. The data collection and calculation problems encouraged research into alternative approaches of solving for the optimum portfolio. These are now considered.

4. Market Model

A significant simplification of the process of portfolio selection was advanced by Sharpe (1963) with the proposal of the market model, also known as the single index model. The underlying concept is straightforward. It is suggested, on the basis of casual observation, that share prices go up and come down in common with some broad factors. Wars, movements in interest rates, riots and strikes are examples of the factors deemed likely to influence the return on securities. If there is a broad based index (I) which captures these factors then the return on individual securities R_i is related by way of a linear function to that index:

$$R_{it} = a_i + b_{it} I_t + U_{it} \tag{2.27}$$

where a_i is the portion of R_i which is independent of I;

b_i is the average change in R_i resulting from a given change in I; and

U_{it} is the error term with variance $VAR(U_i)$.

Fama (1976) derives the market model as an "implication" of the joint distribution of returns on securities being multivariate normal. He notes (p.76.) that: "In the empirical literature; however, the market model is interpreted as more than a statistical description of the association between bivariate normal random variables".

The market index is suggested as an appropriate index, capturing the impact of the underlying political and economic factors which affect security returns. Thus the returns of securities i and j are expressed as:

$$R_i = a_i + b_i R_m + U_i$$

$$R_j = a_j + b_j R_m + U_j$$

where R_m is the return on the market index.

If it is further assumed that the error terms for all pairs of securities are uncorrelated then the number of parameters to be estimated for the purpose of portfolio construction is greatly reduced. The expected return on a security, $E(R_i)$, expressed as a function of the expected return on the marked, $E(R_m)$, is formulated from Equation 2.27 as:

$$E(R_i) = a_i + b_i E(R_m) + E(U_i) \qquad (2.28)$$

where U_i has the following properties:

(1) $E(U_i) = 0$, the mean disturbance is zero;

(2) $VAR(U_i)$ = constant for each i, homoscedasticity;

(3) $COV(U_i R_m) = 0$, the disturbance in uncorrelated with the market;

(4) $COV(U_{it} U_{it+n}) = 0$, no autocorrelation; and

(5) $COV(U_i U_j) = 0$, disturbance of security i is uncorrelated with the disturbance of security j $(i \neq j)$.

Accordingly:

$$E(R_i) = a_i + b_i E(R_m). \qquad (2.29)$$

The expected return in Equation 2.28 is made up of two components. First, the constant term a_i records the expected return for the security when the expected market return is zero and/or the return on the security is uncorrelated with the return on the market, i.e. when

$$b_i = COV(R_i R_m)/VAR(R_m) = 0.$$

The second component of the return is attributable to the covariation of the return on the security and the return on the market. As the coefficient b_i measures the responsiveness of the return on the security to movements in the market return, the greater the responsiveness the larger the value for b_i. Thus, the return may be expressed as a combination of security specific return i.e. unique return, and of market related return:

Return = unique return + market return.

Risk measured by the variance of the security return, as obtained from Equation 2.28, also involves two separate components:

$$\begin{aligned} VAR(R_i) &= VAR(a_i + b_i\ R_m + U_i) \\ &= VAR(a_i) + VAR(b_i\ R_m) + VAR(U_i) \\ &= b_i^2\ VAR(R_m) + VAR(U_i) \\ &= \text{market risk} + \text{unique risk.} \end{aligned} \tag{2.30}$$

Portfolio returns are simply the weighted sum of the individual security returns. The portfolio analog of Equation 2.27 is:

$$\begin{aligned} R_p &= a_p + b_p\ R_m + U_p \\ &= \sum_{i=1}^{M} x_i\ a_i + \sum_{i=1}^{M} x_i\ b_i\ R_m + \Sigma x_i U_i \end{aligned}$$

$$\text{s.t.} \quad \sum_{i=1}^{M} x_i = 1 \tag{2.31}$$

where M is the number of securities in the portfolio; and

x_i is the value weighting of the ith security in the portfolio.

The analogy continues with the portfolio version of Equations 2.29 and 2.30 such that both portfolio return and portfolio risk are constituted by unique and market components:

a_p = unique return;

$b_p(E(R_m)$ = market return;

$VAR(U_p)$ = unique risk; and

$b_p^2 VAR(R_m)$ = market risk.

By construction the expected value of the disturbance term is zero. The effect of diversification, as previously presented in Figure 2.3 is to reduce unique risk toward zero and is a reflection of assumptions (3) and (5) above viz. $COV(U_i R_m) = 0$ and $COV(U_i U_j) = 0$.

Determination of the efficient portfolio is again obtained by a programming algorithm, maximizing returns subject to constraints or minimizing risk subject to constraints, in the same manner as required for a full covariance-variance model. The primary advantage of the Sharpe formulation, from a practical usage position, is the reduction in the data requirement from 0.5M (M + 3) to 3M + 2 observations. This results in a significant reduction in the resource requirements needed to apply portfolio theory. The magnitude of the reduction obtained is shown in Table 2.2 which contrasts the necessary number of input data points required for Markowitz and Market Model analyses.

TABLE 2.2

MARKOWITZ AND MARKET MODEL DATA REQUIREMENTS

Securities in Portfolio	Markowitz Model	Market Model
2	5	8
6	27	20
10	65	32
20	230	62
50	1325	162
100	5150	302
150	11475	452
500	125750	1502

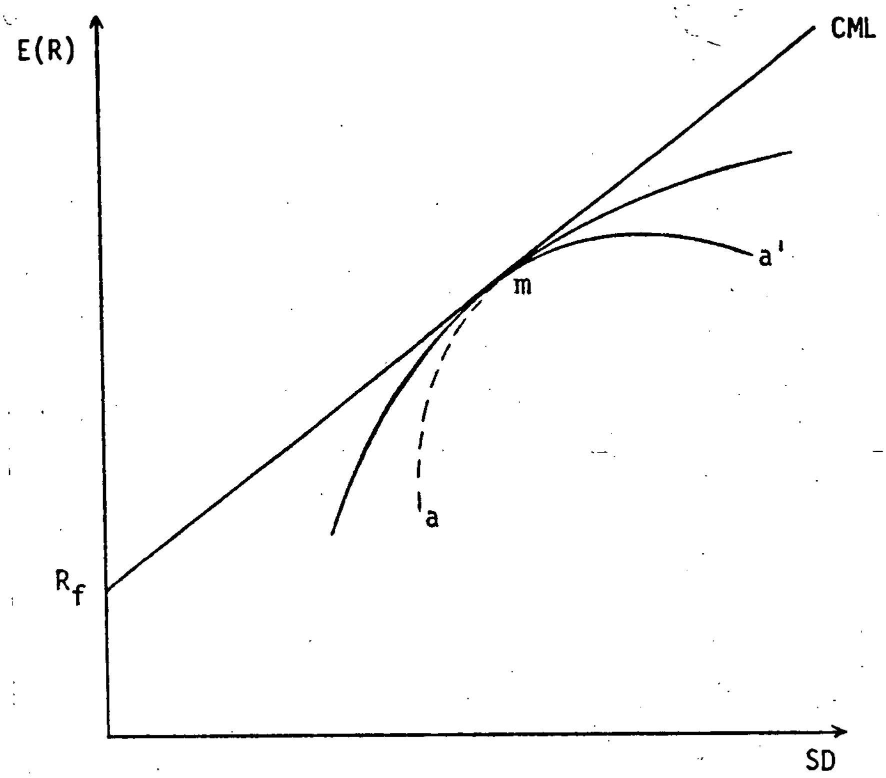
A second important consequence to flow from the market model formulation is a shift in emphasis in the understanding of risk away from total risk to systematic risk. This division of total risk into the two components of market and unique risk, with the latter being avoidable through diversification, is manifested in the capital asset pricing model formulation of equilibrium security prices.

5. Capital Asset Pricing Model

The CML construct, depicted in Figure 2.3, represents a linear relationship between return and risk. The market portfolio, incorporating all risky assets, and a risk-free asset are combined to provide a statement of equilibrium returns at a specific instance in time. As variance is the square of the standard deviation it is possible, and without any loss of intuitive reasoning behind the formulation presented as Figure 2.3, to substitute SD for VAR as the quantitive measure of risk. Figure 2.5 shows this standard deviation version of the CML.

FIGURE 2.5

CAPITAL MARKET LINE



Consider the construction of a portfolio consisting of a risky security i and the portfolio m:

$$R_p = x_i\ R_i + (1 - x_i)\ R_m \tag{2.32}$$

where x_i is the proportion invested in security i; and

$(1 - x_i)$ is the proportion invested in portfolio m.

Now varying the proportion x_i will trace a transformation frontier aa' in risk and return space.

At m the slope of the CML and aa' are equivalent to:

$(E(R_m) - R_f)/SD(R_m)$.

From Equation 2.32 the expected return and variance is formulated as:

$$E(Rp) \quad = \quad x_i\ E(R_i) + (1 - x_i)\ E(R_m)$$

$$VAR(R_p) = \quad x_i^2\ SD(R_i) + (1-x_i)^2VAR(R_m) + 2x_i(1-x_i)\ COV(R_pR_m)$$

At point m:

$$x_i = 0$$

$$\rightarrow \quad \partial E(R_p)/\partial x_i = E(R_i) - E(R_m)$$

and

$$\delta SD(R_p)/\partial x_i = 1/2SD(R_p)[2x_i VAR(R_i) - 2(1 - x_i)VAR(R_m) +$$
$$2COV(R_iR_m) - 4x_i - COV(R_iR_m)]$$

but at m:

$$SD(R_p) = SD(R_m)$$

$$\delta SD(R_p)/\partial x_i = (COV(R_iR_m) = VAR(R_m))/SD(R_m)$$

The chain rule suggests that:

$$\partial E(R_p)/\partial x_i = \partial E(R_p)/\partial SD(R_p).\ \partial SD(R_p)/\partial x_i$$

$$\rightarrow \quad \partial E(R_p)/\partial SD(R_p) = \partial E(R_p)/\partial x_i\ /\partial SD(R_p)/\partial x_i$$

As $\partial E(R_p)/\partial SD(R_p)$ is the slope of aa' (and of course the CML) at m this may be re-expressed as:

$$(E(R_m) - R_f)/SD(R_m) = (E(R_i) - E(R_m))SD(R_m)$$
$$/(COV(R_iR_m) - VAR(R_m))$$

$$\rightarrow \quad E(R_i) = R_f + (E(R_m) - R_f)COV(R_iR_m)/VAR(R_m)$$

$$\text{Let } b_i = COV(R_iR_m)/VAR(R_m)$$

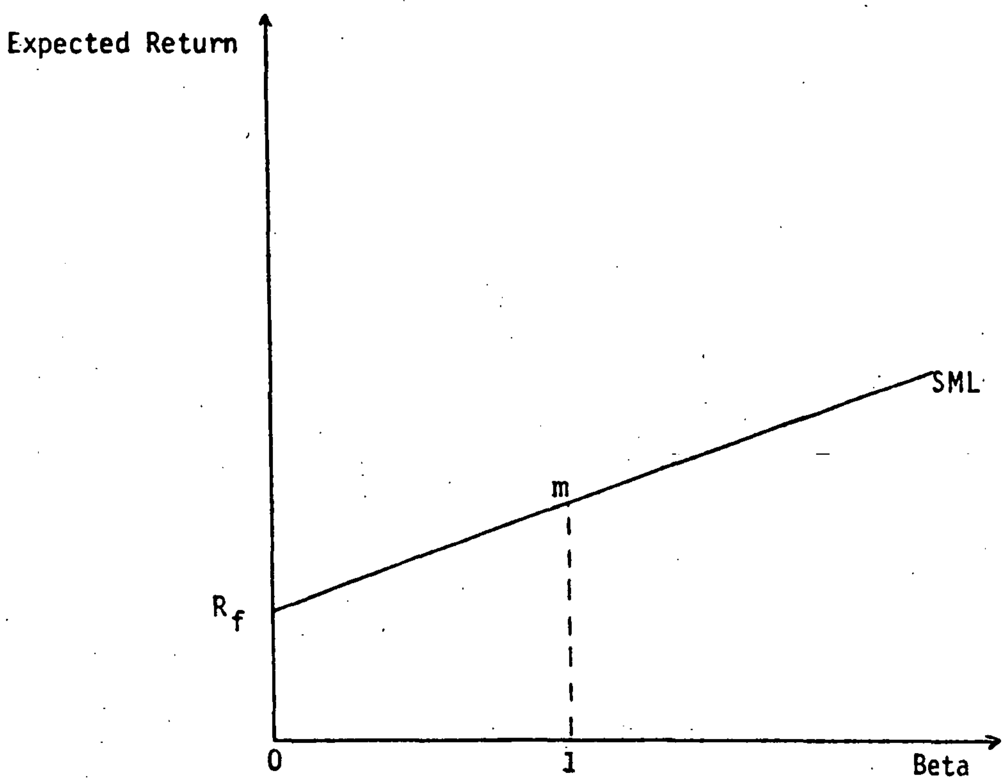
$$\rightarrow \quad E(R_i) = R_f + (E(R_m) - R_f)\ b_i, \qquad (2.33)$$

where b_i is the beta coefficient.

This is known as the capital asset pricing model (CAPM) according to Sharpe (1964). When this linear relationship is drawn in a cartesian plane with axes of expected return and beta, as shown in Figure 2.6, the CAPM plot is termed the security market line (SML). As a statement of relative prices in equilibrium it follows that all assets must lie somewhere along the SML. This is in accord with the derivation of CAPM as the risky security i can be any nonriskless asset without loss of generality in the proof above.

FIGURE 2.6

SECURITY MARKET LINE



Further to this derivation, if a number of assumptions regarding the variables and the population of individuals are made, then the SML formulation is a general statement of market equilibrium. The assumptions of individual risk aversion and the selection of dominant portfolios in accord with the mean-variance criterion, as per Markowitz, are supplemented with the requirements that:

(1) The market consists of atomistic buyers and sellers;

(2) There are no transaction costs;

(3) There are no income, capital gains or transfer taxes;

(4) R_f is the same for all investors;

(5) All investors have the same uniform investment period; and

(6) All relevant information is available to all investors who have the same expectations regarding R_i and $SD(R_i)$, for all i contained in the portfolio m,

[Levy and Sarnat (1984, pp.396-397, and Copeland and Weston (1983, p.306.)].

Conditions 1, 2, 3 and 6 are sometimes expressed in one statement, as the need for capital markets to be perfectly competitive. Subsumed in both approaches is a requirement for the market to be informationally efficient and for individuals to be rational maximizers of expected utility [eg. Ward and Wright (1977, pp.36-38.) and Browning and Browning (1983, p.238.)]. This point is returned to in Chapter 5 where it is shown that the rational expectations hypothesis provides a means of directly linking the equilibrium model, CAPM, to tests of informational efficiency.

The relationship between the market model and CAPM is straightforward when two additional assumptions are made. First, the weighting x_i for assets is the market value weight when all assets are considered. The conventional CAPM is written as:

$$E(R_{it}) = R_{ft} + [ER_{mt} - R_{ft}]\, b_{it}.$$

Let $$d_{it} = R_{it} - E(R_{it})$$

$$\rightarrow \quad R_{it} - d_{it} = R_{ft} + [\sum_{i=1}^{M} x_i\,(R_{it} - d_{it}) - R_{ft}]\, b_{it}$$

$$= R_{ft} + [\sum_{i=1}^{M} x_{it}\, R_{it} - \Sigma\, x_i\, d_{it} - R_{ft}]\, b_{it}.$$

Removal of the expectational operators and the inclusion of an error or disturbance term allows for CAPM to be rewritten as:

$$R_{it} = R_{ft} + [R_m - R_{ft}]\, b_{it} + e_{it}.$$

Thus, $\quad e_{it} \quad = \quad d_{it} - b_i \sum_{i=1}^{M} x_i \, d_i$

with (i) $\quad E(d_{it}) \equiv R_{it} - E(R_{it}) = 0$

(ii) $\quad E(\sum_{1=i}^{M} x_i \, d_{it}) = 0$

(iii) $\quad E(E_{it}) = 0$ for all i.

Hence $\quad R_{it} = R_{ft} (1 - b_{it}) + b_{it} R_{mt} + e_{it}.$

Let $\quad a_i = R_{ft} (1 - b_{it})$

$\rightarrow \quad R_{it} = a_i + b_{it} R_{mt} + e_{it}.$

6. Empirical Testing of CAPM

The capital asset pricing model expressed in Equation 2.33 is simply a linear model of expected return and expected risk. Empirical testing of CAPM requires a transformation from an ex ante expectational form to a model which can be estimated using observed data. If the market is efficient in the sense that all publicly available information is impounded in asset prices, as discussed in Chapter 5, then rational expectations imply that the expected return on an asset is equal to the realized return on average. This is the same as saying, as do Copeland and Weston (1983, p.205.), that the rate of return on any asset is a fair game. Accordingly, if the asset returns are jointly normal, then the ex post version of CAPM is written as:

$$R_{it} = R_{ft} + (R_{mt} - R_{ft}) \overset{\circ}{b}_i + \overset{\circ}{e}_{it} \tag{2.34}$$
$$= (R_{it} - R_{ft}) = b_i (R_{mt} - R_{ft}) + \overset{\circ}{e}_{it}$$

where superscript ° designates an estimated parameter. The model, generally is estimated via a two stage process.

First, a time-series regression, the first pass regression, using for example ordinary least squares is undertaken to estimate the beta coefficient, in accordance with the market model for each of the n portfolios constructed from observed data:

$$R_{it} = \overset{o}{a}_i + \overset{o}{b}_i R_{mt} + \overset{o}{U}_{it} \quad i = 1, 2, \ldots, n.$$

The n $\overset{o}{b}_i$ estimates are next used in a cross-section regression, second pass regression, on the n portfolios as:

$$'R_i = \overset{o}{V}_0 + \overset{o}{V}_1 'b_i + \overset{o}{e}_i \tag{2.35}$$

where $'R_i = \bar{R}_i - \bar{R}_f$;

$'b_i = \overset{o}{b}_i$ from first pass regression;

$\overset{o}{V}_0$ and $\overset{o}{V}_1$ are estimated coefficients; and

$\overset{o}{e}_i$ is the error term.

A comparison of Equation (2.35) with CAPM in Equation 2.33 indicates that the following should hold and may be tested empirically:

(1) $\overset{o}{V}_0 = 0$. If this is not the outcome then it is likely that CAPM omits an important factor which is captured in the intercept coefficient;

(2) the inclusion of additional terms such as b_i^2, price earnings ratio, or others should be found to have no explanatory power;

(3) the relationship must be linear in b;

(4) $\overset{o}{V}_1 > 0$. The return on the market should be greater than the risk-free rate when a sufficiently long time period is used; and

(5) $\overset{o}{V}_1 = \bar{R}_{mt} - \bar{R}_{ft}$.

Empirical investigations of the model, almost without exception, have encountered problems. Douglas (1968) reports the results of a large cross-sectional study conducted in seven time periods. The paper also summarizes some previously unpublished results that Litner had calculated. It is found that V_0 is significantly different from zero, that there exists a significant positive relationship between the realized returns on the securities and the variance of returns, and V_1 is considerably less than the average $R_m - R_f$. Studies by Black, Jensen and Scholes (1972), and Fama and Macbeth (1973) provide further corrobatory evidence regarding CAPM relationships.

In summary the empirical analyses of Equation 2.35 conclude that:

(1) $V_0 \neq 0$;

(2) $V_1 < (R_m - R_f)$;

(3) $V > 0$;

(4) b_i^2 and $VAR(R_i)$ are sometimes important in some time periods, but are not as significant as b_i; and

(5) factors other than beta have significant explanatory power:

- (i) firm size [Banz (1981), Reinganum (1981)],
- (ii) high dividends are related to high rates of return [Litzenberger and Ramaswamy (1971)],
- (iii) low price earnings ratio have higher rates of return than predicted by CAPM [Basu (1977)].

Serious econometric problems are identified in several studies and the difficulties in estimating and testing the model are discussed by several writers. An early survey by Miller and Scholes (1972, p.71.) suggests that the seeming conflict between the results of empirical research and those suggested by the model may be simply artifacts of the testing procedure. Further work by Scholes and Williams (1977), Roll (1977, 1981) and Dimson (1979) raise important issues regarding the formulation of the experimental design. Fogler and Ganapathy (1982) condense many of these issues in their recommended approach to CAPM testing.

The point that the empirical estimation of CAPM along the lines mentioned above cannot be undertaken in the absence of assumptions regarding the security market warrants reiteration. In particular the requirements of the model are such as to necessarily make direct estimations of Equations 2.34 and 2.35 joint tests of the efficient market hypothesis. Copeland and Weston (1983, p.306.) remark:

> However, one should always keep in mind the fact that the CAPM and capital market efficiency are joint and inseparable hypotheses. If capital markets are inefficient, then the assumptions of the CAPM are invalid and a different model is required. And if the CAPM is inappropriate, even though capital markets are efficient, then the CAPM is the wrong tool to use in order for efficiency.

7. Modifications and Extensions of CAPM

As various observed flaws in CAPM emerged, in the sense of the data not displaying the theoretically desirable properties, researchers have suggested modifications to the initial model. To the extent that such amendments improve the predictive ability of the model there is good reason for considering these advances. This section takes the form of a literature survey indicating those modifications considered to be the most important.

The choice of the risk-free rate of interest is found to be of importance. Black (1972) recommends a reformulation of the basic model to overcome this difficulty. The R_f term is proposed to be replaced with the return on a zero beta portfolio R_z. As R_z is uncorrelated with R_m a linear relationship to express the equilibrium return/risk combination is:

$$E(R_i) = E(R_z + b_i [E(R_m) - E(R_z)]. \tag{2.36}$$

Thus, the security market line is now drawn in a similar manner to that for CAPM, in Figure 2.6, with the R_f term replaced by R_z. This reformulation proposed by Black appears, from the empirical investigations undertaken, to be "more consistent with the equilibrium conditions than is the simple CAPM" [Elton and Gruber (1984, p.340.)]. Black (1972) also suggests that the relaxation of the assumption that borrowing and lending rates, which investors face, do not differ. Incorporating this amendment into the model considerably enhances the estimates obtained for equilibrium from the empirical analysis. However, it must be recognized this is an alteration to one of the fundamental propositions on which CAPM is founded.

Potential for amendment of other basic assumptions has also been examined. Black and Scholes (1974) demonstrate strong support for dividends influencing equilibrium. Differential rates of taxation as between income, capital gains, wealth and transfer taxes which exist in most countries are likely to have an effect. Heterogeneous expectations as contrasted with the assumed homogeneous expectations were also subject to early examination. Lintner (1965) considered the question within a two period framework and found it to be of little consequence, however, Radner (1970) and Long (1972) indicate the issue is more complicated in a multiperiod analysis.

Inflation and transaction costs, which vary over time and between countries, may have an impact on CAPM. The recasting of the model into real terms is one means of dealing with inflation. Friend, Landskroner and Lisq (1976) provide a form of CAPM in nominal terms which will hold for periods of uncertain inflation.

Transaction costs are thought likely to influence the size of a portfolio in terms of the number of different securities that investors will hold. Institutional investors may negotiate more favorable brokerage rates and not all investors will hold the same number of risky assets. Levy (1978) investigates the impact of transaction costs on the expected rate of return of an asset and from this deduces an appropriate form of CAPM.

The impact of large transaction costs, on the existence of equilibrium prices is difficult to analyze. Jensen (1972) notes that discontinuities in the observation of prices and the dependence of the solution on the initial distribution of resources ensure the intractability of the problem as a general case. However, at the extreme where the transaction costs are prohibitively large, such that the universe of assets can be subdivided into marketable and nonmarketable, a general solution is available [Mayer (1972)]. Elton and Gruber [1984, p.310.] imply that the categories of marketable assets which an investor may be able to sell are considered as fixed. "For example, investors who own their own home can market it, but they will often not consider switching houses as part of changes in their optimum investment portfolio."

The original Mayer exposition demonstrates that the separation theorem continues to operate and the equilibrium relationship is expressed in terms of the expected return on any asset and its covariance risk in terms of market parameters. The CAPM form is:

$$E(R_i) = R_f + [E(R_m - R_f)/[P_m Var(R_m) + COV\ (R_m R_H)]] \\ [P_m COV(R_i R_m) + COV(R_i R_H)] \qquad (2.37)$$

where P_m = current market value of all marketable assets;

$COV(R_iR_H)$ = covariance between return on asset i and the nonmarketable assets; and

$COV(R_mR_H)$ = covariance between return on aggregate marketable and nonmarketable assets.

The market price per unit of risk now includes, in addition to the market variance, the covariance between returns on marketable assets and the aggregate return on nonmarketable assets.

An alternative expression for Equation 2.37 suggested by Elton and Gruber (1984, p.310.) permits an easier comparison with the standard form CAPM:

$$E(R_i) = R_f + [E(R_m - R_f)/(VAR\ R_m + (P_H/P_m)\ COV(R_mR_H))]$$
$$[COV(R_iR_m) + (P_H/P_m)\ COV\ R_iR_H] \qquad (2.38)$$

where P_H = total value of all nonmarketable assets.

The difference in the magnitude of risk and the reward to risk ratio, indicates that the equilibrium return for a specific asset may be higher or lower under Equation 2.38 when compared with Equation 2.33. For assets which are positively correlated with the total of nonmarketable assets the equilibrium return will be higher but the price of risk will also be greater. The ratio P_H/P_M underlies the likely importance of including nonmarketable assets in CAPM. If the ratio is small, close to zero, then the impact will be minimal. However, if nonmarketable assets are a large component of the total universe of assets then the impact will be of significance.

The Mayer (1972) formulation gives rise to an obvious question as to what is the appropriate market index. Roll (1977) demonstrates that the ex post testing of the linear relationship of Equation 2.36 is not dependent upon a unique market portfolio. The choice of any efficient portfolio as an index (R_I) is adequate. First, find the minimum variance portfolio which is uncorrelated with R_I denoted (R_{ZI}). Second, Equation 2.36 may be rewritten as:

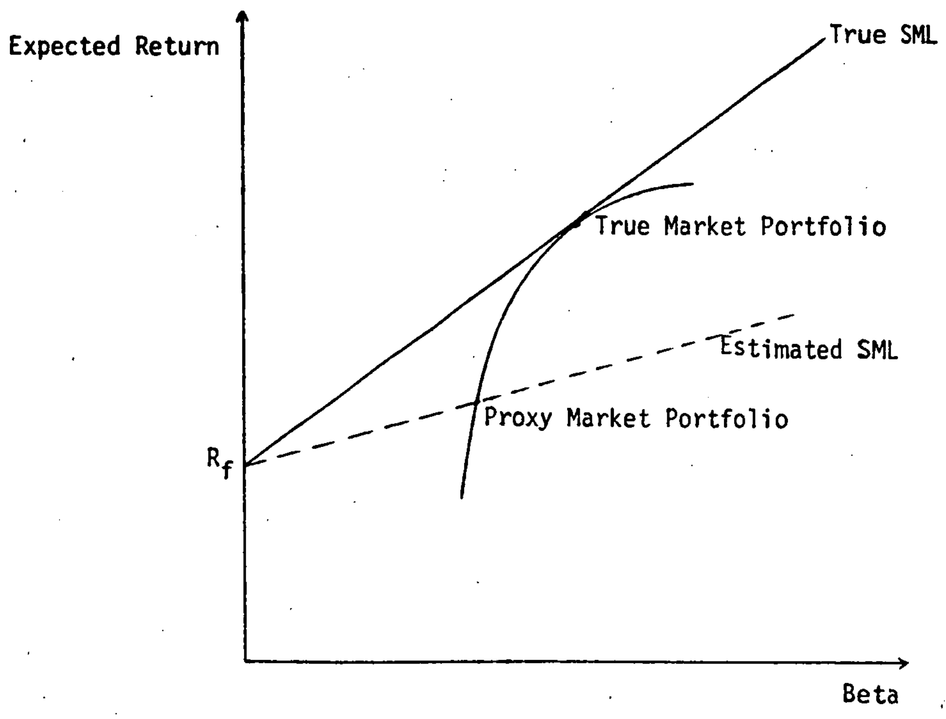
$$E(R_i) = E(R_Z) + b_i [E(R_I) - E(R_{ZI})]. \tag{2.39}$$

The expected return on any asset can be expressed as a linear function of the efficient index. Any efficient index is sufficient.

Choice of the market proxy will cause the CAPM relationship to change. Roll's elucidation of the problems which ensue, as a result of difficulties in specifying the precise composition of the market portfolio appears to cast doubt on the propriety of using CAPM. It is not an invalidation of CAPM per se but rather a serious questioning of its implementation. An illustration of the potential distortion is shown in Figure 2.7 where the true SML and an estimated SML are depicted. The proxy for the market while on the efficiency locus for mean-variance efficient portfolios is not the true market portfolio. Higher levels of indifference curves are obtainable on the true SML which has a steeper slope.

FIGURE 2.7

TRUE AND ESTIMATED SML



Estimation of the beta coefficient is of special importance not only for an understanding of the risk-return relationship in capital market theory but also because of its role in the making of investment decisions [Alexander and Chervany (1980, p.123.)]. In Chapter 3 attention is directed toward two aspects of investment decisionmaking; project evaluation and portfolio performance evaluation. Accurate beta estimation is also required for semistrong-form tests of the efficient market hypothesis, as discussed in Chapter 5 and applied in Chapter 6.

Investigations by Blume (1971, 1975), Levy (1971), Sharpe and Cooper (1972) and others find that beta is not stable over time. Bloomfield (1973, p.34.) presents a table, reproduced as Table 2.3, which indicates several points:

> average beta values are reasonably stable for large portfolios, less so for smaller portfolios and quite unstable for individual assets; and stability is more evident over longer periods than short.

TABLE 2.3

Assets in Portfolio	EXPLAINED VARIATION % IN SUBSEQUENT PERIOD 13 Weeks	26 Weeks	52 Weeks	7 Years
1	12.7	19.2	23.6	38.4
5	37.6	50.8	59.1	72.3
10	51.1	66.4	72.7	84.6
25	70.2	83.5	88.2	92.2
50	80.5	91.8	94.5	96.0

The findings are not surprising when the securities analyzed are the shares of listed public companies. Some businesses may for example experience a change in market risk if their activities alter. Estimates based on a sample period are subject to influences such as good news released by the company during the period from which the limited number of observations are collected, and this will produce a different beta than would be the case if some other interval was chosen.

Blume (1975) and Vasicek (1973) both propose methods which move betas toward one by reducing high betas and increasing low betas. Various evaluations of the two procedures are summarized by Elton and Gruber (1984) who conclude that the Bayesian adjustment technique performs best.

The Bayesian revision approach suggested by Vasicek (1973) involves a process of regression toward the mean. Whereas ordinary least squares regression looks at one asset at a time, this procedure observes trends in the data for all assets in the portfolio. The beta is moved toward the average by an amount which is dependent on both the magnitude of the difference from the average and the error in beta. The "Beta Book" for Australian shares [Sydney Stock Exchange Research Service (1984)] uses this technique. Recent research provides further analyses of this issue, however, the evidence available is at times contradictory. The issues at question are the length of the estimation period which is appropriate and the econometric procedures to be utilized.

Baesel (1974) finds that beta stability is dependent upon both the estimation period and upon "the extremity of the beta chosen" (p.1493.). He suggests that long estimation periods are best and recommends, in accordance with the longest interval employed in his study, that nine years is appropriate. It is straightforward to demonstrate that the longer the estimation period the better is the estimate of beta, in a statistical sense. In the market model the return on a security is estimated, using OLS, as:

$$R_{it} = \overset{o}{a}_i + \overset{o}{b}_i R_{mt} + \overset{o}{e}_{it}$$

and beta is obtained as:

$$\overset{o}{b} = \sum_{t=1}^{T} (R_{mt} - \bar{R}_{mt})(R_{it} - \bar{R}_{it})] / (\sum_{t=1}^{T} (R_{mt} - \bar{R}_{mt}))^2$$

where T is the number of observations in the sample; and

the bars denote the mean value of the random variable.

Accordingly, the estimated variance of the beta estimate:

$$VAR(b_i) = VAR(\overset{o}{e}_i) / \sum_{t=1}^{T} (R_{mt} - \bar{R}_{mt})^2$$

where:

$$VAR(\overset{o}{e}_i) = \sum_{t=1}^{T} \overset{o}{e}{}^2_{it} / (T - 2)$$

has a reduced sampling error as the sample size is increased.

Gonedes (1973) while observing that increased estimation intervals result in more precise estimation of beta also notes that a result of increasing the sample period is an increasing possibility that returns are generated under different structural conditions. These two factors are addressed analytically by Theobald (1981) reports that "beta stationarity, as measured by product moment correlation coefficients, is an increasing function of the length of the estimation period, provided a particular constraint upon the (geometric) decline in correlation coefficients is fulfilled" (p.755.). Unfortunately the approach deals with an average measure of stationarity for the beta of the asset under consideration, even though the beta of an asset "could change dramatically as the estimation period increases" (p.756.). Theobald suggests that where "betas have changed by 50 percent it is better in terms of the mean square errors of the resultant beta estimates to use reduced data sets down to a minimum of around 15 monthly observations" (p.756.).

Changes in the beta of a security may be dealt with using appropriate length estimation intervals. The problem to be addressed is when do the changes occur, as this is necessary information for the establishment of an appropriate measurement period. Time-varying parameter regression methodology [Johnston (1984, pp.405-419.)] provides a tractable technique for improved estimation of beta. Two basic alternatives are available within the variable-parameter model framework. The switching regression regime is the simplest case and may be used when a structural shift has occurred. This shifting may be in response to a threshold value of some variable or it may be triggered stochastically.

A study of mutual fund performances by Kon and Jen (1978) recognizes that the portfolio betas are likely to shift as actively managed funds alter the composition of the securities held to reap full advantage of some forecasted changes in the economic environment. A model specification using a switching regression formulation and maximum likelihood estimation of parameters is discussed.

An alternative view of historical beta changes is supported by Ohlson and Rosenberg (1982). Their study of systematic risk in the CRSP Equal-weighted Common Stock Index found that "the data suggest, rather unambiguously, that the behavior of betas can be attributed to two distinct stochastic factors" (p.122.). In particular they suggest the "tendency of beta to converge slowly toward a norm (the stationary mean)" is best modeled by attributing the beta with a memory using a stationary first-order autoregressive process.

Concurrent with this mean reverting behavior, beta manifests a purely stochastic pertubation. This suggests that a random coefficient model is required.

The linear stochastic parameter model, attributed originally to Hildreth-Houth, provides a second means of estimating variable beta coefficient equations. Fabozzi and Francis (1978) report further evidence which supports the application of this form of model. Chen (1981) adopts a Bayesian approach to estimate the time-varying beta coefficient.

The question as to which approach should be utilized in the estimation of beta coefficients has no final answer. The principle of adopting the most parsimonious procedure which provides reliable estimates is pursued in the empirical estimations of beta in following chapters. There are available a number of statistical procedures for investigating the potential instability of beta. Izan (1985) describes, in some detail, one method of testing for changes in the beta coefficient. The method originally devised by Brown, Durban and Evans (1975) was used by Locke (1985c) in a more general setting than Izan. Locke uses the procedure to test for instability of beta over the whole period while Izan considers the "technique is useful in cases where we are interested to see whether the timing of such a change is related to certain events in history" (p.39.). As will be discussed in Chapter 6, this timing issue may have been more simply explored with a Chow test.

8. <u>Summary</u>

The capital asset pricing model is presented in this Chapter as a theoretical construct concerned with how the relative prices of assets are determined in equilibrium. Within a world of perfect certainty, as discussed in Section 1, the choice between current and deferred consumption is straightforward. The decision not to consume but rather to invest or save is simply modeled. It is, however, readily observed that the returns available on securities in the real world do not accord with the predictions of a perfect certainty framework.

Risk is introduced as a further key parameter in consumption/investment decisions. The necessity not only to quantify risk but to be able to rank alternatives with different risk characteristics is discussed. Individual choice founded on utility theory provides a means of viewing alternative risky options. Various stochastic dominance criteria are one way of obtaining a definite ranking. In instances where the probability density function for returns on an asset are fully described by the first two moments, the mean-variance criterion offers an alternative choice algorithm.

The holding of investments in sets of assets known as portfolios raises further issues regarding the concept and quantification of risk. In particular, the observation that the variability in the returns of a portfolio is not the sum or weighted sum of the variability in returns of the individual assets, directs attention toward the effect of diversification. Increasing the number of assets in a portfolio reduces variability in portfolio return asymptotically to the level known as market or systematic risk. Next, it is shown that assets are priced so as to compensate investors for the unavoidable level of risk that must be borne. This nondiversifiable risk is known as market risk.

Factors which cause the uncertainty and thus variability in asset returns appear to influence all securities to a greater or lesser extent. The market model reflects an attempt to relate the return on individual assets to those market wide factors captured by a single index. The concept of market risk is again brought clearly into focus. It is shown that the slope coefficient of the linear function of the return on an asset relative to the market index return serves as a proxy or index of market risk.

Further, theoretical refinement of the portfolio approach provides a simplified model for explaining the relationship between asset prices in equilibrium. The capital asset pricing model, which offers many of the simplicities of the market model, is founded on the mean-variance criterion. When drawn in a cartesian plane, the security market line, as the plot of CAPM is known, provides a surface upon which all assets should lie when in equilibrium. Considerable reduction in data requirements and computer-effort is achieved in moving from a full portfolio analysis based on Markowitz analysis to the CAPM approach.

Empirical testing of CAPM, as reported, indicates that the data do not fit the model perfectly in a number of instances. Some incompatibilities may be purely random events while others are the result of questionable econometric practices. More elaborate and sophisticated tests continue to reveal anomalies between what is expected and actual outcomes.

Modifications and extensions to CAPM are advocated by various researchers attempting to make the model compatible with the data. Some suggested alterations appear to be minor and almost cosmetic in nature. Other changes are examples of far more radical surgery such that the model can no longer be clearly seen to be CAPM.

Acceptance of the theoretical and simplistic characteristics of CAPM, combined with an expectation of potentially reasonable empirical estimations, suggests that an investigation of its potential uses in real estate investment analysis is worth pursuing. Chapter 3 indicates the potential applications to which it may be most readily applied. Before estimating CAPM and using the parameter estimates it is first necessary to ensure the required conditions of market efficiency hold. This is investigated in Chapters 5, 6 and 7.

CHAPTER THREE

APPLICATIONS OF THE CAPITAL ASSET PRICING MODEL

Introduction

The capital asset pricing model occupies a central position in all aspects of finance concerned with the valuation of investments. Initially, the insights afforded by CAPM into the relationship between risk and return were rapidly deployed in the analysis of financial securities, and in particular shares. As the generality of CAPM was accepted it found a role in the area of project evaluation. Capital investment analysis, or capital budgeting as it is sometimes called, is concerned with the evaluation of fixed assets. The similarity between an investment in plant and machinery and investment in real estate has given rise to recent interest in the use of CAPM for real estate valuation. Sections 1, 2 and 3 provide a discussion of these uses of CAPM.

An appreciation of how CAPM is referred to in the real estate literature is important. As is apparent from the descriptive treatment of several articles provided below, there is confusion and misunderstanding regarding the model at both the theoretical and implementation levels. This supports a need to thoroughly explore how it may be used and under what conditions.

First, the investment criterion is reviewed in Section 1. The net present value (NPV) approach is proposed as the appropriate method with which to consider investment projects. Second, Section 2 explains the relationship between the NPV technique and CAPM which is viewed as the appropriate source of the required rate of return. Third, attention is directed, in Section 3, to the application of these models to real estate investment.

Section 4 deals with a different yet conceptually closely related issue of portfolio performance assessment. Various indexes of performance related to CAPM are discussed. Chapter 7 investigates the performance of various real estate assets in the context of this framework. Finally, a summary of the topics covered in the four main sections is presented to finish the Chapter.

1. Investment Criterion

The net present value rule used in the analysis of investment opportunities is derived from the consumption/savings formulation presented in Chapter 2. As indicated, at that point, the original wealth which acts as a constraint to the maximization of utility over current and next periods consumption, is in fact the present value of current and future consumption. The model proposed is:

$$\text{Max } U = f(C_o, C_1)$$
$$\text{s.t. } W_o = C_o + C_1/(1 + r_f), \text{ or}$$
$$PV = C_o + C_1/(1 + r_f) \tag{3.1}$$

If some portion of the current endowment of wealth (W_o) is saved, W_o-C_o, so as to obtain a future consumption C_1, then the present value of this future consumption $PV(C_1)$ is equal to the initial investment (saving):

$$PV(C_1) = C_1/(1 + r_f) = (W_o - C_o) \tag{3.2}$$

Deduction of the present value of the investment, termed the outflow, from the present value of the future consumption, termed the inflow, is defined as the net present value, i.e. the present value of the net flows:

$$\begin{aligned} NPV &= PV(C_1) - PV(W_o - C_o) \\ &= C_1/(1 + r_f) - (W_o - C_o) \end{aligned} \tag{3.3}$$

Within the structure of the perfect certainty model, discussed above, the net present value of deferred consumption choices is zero.

Introduction of uncertainty into the consumption/saving choice framework reduces the probability that the net present value of an investment will be greater than or equal to zero. The future consumption aggregate $\overset{o}{C}_1$ is not known with certainty. The NPV of a consumption deferring action is zero when $\overset{o}{C}_1$, now a random variable, is equal to its expected value. Dependent upon the probability density function of C_1 there is, at least, some probability that $\overset{o}{C}_1 < E(C_1)$, and this implies a probability that the net present value will be less than zero. Utility maximizing individuals will, in general, engage in investments where a nonnegative NPV is expected.

The net present value approach is readily applicable to multiperiod consumption deferment possibilities as shown by Fama (1970). The emphasis in the valuation of any project focuses on the current and expected future cash flows. The net present value of such a project is found as:

$$\begin{aligned} NPV &= C_0 + C_1/(1 + r_1) + C_2/(1 + r_2)^2 + \ldots + C_N/(1 + r_N)^N \\ &= \sum_{n=0}^{N} C_n/(1 + r_n)^n \qquad (3.5) \end{aligned}$$

where C_n is the expected net cash flow associated with the project in period n; and

r_n is the investor's required rate of return in period n.

The required rate of return is not fixed but varies with the perceived risk of the project under consideration. Sykes (1983, p.253.) observes that:

> The quantitative assessment of the degree of risk associated with direct acquisition of commercial property for investment purposes is practically non-existent. There is almost always a total reliance on unquantified subjective feeling with no attempt to

transform such a qualitative treatment into an analytically more acceptable and useful form.

The CAPM, discussed in Chapter 2, states that assets which are correctly priced relative to other assets yield a return commensurate with their market risk. Consistent with this model of asset pricing is the proposition that the minimum required rate of return for a project (saving, investment, asset) is determined by its market risk. Thus, the CAPM formulation of return on the ith asset:

$$R_{in} = R_{fn} + b_{in}(R_{mn} - R_{fn}) \tag{3.6}$$

may be directly entered into the valuation process. The net present value formula for asset i is reexpressed as the sum of multiple single-periods:

$$NPV_i = \sum_{n=0}^{N} C_{in}/(1 + r_{in})^n$$

$$= \sum_{n=0}^{N} C_{in}/[1 + R_{fn} + b_{in}(R_{mn} - R_{fn})]^n \tag{3.7}$$

where C_{in} is the expected net cash flow of asset i in period n

with n = 0, 1, 2, ..., n; and

$[1 + R_{fn} + b_{in}(R_{mn} - R_{fn})]^n$, is the required rate of return in each period to compensate for the nondiversifiable risk associated with the ith asset.

A constant discount rate r_i ($r_{i1} = r_{i2} = ,,, = r_{in}$) for each period may not be appropriate and can be readily adjusted for using the appropriate CAPM based forecast, R_{in}, in each period.

The implicit assumption that cumulative risk increases at a constant rate into the future can only be sustained if the investment's future beta will remain constant [Fama (1977)]. If this assumption is unrealistic, then the investment's life must be broken into discrete components where the beta will remain constant.

Bogue and Roll (1974) consider the relationship between periods within a recursive procedure and develop a multiperiod valuation model. They find that in addition to beta, the market risk, that the covariation of the intermediate values of a project's net cash flow and the possibility of interest rate fluctuation are two additional sources of risk, which should be included in the analysis. Fama (1977) explains these concerns are inconsistent with CAPM and that the only admissible form of uncertainty relates to the potential variability in expected cash flows in each period t as assessed at each point in time of t-1. An analysis of the minimum necessary assumptions for CAPM to be valid in a multiperiod setting is provided by Constantides (1980).

The assumptions required are that:

(1) there are perfect markets;

(2) investors have homogeneous expectations;

(3) investors' utility functions are independent of the outcomes of states of nature i.e. separation theorem holds; and

(4) competitive profit maximizing agents produce outputs in period t which are a function of inputs at t-1 and a random shock which is independent of the state of nature prevailing at t-1.

If the distribution of returns are normal then the multiperiod CAPM is valid.

Although the concerns expressed by Bogue and Roll are formulated in a manner inconsistent with CAPM, research by Boquist, Racette and Schlarbaum (1975) and Livingston (1978) provides an opportunity to reassess the interest rate issue. In particular, these papers present an analysis of how an asset's beta can be expressed as a function of its duration. Lanstein and Sharpe (1981) argue that there may be an association between duration and the unique risk of individual assets. Further investigation of this issue by Bildersee and Roberts (1981) indicates the Langstein and Sharpe evidence may equally be attributed to instability in the asset's beta. This possibility of beta instability is considered further by Bildersee and Roberts who report that "betas calculated over periods of changing interest rates will vary systematically in accordance with their values relative to the market and the pattern of interest rate changes." For example "if $\overset{o}{b}_i$ is typically less than one for a security with a duration less than the market's duration, then interest rate changes will amplify beta regression tendencies under rising rates, but will dilute such tendencies under falling rates" (p.380.) [$\overset{o}{b}_i$ denotes estimated beta].

Evidence available suggests interest rate variations in the marketplace may cause the market risk to vary. The effect of the variation in the interest rates is impounded into the beta coefficient which must, according to the discussion in Chapter 2, be estimated according to a variable parameter procedure.

2. Capital Asset Pricing Model and Net Present Values

In order to utilize Equation 3.7 for measuring the appropriate discount rate of a project it is necessary, inter alia, to estimate the beta. This is not a straightforward task. Resort is typically made to utilizing historical data, which are readily observable, and adjusting such figures in a subjective, but hopefully informed manner, to obtain a realistic estimate of beta. The initial starting value of beta is typically obtained from either a published "beta book" or estimated as a time-series regression of the market model (Equation 2.6). In both of these approaches the equity selected is for a publicly listed company or an industry aggregate which is most similar to the investment under consideration. This is founded on the assumption that the future variability in the earnings of the asset will follow a pattern similar to those exhibited in the past by this company or industry index.

Beta books such as the Statex Beta Book, published by the Sydney Stock Exchange, are readily available on an annual basis. In Australia more up to date estimates are available for a fee from the Stock Exchange Research Service and private agencies. Direct estimation of beta via the market model, with security prices from the daily newspapers, is a means of obtaining an up to date estimate. There are a number of technical issues which arise when direct estimation is the approach adopted. These are discussed in the relevant empirical sections of subsequent chapters.

The estimated beta obtained is an equity beta and reflects the variability in returns to equity holders. The investment under consideration is an asset. Accordingly it is the beta of the asset which must be calculated. In general the asset beta may be found according to Brealey and Myers (1984, p.175.) as:

$$\text{Asset beta} = \text{Debt beta}\ [\text{debt}/(\text{debt} + \text{equity})] + \text{Equity beta}\ [\text{equity}/(\text{debt} + \text{equity})]. \tag{3.8}$$

This degearing of the equity beta, that is removing the impact of the leverage provided by the debt, is undertaken as a matter of course in publications such as the Statex Beta Book. An adjustment for the incidence of tax [Hamada 1969] ensures the value of the project is not dependent on how it is financed. This is consistent with the view expressed by Mogidliani and Miller (1958, 1963).

The asset beta calculated in accordance with the procedure discussed is a guide to the appropriate beta to be used. An appreciation of the factors which determine asset beta enables the analyst to adjust the mechanically derived betas in the light of distinguishing features. Empirical evidence available suggests that both economic variables and accounting variables provide a useful guide as to underlying factors to be considered [Foster (1986, ch. 10.)].

Operating leverage measured as the ratio of fixed to operating costs is suggested by Lev (1974) and Mandelker and Rhee (1984) as increasing the volatility of returns and thus beta. This is consistent with the earlier findings of Hamada (1969) who found that borrowing by a firm whilst maintaining a constant share capital increases the equity's beta. Sharpe (1977) presents a decomposition of market risk with a multibeta model which again supports the view that major economy factors are important in considering the uncertainties affecting a specific project. Sharpe suggests there are many factors which influence security returns and hence the aggregate return on the market. Further he suggests that historic betas, measured via regression analysis using data from previous periods, may be poor surrogates for ex ante betas. "This is most likely to occur when current relative uncertainties about major factors differ considerably from relative variations in anticipations about those factors in the historic period" (p.134.).

In an aggregate sense economy wide factors impact upon the rate of return on the market portfolio. The ex ante beta selected for a project embodies the expected responsiveness of the project's return to changes in the market portfolio's returns. As discussed above, a historical beta for an asset which has similar characteristics to the project is a good starting point. The concern presented by Sharpe regarding the likely failure of historically estimated betas to be useful as ex ante betas is reasonable. Within the econometric estimation procedures available, especially in the class known as variable parameter or random coefficient models, considerable improvements may be achieved. The alternative of attempting to add new variables into the framework represents a departure from CAPM as traditionally understood.

3. Capital Asset Pricing Model and Property Analysis

The applicability of CAPM to real estate evaluation is intuitively appealing as a specific area of asset acquisition. Recent texts in the valuation area deal with the conceptual basis of modern portfolio theory and suggest that risk should be considered in a portfolio framework. Fraser (1984) discusses the topics of efficient market theory, risk and portfolio theory, modern portfolio theory, and portfolio planning and management. However, the illustrations are entirely confined to the share market and there is no attempt to extend this to real estate evaluation, which is the primary concern of the text.

A more questioning approach is adopted by McIntosh and Sykes (1985). The discussion again focuses on the equity market applications, with the observation that:

> whatever the apparent uses may be for stock markets, where massive volumes of historic share price data are readily to hand, the transferability of such a technique to the property market, involving as it does the assessment of capital values, is highly dubious (p.306.).

A number of interesting points in support of this contention are raised.

The first objection they suggest is that the inherent magnitude of the uncertainty of capital value is a significant contributor to the volatility of property assets. Second, the risk measure obtained in CAPM is retrospective. Finally, the risk measure associated with individual properties is unlikely to remain stable over time and will alter with changing economic circumstances. These three difficulties are sufficient for McIntosh and Sykes to conclude "It is a pity that proponents of the use of CAPM often lose sight of the practical problems involved in its application" (p.307.).

The questions of capital value volatility and the stability of beta for properties are issues subjected to empirical analysis in subsequent chapters. If the "retrospectively" estimated beta is a good predictor of the current and future period beta, then the second criticism is rather hollow. These points are discussed more fully later.

The making of property investment decisions via capital market theory is discussed by Brown (1984). The paper provides a general introduction to modern portfolio theory and then proceeds to show how real estate may be analyzed by CAPM with plots in the security market line framework. Although the treatment provided is entirely conceptual, reference is made to the difficulties of implementing the procedures. Brown believes that because all property indexes are based on valuations this introduces serial correlation into a time-series of rates of return. This observation may or may not be accurate and is subjected to empirical investigation in Chapter 5. Unfortunately, Brown goes on to assert that this autocorrelation within the indexes "causes estimates of systematic risk based on a property market portfolio to be biased downward". This conclusion is an error. Autocorrelation in the dependent variable does not imply an econometric problem of itself and Johnson (1984, p.310.) states that autocorrelation in the disturbance term means that the estimates are inefficient but not biased.

Although Brown errs in that specific observation he proceeds to demonstrate correctly by way of example how identical commercial properties let to tenants subject to different lease terms will have different values. The lease determines the cash inflows to be received and stipulates how and when rent reviews are to occur. The lease will control to some extent the variability in the expected cash flows, influencing the appropriate discount rate through the impact of the market risk of the asset, as exhibited in the expected cash flows. In effect Brown is arguing in terms of the security market line framework that the market risk establishes the rate at which the income stream for the class of property under consideration should be discounted in order to determine its equilibrium market value.

This approach contrasts with the traditional manner in which discounted cash flow techniques are applied. The Royal Institution of Chartered Surveyors (1980, p.43.) recommends that the appropriate required return is the yield on undated gilts plus a margin of 2%. An arbitrary rule such as this implicitly places all real estate in the same risk class and ignores entirely any factors which influence the required rate of return and risk tradeoff other than the yield on a specific government security. To the extent that the market determined rate of return on undated gilts covaries with the market, the second concern may not be of significant proportions.

The security market line approach to risk is new to the real estate literature. Sykes (1983, p.253.) strongly argues in favor of recognizing that the notion of economic value for assets as the present value of expected future net returns should be the basis for real estate appraisal. He asserts that the discount rate which is used must be appropriate for the risk involved. Although Sykes acknowledges the importance of risk in determining the appropriate discount rate this application of a total risk measure, the standard deviation, is inappropriate. More recent papers such as Brown (1984) and Locke (1985b) correct this misunderstanding. Locke (1985b) provides an illustration of the importance of viewing risk in a portfolio context rather than just as a single asset.

Hargitay (1984) attempts to extend the "capital market theory" approach to real estate investment suggesting "the concept of market-related or systematic risk is a valuable tool for the assessment of the likely contribution of a new project to the portfolio" (p.272.). The single index model, Equation 2.29, is proposed as an appropriate procedure for estimating an index of systematic risk, and historic records are suggested as a means of obtaining a time-series of data from which to estimate the model. "These historic Beta coefficients could be used for the assessment of systematic or property market related risk associated with property projects. Property investment projects could then be ranked on the basis of their return-systematic risk characteristics" (p.273.).

Rather than proceed with the net present value approach discussed above, a composite index combining both expected return and risk is recommended as the basis of the decision rule. Two such indexes, the first attributed to Sharpe and the second to Treynor, are demonstrated. These indexes, proposed originally in the context of portfolio performance assessment [Sharpe (1966) and Treynor (1965)], provide an operational decision model in the context of project selection. The method recommended by Hargitay is inconsistent with the capital market theory from which it is derived. However, the approach may be modified with relative ease to a rule which is internally consistent. Both the Sharpe and Treynor Indexes are now examined with the Hargitay decision rule stated, and then modified to remove the inconsistency.

Sharpe [1966] develops a performance index (PI) known as the reward-to-variability ratio from the CML formulation of equilibrium depicted as Figure 2.5. In equilibrium there exists a linear relationship between the expected return and standard deviation of the form:

$$E(R_p) = E(R_f) + [E(R_m) - E(R_f)]SD(R_p)/SD(R_m) \qquad (3.10)$$

where $E(R_p)$ is the expected return on a portfolio;

$E(R_m)$ is the expected return on the optimum risky portfolio known as the market;

$E(R_f)$ is the expected return on the risk-free asset;

$SD(R_m)$ is the standard deviation of the market portfolio; and

$SD(R_p)$ is the standard deviation of the portfolio.

This involves the calculation of the reward-to-variability ratio (PI_S)

for the project asset i and the current portfolio p as:

$$PI_S(i) = [E(R_i) - E(R_f)]/SD(R_i)$$

and $$PI_S(p) = [E(R_p) - E(R_f)]/SD(R_p) \quad (3.11)$$

If the reward-to-variability of the project is at least as large as for the project, i.e.:

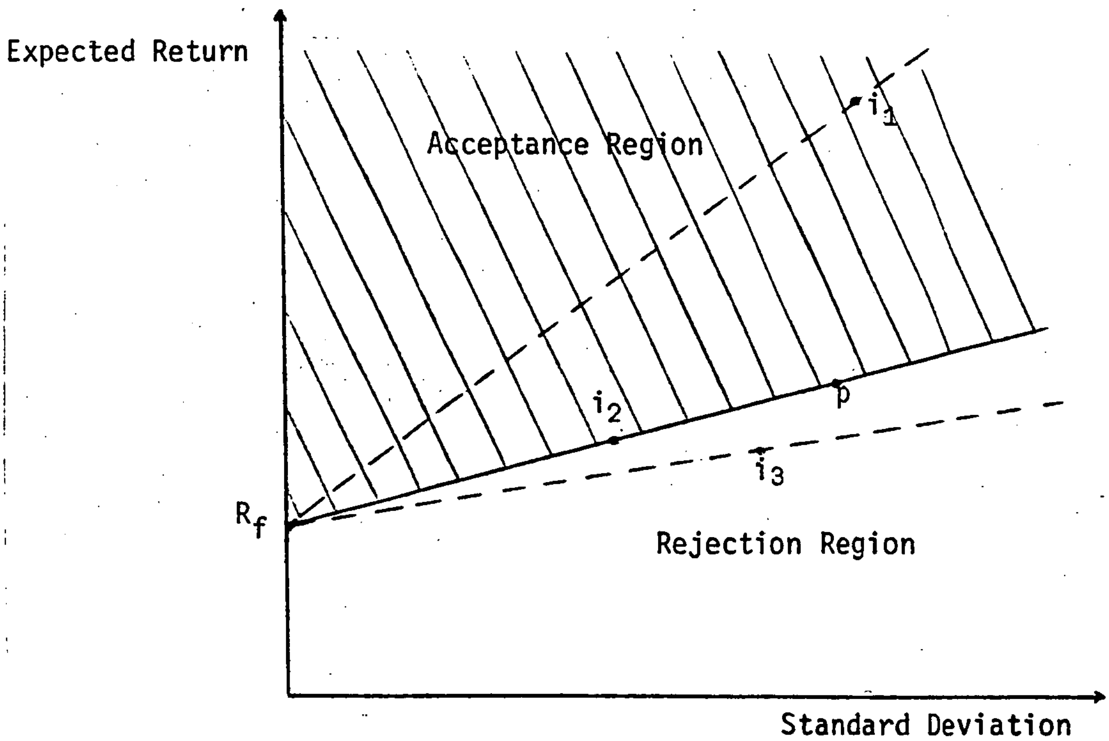
$$PI_S(i) \geq PI_S(p)$$

then the project should be undertaken.

Diagramatically, in expected return/standard deviation space, the acceptance region for investment opportunities lies between the vertical axis and a ray drawn from R_f through p. As depicted in Figure 3.1 assets i_1 and i_2 are acceptable whereas asset i_3 is not acceptable.

FIGURE 3.1

REWARD-TO-VARIABILITY ACCEPTANCE REGION

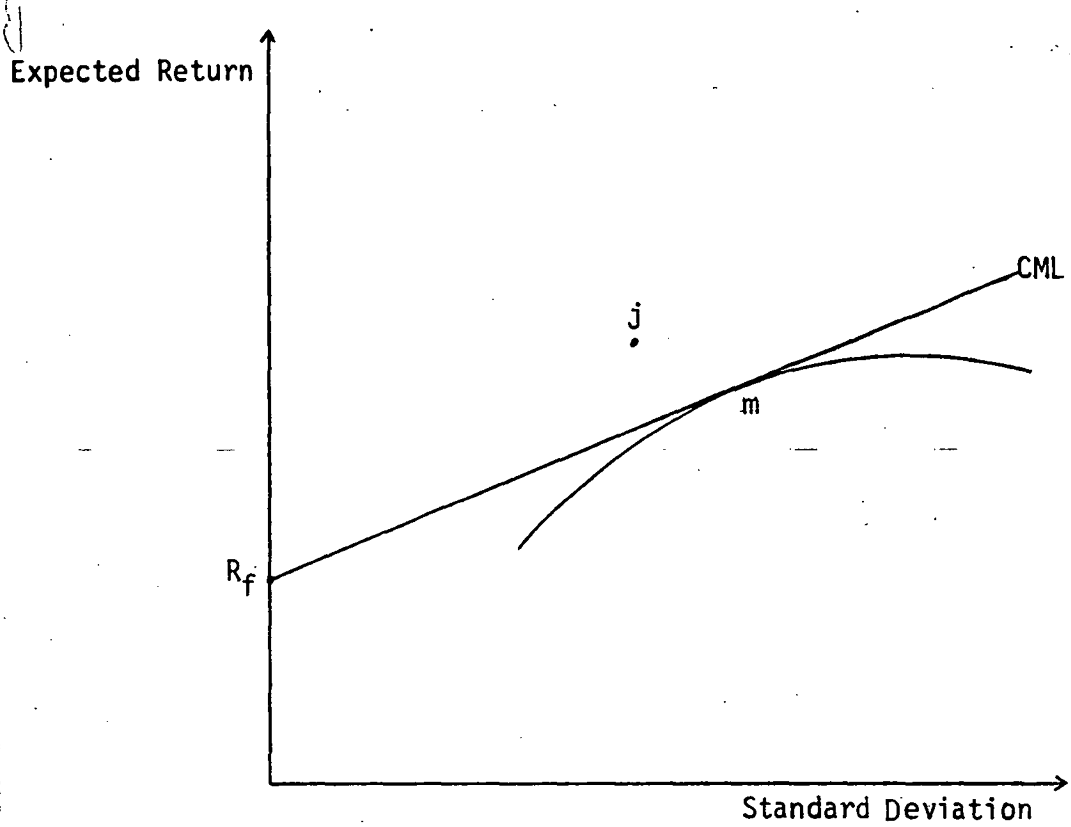


The formulation of the reward-to-variability index is founded on a linear relationship between expected return and risk as quantified by standard deviation. The economic rationale lies in the concept of there existing one only optimum portfolio of risky assets, viz., the market portfolio. Individuals select, in accordance with their indifference map, where along the ray from R_f through m they wish to be. The option to lend at R_f or borrow at R_f provides the opportunity to be either aggressive, i.e. beyond m, or defensive i.e. between R_f and m, in the selection of the desired portfolio. In equilibrium all investment opportunities must lie along the CML. Investments opportunities above the CML, such as j, are assets beyond the efficient frontier as depicted originally in Figure 2.5 and redrawn as Figure 3.2 below. When the asset is integrated into the market portfolio then m will move slightly. It is possible that projects like j do exist from time to time and the finding of these provides attractive investment opportunities. They cannot exist for long as investors bidding up the price will force down the expected return to the equilibrium level.

The point at issue is that a reward-to-variability approach to investment selection makes sense in terms of the capital market line theory when two conditions are jointly satisfied. First, the comparison is to be between $PI_S(i)$ and $PI_S(m)$. Second, in equilibrium $PI_S(p)$, as described above, can at best lie on the CML. If it is above the CML, $PI_S(p) > PI_S(m)$, then this can only be temporary and projects such that $PI_S(i) > PI_S(m)$ are still desirable. If $PI_S(p) < PI_S(m)$ then there is no point in investing in another loser such that $PI_S(m) > PI_S(i) > PI_S(p)$. The investment is better made into the market portfolio. The use of the decision criteria must be applied in terms of the market portfolio.

FIGURE 3.2

CAPITAL MARKET LINE



An asset will yield a return commensurate with its market risk not its total risk. Standard deviation is a measure of total risk not market risk. It is worth noting that, in the context of the original Sharpe paper on mutual funds, the use of standard deviation may be quite appropriate. If mutual funds as portfolios are proxies for the market portfolio and investors use them as such, then total risk is market risk. However, for individual investment projects the relevant risk is market risk. Hargitay (p.274.) is aware of this and quotes Sharpe on the subject:

> To evaluate the performance of a single security, or that of a portfolio constituting only part of an investor's holdings, a different measure is needed. Variability will not adequately represent the risk

actually borne. A more appropriate choice is volatility.

Volatility in this context refers to movement with the market, measured by beta, as compared with variability which means variation in the return of the security. Treynor (1965) investigating the performance of mutual funds proposes a performance index referred to as the reward-to-volatility ratio. This is derived from the capital asset pricing model where the expected return on a security i is expressed as:

$$E(R_i) = E(R_f) + [E(R_m) - E(R_f)]\ b_i$$

Treynor proposes a composite index:

$$PI_T(i) = (E(R_i) - E(R_f))/b_i \qquad (3.12)$$

where subscript T denotes Treynor's performance index.

Hargitay suggests the appropriate decision rule is to accept a project (asset) for investment when its reward-to-volatility is at least as large as that of the current portfolio (p). This requires that:

$$PI_T(i) \geqq PI_T(p).$$

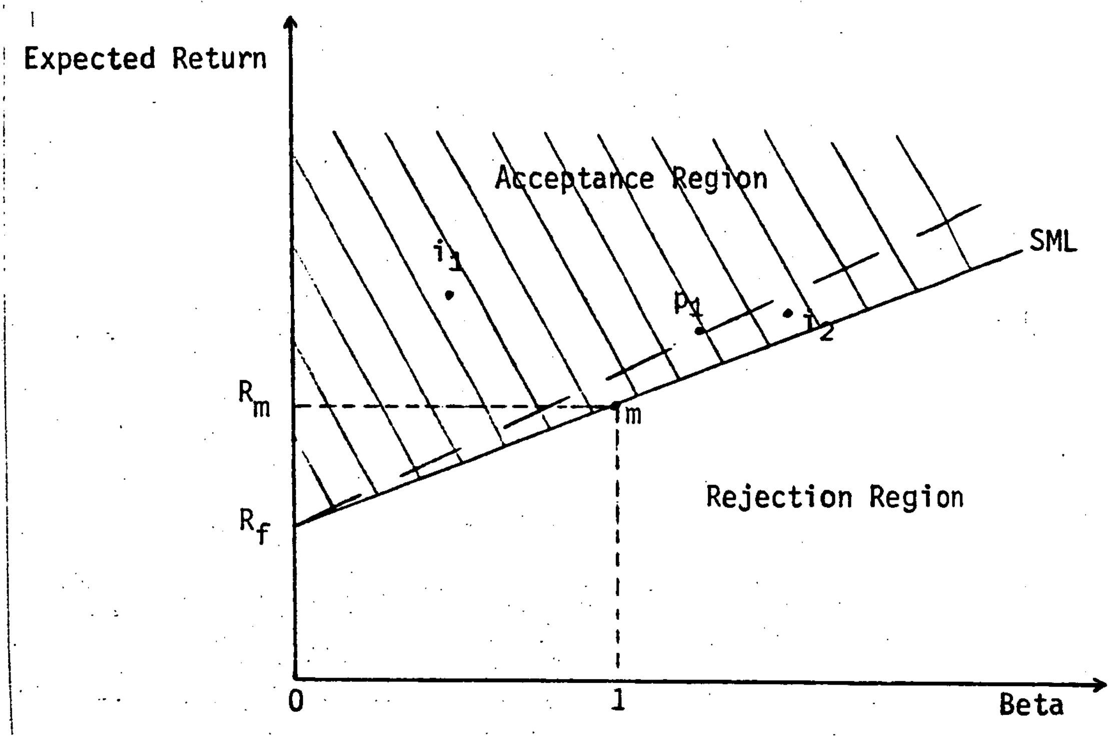
The same conceptual problem which arose with the initially advocated decision rule for the Sharpe Index is apparent in this criterion. Again a diagramatic exposition of the conflict is the easiest way to observe the inconsistency of the criterion. CAPM, from which PI_T is derived, requires that in equilibrium all assets plot along the SML. Where an asset lies above the SML, as in the instance of i, in Figure 3.3, it is desirable. However, the price of i, will be increased quickly by investors bidding for it and the return level will fall back onto the SML.

The reference point is the SML founded on the risk free asset and the market portfolio. An investor's current portfolio in equilibrium will lie on the SML. If it is temporarily above the SML as in the instance of p_1, depicted below, then an asset such as i_2 is, nevertheless, desirable. As the SML represents the equilibrium asset pricing position the appropriate decision rule is to accept an asset for investment when its reward-to-volatility ratio is greater than or equal to that of the market portfolio:

$$PI_T(i) \geq PI_T(m).$$

FIGURE 3.3

REWARD-TO-VOLATILITY ACCEPTANCE REGION



Practical problems regarding this approach remain and several further theoretical concerns regarding the propriety of employing composite performance indexes require attention. These latter issues are explored in the next Section which deals with performance assessment of real estate portfolios. From the purely practical position of calculating PI_T there are problems when beta is less than or equal to zero. The strict inequality is unlikely to hold except in vary rare instances. However, a beta coefficient which is not significantly different from zero, in a statistical sense, results in an undefined value for PI_T.

A decision rule which states that a project lying above the security market line in expected return beta space should be accepted is identical to a rule advocating acceptance of projects with positive net present values, calculated in the manner discussed in the previous Section. Sharpe (1970, p.94.) expresses the equivalence of the two methods:

> Thus, if a project plots above the security market line, it should be accepted; if it plots below the line it should be rejected. In more traditional terms, the cost of capital for a project is the expected rate of return shown by the security market line for projects of equal volatility. The expected dollar cash flow should be discounted at this rate of interest; if the present value is positive the project should be undertaken; if not, it should be rejected.

An illustrative example of the equivalence of the two decision rules is provided by Bloomfield (1973, pp.57-63.).

4. Assessment of Portfolio Performance

The capital asset pricing model may be applied in the assessment of portfolio performance. Reilly (1985, pp.677-8.) suggests that two major factors are to be taken into account when considering the performance of a portfolio manager. First, is the ability of the manager to earn above average returns for the portfolio given its risk class. Second, is the ability to diversify and thus eliminate to the maximum extent possible all unique risk from the portfolio. Although these remarks are made in the context of assessing the manager's skill, the methods proposed relate to the performance of the portfolio. Where the portfolio earns above average returns for its risk class the manager is applauded. Similarly, if the portfolio exhibits low amounts of unique risk then the manager is again given a favorable mark.

As discussed in the previous Section the Sharpe reward-to-variability ratio and the Treynor reward-to-volatility ratio are both composite performance indexes originally proposed for the assessment of portfolio performance. A further performance index based on CAPM is proposed by Jensen (1968). The general form of CAPM:

$$E(R_i) = E(R_f) + [E(R_m) - E(R_f)]\ b_i$$

is estimated, by a regression procedure on time-series data, as:

$$(R_{it} - R_{ft}) = \overset{o}{b}_i\ (R_{mt} - R_{ft}) + \overset{o}{e}_{it}.$$

This formulation is discussed as Equation 2.34 in Chapter 2. Jensen argues that a portfolio which is outperforming its risk class will consistently exhibit positive random errors. Accordingly, the removal of the constraint of a zero intercept will allow for under or over performance relative to average commensurate returns to be captured as a non-zero constant. Hence the estimation of:

$$(R_{it} - R_{ft}) = \overset{o}{a}_i + \overset{o}{b}_i\ (R_{mt} - R_{ft}) + \overset{o}{e}_{it} \qquad (3.13)$$

incorporates the consistent random errors in the $\overset{o}{a}_i$ intercept coefficient. The a_i term, which is the performance index PI_J, represents the average incremental (decremental) rate of return on the portfolio per unit of time derived from the above (below) average returns adjusted for risk.

Both the Jensen and Treynor Indexes adjust returns for market risk. It is readily shown that these two measures are closely related to each other. The estimation of Equation 3.13 for a portfolio provides the regression estimates to write the relationship as :

$$(R_p - R_f) = \overset{o}{a}_p + \overset{o}{b}_p (R_m - R_f)$$

which may be rearranged to:

$$\overset{o}{a}_p = (R_p - R_f) - \overset{o}{b}_p (R_m - R_f).$$

If both sides are divided by $\overset{o}{b}_p$ then:

$$\overset{o}{a}_p/\overset{o}{b}_p = (R_p - R_f)/\overset{o}{b}_p - (R_m - R_f)$$

which when rearranged as:

$$(R_p - R_f)/\overset{o}{b}_p = \overset{o}{a}_p/\overset{o}{b}_p + (R_m - R_f) \qquad (3.13)$$

which indicates that:

$$PI_T(p) = PI_J(p)/\overset{o}{b}_p + (R_m - R_f) \qquad (3.14)$$

Treynor's reward-to-volatility ratio is equivalent to a constant excess return on the market plus Jensen's performance index divided by the asset's beta. The Jensen Index is calculated in a manner which provides for the simultaneous estimation of the two key parameters, $\overset{o}{a}$ and $\overset{o}{b}$, while the Treynor Index utilizes a previously estimated beta.

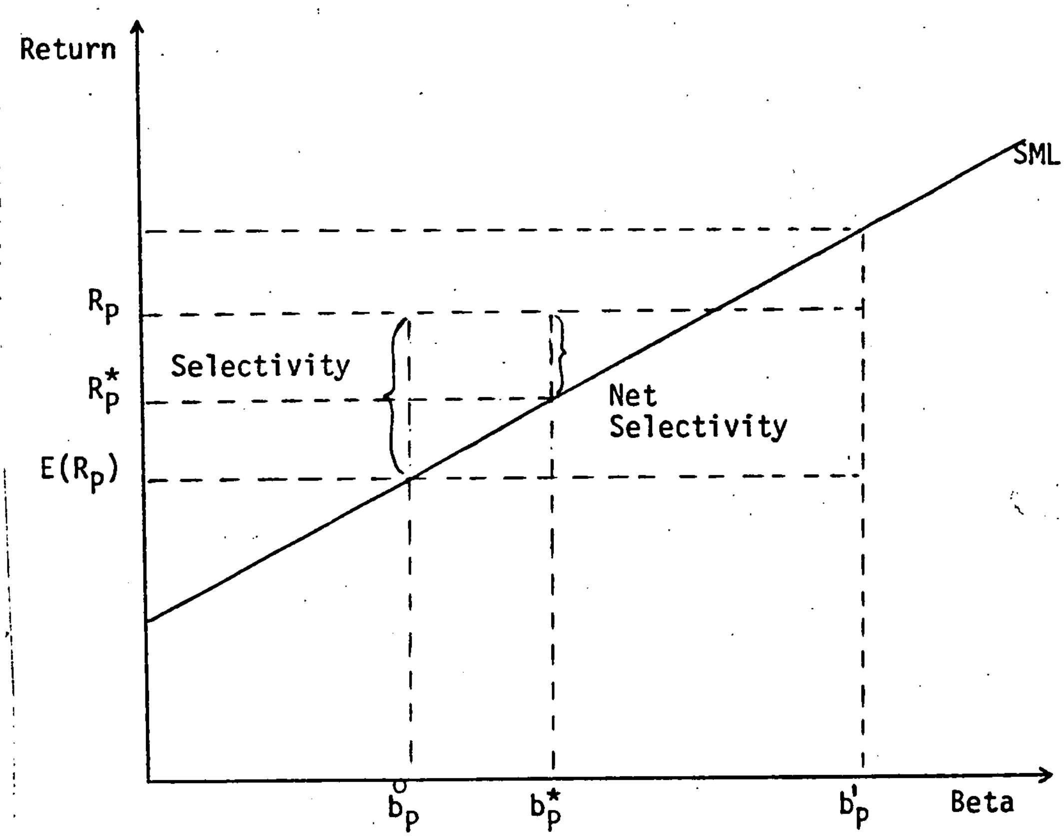
The three indexes discussed, Sharpe, Treynor and Jensen, are composite indexes in that estimates of return and risk are combined in the calculation of PI. The Sharpe reward-to-volatility ratio differs from the other two in the choice of the quantitative risk measure. Specifically, the standard deviation, a measure of total risk, is employed rather than beta, an index of market risk. When a portfolio is well diversified the unique risk is reduced to zero, and in such instances the total risk and market risk are the same. Accordingly, when the portfolios under consideration are well diversified the Treynor and Sharpe Indexes will rank them in the same order. The extent to which the ordering differs between these alternative performance measures is evidence regarding the second factor that Reilly, cited above, suggests as important, viz. diversification. A poor Sharpe Index score and a good Treynor Index score reflects poor diversification. Both Sharpe and Treynor Indexes are necessary to consider the combined requirements of risk adjusted return and diversification.

The Jensen Index provides direct evidence regarding the extent of diversification of the portfolio through the coefficient of determination of the estimated equation. As Tinic and West (1979, p.553.) explain, the higher the correlation between returns of a portfolio and the proxy market portfolio, the smaller is the unique component of the portfolio's risk. Thus the R^2 of the estimated equation for a portfolio provides information about the extent of diversification. The square root of the coefficient of determination of the regression Equation 3.13 is the sample estimate of the true correlation between the portfolio returns and the returns on the market portfolio.

Fama (1972) suggests a decomposition of the aggregate performance statistic into a number of components. Of particular interest is the treatment of "selectivity" as defined in the context of mutual funds. This concept is equally applicable to other portfolios such as property trusts in which investors buy units or shares, and also in portfolios of physical real estate investments. The Jensen performance index for a portfolio estimated according to Equation 3.13 may be thought of as the difference between expected return, according to CAPM, for the portfolio $E(R_p)$ and the actual return on the portfolio R_p. This is depicted in Figure 3.4 as an example where it is assumed an abnormal return is earned. The difference $R_p - E(R_p)$ is the return to selectivity which results from the selection and weighting of the securities in the portfolio.

FIGURE 3.4

DECOMPOSITION OF EXCESS RETURN



If the portfolio is not completely diversified then the investor who holds this portfolio, or in the case of a trust for those individuals who have the majority of their wealth invested in the trust, then the actual risk exposure is to the total variability of the portfolio. The portfolio's total risk consists of both the market risk and the unique risk:

$$VAR(R_p) = b_p^2 \, VAR(R_m) + VAR(e). \qquad (3.15)$$

Hence, the abnormal return obtained by the portfolio is necessary to compensate the investors for the additional unique risk which they are bearing.

The question to be addressed is the extent to which the abnormal return fully covers the unique risk component. First, a notional portfolio beta b^*_p, which is the beta appropriate for a portfolio with a correlation coefficient of one with the market, is established. As there is no unique risk in such a portfolio the total risk is now:

$$VAR(R_p) = \overset{*}{b}{}_p^2 \, VAR(R_m) \qquad (3.16)$$

and the beta is the ratio of the standard deviations of the portfolio and market returns:

$$b^*_p = SD(R_p)/SD(R_m). \qquad (3.17)$$

The required return for a portfolio with a beta of b^*_p, according to CAPM, is greater than for $\overset{o}{b}_p$. In Figure 3.4 an arbitrary position is selected and it can be seen that the abnormal return $R_p - E(R_p)$ is greater than the required notional return of R^*_p. The difference between actual return and required notional return, $R_p - R^*_p$ is referred to as the net selectivity return. The return to net selectivity may be either positive, as in the illustration, or negative. If the notional beta was b'_p rather than b^*_p, a negative return to net selectivity results.

Fama also provides a number of other decomposition procedures which address the skill of the portfolio manager. In particular, the timing of transactions so as to maximize portfolio returns may be explored. In an actively managed portfolio where assets are bought and sold the beta of the portfolio will alter through time. Subperiod betas are required if further decomposition statistics are to be used.

Kon and Jen (1978) recognize this problem and use it as motivation for the analysis of the potential application of switching regression estimation procedures. They suggest that active portfolio management involves the selection of securities consistent with the managers forecast of economic outlook. If the economy is thought likely to take off, then high beta securities will be acquired. The overall portfolio beta estimated over a long period smoothes this structural shift. A recursive estimation or switching regression is required to detect the change which may then be used in performance assessment studies.

5. Summary

The capital asset pricing model, developed in Chapter 2, as a statement of how the relative price of assets are established in equilibrium, is shown to have several applications. In particular the valuation of property and evaluation of property performance are amenable to this model.

The net present value criterion for project appraisal is presented as compatible with the fundamental consumption/saving choice issue. Selection of an appropriate required rate of return for use in the discounting of expected net cash flows raises the problem of risk and how this may be incorporated into the analysis. CAPM provides a means of viewing risk and return. It is shown that the market risk concept fundamental to CAPM is an appropriate means of determining the risk-adjusted required rate of return for use in NPV calculations.

In Section 2 the linkage between NPV and CAPM was developed further. The empirical estimation of CAPM and the adjustment of equity betas to asset betas are explained. While degearing beta is an important first step, additional alterations made in the light of an appreciation of various determinants of beta may be advisable. Although this latter stage tends to be discretionary, prior research does provide some indications of the various factors which it is desirable to address.

Direct application of CAPM to property valuation is viewed as undesirable by some authorities and strongly supported by others. The security market line construct provides one means of evaluating the desirability of a prospective property acquisition. This mode of analysis is directly comparable with the NPV routine discussed in Sections 1 and 2. The SML approach described in the Section 3 is evidence of the internal consistency of the CAPM. This method of property valuation is directly compatible with the NPV criterion derived from the original consumption/deferred consumption choice model.

CAPM is applicable not only to the valuation of property ex ante but also for ex post performance evaluation. The Sharpe, Jensen and Treynor Indexes provide a means of assessing the risk-adjusted returns earned on a property or property portfolio. Where there exist alternative portfolios which represent competing investment possibilities the ex post assessment of performance is in many respects identical to an ex ante valuation of the property portfolio. The CAPM model is central to these two aspects of investment choice.

Implementation of these procedures as practical techniques requires an availability of data regarding property returns, market returns and risk-free asset returns. Consideration of the desirable properties of such data and a discussion of readily available sources is the subject matter of Chapter 4 which follows.

CHAPTER FOUR

DATA FOR ESTIMATION OF CAPITAL ASSET PRICING MODEL

Introduction

The empirical estimation of the capital and pricing model requires data inputs. The form of presentation followed in this Chapter is to discuss first the conceptual requirements for the data and second the data that is available. Criteria which the data should satisfy can be derived from and must be consistent with the model to be estimated. Sections 1-3 discuss, in turn, the desirable properties of the return on the market, the return on the risk-free asset and the return on individual assets. Various proxies for these returns are used in many previous studies employing CAPM and these have been subjected to criticisms.

Ideal measures are not available and the data used in this thesis falls short of satisfying the desirable criteria. Sections 4-6 discuss the available data used as surrogates for the R_m, R_f and R_i or R_p variables.

1. Return on the Market

The market model, discussed in Chapter 2, is founded on an assumption that there is a relationship between the rates of return of various assets exhibited by a correlation with underlying common factors. These factors are represented by an index, and in practice a broadly defined stock market index is employed for the purposes of empirical estimation. The model does not assume any particular equilibrium characteristics in the index portfolio. This is in contrast to CAPM where the index portfolio is the true market portfolio and it is required to lie on the locus of Markowitz efficient portfolios. Not only is it required to be mean-variance efficient but it must also be at the point of tangency of the capital market line and the efficient frontier.

As Roll (1977) indicates, it is impossible to test CAPM without the true market portfolio. It is possible, however, to test that the proxy being used for the market portfolio is mean-variance efficient. This is not a simple task as any well diversified portfolio, as contrasted with an efficiently diversified portfolio, is unlikely to be significantly different, in a statistical sense, from the efficient set. Nevertheless, it must be accepted that none of the proxy indexes are specifically designed to represent the market portfolio (m).

In practice, quantitative studies almost entirely confine the proxy for m to a share market index. Although it is well known that international diversification yields significant risk-reducing benefits [Levy and Sarnat (1970)], national stock indexes are typically used. Keane (1983, p.105.) reports the data presented as Table 4.1 below. He suggests that "if one assumes that all leading stock markets have efficient pricing mechanisms and that they are sufficiently integrated to produce a common risk-reward relationship, then the investor's portfolio should logically consist as far as possible of these proportions." A more recent survey by Capital International SA of Geneva Switzerland (1985) provides data reproduced in Figure 4.1 as a piechart presentation.

TABLE 4.1

WORLD STOCKMARKETS
PERCENTAGE OF TOTAL MARKET VALUE

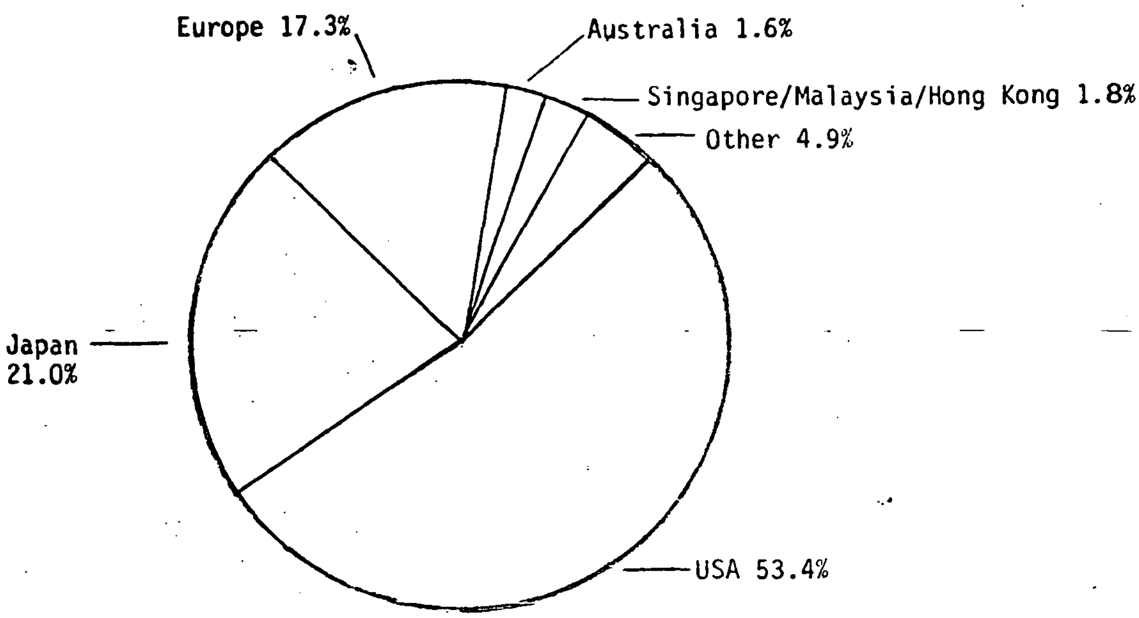
Country	Percentage
United States of America	45
Japan	18
United Kingdom	7
Continental Europe	16
Canada	6
Australia	1
Others	7

Source: Stock Exchange Fact Book, March 1979

FIGURE 4.1

WORLD STOCKMARKETS

PERCENTAGE OF TOTAL MARKET VALUE - 29 MARCH 1985



Acceptance of Keane's proposition implies that Australians should hold 99% of their portfolio in foreign assets. This is typically not the situation and the vast majority of CAPM studies conducted in Australia and other countries confine themselves to the use of a national stock exchange index. More specifically the studies concentrate on equities and a stock market index. Friend, Westerfield and Granito (1979) consider the inclusion of marketable debt instruments into the analysis. They were surprised that "heretofore no systematic attempt has been made to determine whether the only major class of risky marketable assets other than stocks for which returns can readily be estimated appears to conform to the return-risk relationship observed for stocks." (p.58.).

Support for the practical expediency of using a stock market index is offered by the Mayer and Rice (1979) investigation. Consistent application of one index for ongoing and subsequent research of either a time-series or cross-sectional type provides results which are of greater intertemporal consistency. Omission of components from the measure of the index introduces errors into the findings but the indications are, according to Mayer and Rice, that these errors are random events.

An entirely appropriate answer to the question of what is the market portfolio will probably never be determined. Evidence available does indicate that various components of the market are less than perfectly positively correlated with each other. Accordingly, changes in the weighting given to the constituent parts and the estimation of the components' return will alter the value of R_m. A study of the market portfolio in the United States by Ibbotson and Fall (1979) provides a "Capital Market Security Returns Correlation Matrix" (p.91.) which indicates the extent of the diversity. The index for the New York Stock Exchange has a correlation coefficient of 0.884 with the index of the American Stock Exchange, -0.227 with Total Real Estate, -0.454 with Commercial Paper and 0.849 with the Total Market.

Ibbotson and Siegel [1983] extend this previous study to the world portfolio. There are obviously points of contention once again as to the measurement processes and the weighting ascribed each component of the world portfolio. Nevertheless, the correlation matrix is of interest. United States Equities are correlated with European Equities, Canadian and Australian Equities, and Asia Equities with coefficient values of 0.627, 0.787 and 0.260

respectively. Total United States Real Estate is now reported as having a correlation coefficient with Total United States Equities of 0.035 compared with a figure of -0.231 between Real Estate and New York Stock Exchange Index in the previous study. This lack of a high degree of correlation between components of the market, and also differences caused by introducing fixed interest securites into consideration, or opening the market measure to an international choice of market proxy, impacts upon the validity of the results.

The selection of an index based on shares traded on one or more of a nation's stock markets does not remove all these complications. Factors such as how the index is compiled influences the aggregate value of the market. Foster (1978, ch. 5.) discusses several issues in index number construction and emphasizes three matters of choice. First, whether to include all companies in the population or include only a sample of firms. Survivorship is of importance in this context as consideration must be given to the handling of corporations which are delisted. Second, not all listed companies have the same fiscal year. Should the index consist only of firms with a common year end? Finally, the choice between an equal weighted or value weighted index must be made.

The market portfolio as a unique point on the locus of all Markowitz efficient portfolios is constituted by all assets at a specific point in time. Thus, R_m is obtained as the value weighted sum of the returns of all the assets which are part of this market portfolio. Conceptually the adoption of a value weighted all inclusive share index appears consistent with the concept of the market portfolio. However, in a statistical sense, recognizing that any share index is only a proxy for the real market portfolio, it is not possible a priori to suggest that one surrogate index is a more consistent unbiased surrogate than another.

2. Return on the Risk-Free Asset

Within the framework of CAPM, as developed in Chapter 2, the riskless rate according to Phillips and Ritchie (1983, p.279.) "represents the pure price of time, which is among other things, the maximum return that one can realize by an investment in a financial asset without bearing risk". Risk in the context of CAPM refers to market risk, the risk that cannot be diversified away when the asset is held in an efficiently diversified portfolio. Fama (1976, p.275.) argues that, as CAPM is a statement of equilibrium conditions, it is necessary that the market clears at those prices. This requires that the value of R_f be such that the aggregate of demands and supplies of loans are equal.

In Figure 2.5, R_f is depicted as having a zero standard deviation when efficiently diversified portfolios only are considered. The appropriate measure of dispersion, or risk, in efficient portfolios is the standard deviation of expected return. Risk and return coordinates for nonefficiently diversified portfolios do not, in general, plot along the capital market line. The unique risk which has not been diversified away is included in the standard deviation although the return includes only compensation for the undiversifiable market risk. The appropriate return-risk measure for nonefficiently diversified portfolios is the security market line as depicted in Figure 2.6. The risk-free rate of return is obtained at a beta equal to zero within CAPM framework. The true-risk free security has a standard deviation of zero in the CML construct and this is sufficient for it to have a zero beta in the SML formulation:

$$b_f = COV(R_f R_m)/VAR(R_m)$$
$$= COR(R_f R_m)\ SD(R_f)\ SD(R_m)/VAR(R_m)$$
$$SD(R_f) = 0 \rightarrow b_f = 0$$

Selection of an asset, the return on which may be used as a proxy for the risk-free rate, consistent with these theoretical requirements is not a simple matter. An initially reasonable course of action chosen in early empirical studies is the selection of a government security on the grounds that it is as riskless as can be achieved. If the model is in real terms then the assumption, given homogeneous expectations, that the rate of return on government securities reflects the rate of time preference may be reasonable. This view coupled with the suggestion that there is a long-run constant real rate of return is reflected in the early empirical estimations of CAPM employing a short term government security as a proxy for the riskless asset.

The majority of studies are in nominal and not real terms. Nevertheless, if the Fisher model of interest rates holds, then estimation in nominal terms introduces no further inaccuracies. This assumes that the nominal return on a security is equal to the real return, plus the anticipated price change for the period, plus the cross product of the real return and expected inflation. The last term reflects the depreciation in the value of the return which occurs by the time it is obtained at the end of the period. Extensive testing of the Fisher model:

$$R_{it} = r_i + \dot{p}_t + r_{it}\dot{p}_t \qquad (4.1)$$

where R_{it} is the nominal return on security i in the period t-1 to t;

r_{it} is the real analog of R_{it}; and

$\hat{p}_t$ is the anticipated price change (inflation/deflation)

in the period t-1 to t

by Fama (1975) indicates that for reasonably short periods of, say three to six months, price changes are accurately anticipated and impounded in the nominal return on fixed interest securities. The research method, the specification of the model and the time period over which the study is conducted, have drawn comments. Holden, Peel and Thomson (1985) review this debate and more recent analyses of the issue. They conclude that "Clearly the question of the Fisher Hypothesis is unresolved at the moment" (p.105.).

The existence of government securities which are indexed to the consumer price index provides a riskless asset in real terms. Both the interest indexed and the capital indexed bonds offered by the Australian Government achieve this end. It is possible to reexpress CAPM in purely nominal terms as demonstrated by Friend, Landskroner and Losq (1976) and mentioned in Chapter 2.

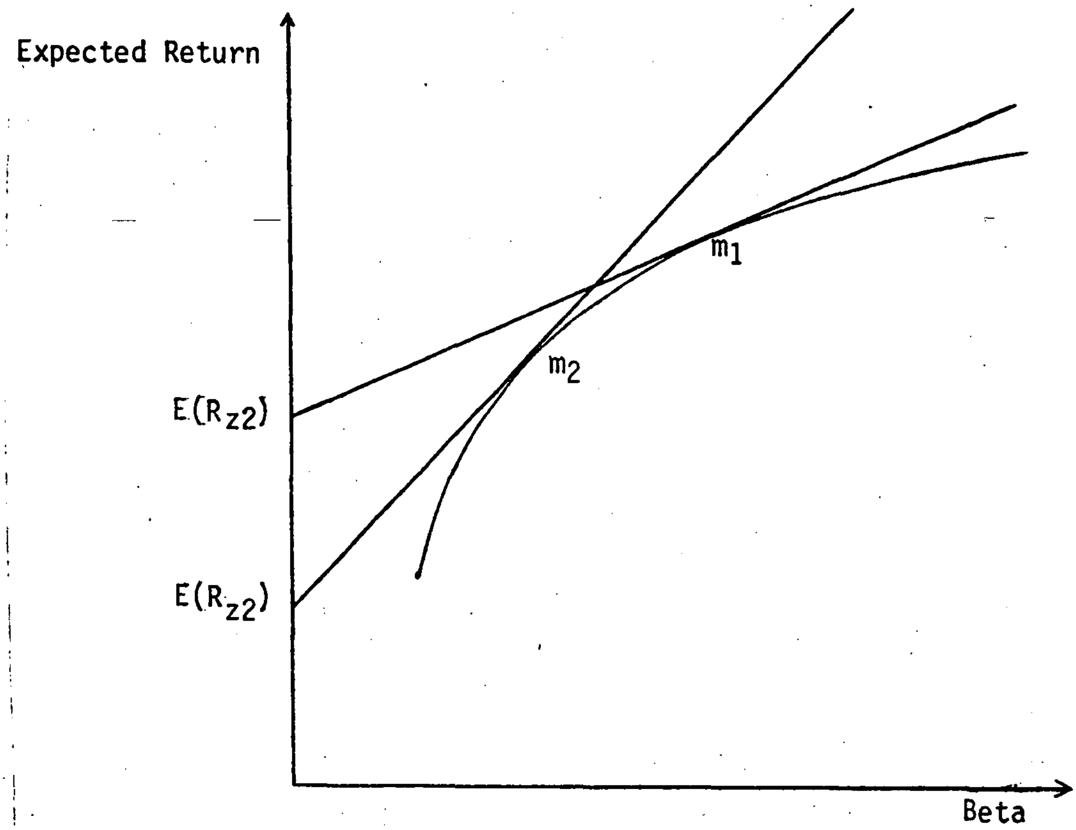
Difficulties with establishing the reasonable existence of individuals being able to borrow and lend at the risk-free rate lead Black (1972) to propose the construction of a minimum variance portfolio, z, such that R_z is uncorrelated with R_m. This implies that b_z is zero. Portfolio z is inefficient and there is a different z for each point m on the locus of minimum variance efficient portfolios. As depicted in Figure 4.2, unlike the determination of a unique optimal market portfolio from R_f shown in Figure 2.6, there is now a one to one mapping between efficient portfolios and zero beta portfolios:

$f : m \rightarrow z$

where f is a bijective function for m and z. When the proxy for the market index is selected then R_z follows.

FIGURE 4.2

ZERO-BETA AND MARKET PORTFOLIOS



The acceptance of the standard form of CAPM with a unique risk-free asset poses a problem as to which proxy is appropriate. If it is assumed that inflation is anticipated and impounded into the yield on government fixed-interest securities, then the issue to be considered is which of the alternative government bonds should be employed in an analysis. Peirson, Bird and Brown (1985, p.165.) argue that when CAPM is used for capital investment analysis the appropriate measure of the risk-free rate is the current yield on a government security whose term to maturity matches the life of the proposed project. In the majority of instances, Officer (1981, p.43.) feels it is probably appropriate to choose a long-dated security. A security of similar maturity reflects the yield curve and the long run pattern of pure time preference.

It is rare for projects or assets to be single period assets with only a terminal return. A far more common situation is for regular periodic, or approximately regular, returns. CAPM is a single period model but may nevertheless be applied in multiperiod situations. Research by Fama (1970), Merton (1973, 1980) indicates that the sequential, period by period application of single period analysis is appropriate. Long-run interest rates are, according to the pure expectations theory of interest rate determination, the average of the short-term rates expected to be in effect during the long-term [see Malkiel (1970)]. It is, therefore, appropriate to use short-run government securities as a source of interest rates. This is supported by the additional consideration that the market for short-dated instruments is generally more heavily traded and accordingly more reliable, in a statistical sense, when samples are drawn.

The more liquid short-term securities will impound any alterations to anticipated inflation more rapidly than longer term securities in a thinner market. Fama and Gibbons (1980) find that the inflation rate varies up to five times the changes in the real rate of return. It is important that an appropriate, that is, correct in the Fisher sense, nominal R_{ft} be used in the calculation of excess returns in CAPM. Roll (1969) discusses in detail the econometric consequences in the estimation of CAPM when there are errors of measurement in the return on the risk-free asset. If the risk-free rate varies from period to period, $R_{ft} \neq \bar{R}_f$, then failure to use R_{ft} results in attenuation bias being an increase in the error resulting from any errors in the measurement of market returns, such as from the choice of the proxy index to calculate R_m.

Treasury Notes (Bills) are the most commonly used proxy for R_f and this is considered appropriate [Davis and Pointon (1984, p.80.)]. Average market premium figures are available, such as those of Frank and Broyles (1979) who report that the average market premium, $\bar{R_m} - R_f$, for the period 1919-75 in Britain was 9.1%. In Australia for the decade commencing 1968 it is approximately 6% according to the Peirson, Bird and Brown (1985, p.166.) reworking of the Officer (1981) figures. Although these long term averages are available they must be viewed as averages which have all fluctuations removed. Accordingly, the use of a short-term period by period R_f is preferred.

3. Return on Real Estate Assets

Calculation of returns for the heterogeneous group of assets considered, for the purpose of this thesis, to be real estate poses a number of problems. Return as a concept first requires definition, and then attention may turn to the measurement of the input information. As will become apparent the gap between what is desirable and what is achievable or available is not insignificant. McIntosh and Sykes (1985, p.242.) discuss three measures of return widely used in the real estate market for the description of property. These separate concepts are not, in general, of the same numerical value and are used for quite different purposes. An example of alternative uses of the return concept arises where a property is held as a trust. One plausible arrangement is that the corpus is to remain intact while the income is available for distribution. A different situation arises where the trust has a life of seven years or more and the objective is high capital growth which is to be distributed on the liquidation of the trust. The first situation is concerned with the aim of maximizing income while the second is concerned with capital appreciation.

Income return (IR) is defined as the ratio of net realized income (Y) accruing to the ith property during the measurement period (t-1, t) to the beginning value of the asset (P_{it-1}):

$$IR_{it} = Y_{it}/P_{it-1}. \qquad (4.2)$$

In those instances where the asset is disposed of during the period, any profit or loss obtained on disposal is included as part of the net realized income. The concept of an income return is widely used in the property sector. Property trusts both listed and unlisted, which disburse income by way of dividends, announce return on this basis, even though it is fraught with practical problems.

The concept of net realized income is not straightforward. Income and profit are accounting terms which may be and are defined in many different ways. Hence any return determined from accounting income is easily altered by adopting a different set of accounting procedures. Recognition of the unsatisfactory nature of accounting in the real estate industry is widespread and some initiatives have been taken to address the problem.

In Australia the accounting profession has given preliminary consideration to the issues involved with the publication of a discussion paper by Phin (1982). This exposition considers the major issues in profit determination, cost capitalization and valuation. In the United States of America, the Financial Accounting Standards Board has promulgated two accounting standards. Both the statements of Financial Accounting Standards No. 66 on "Accounting for Sales of Real Estate" and No. 67 "Accounting for Costs and Initial Rental Operations of Real Estate Projects" were published in 1982. A thorough treatment of the various alternatives and the issues involved is provided by Whipple (1985).

The National Companies and Securities Commission, believing the then prevailing accounting requirements to be inadequate, promulgated a Policy Statement on Property Trusts [National Companies and Securities Commission (1985a)]. There is no conclusive evidence as to whether additional regulation aimed at addressing the concern of the Ministerial Council regarding the marketing and management practices, performance projections, property valuations, and repurchase provisions [National Companies and Securities Commission (1985b)] will in fact achieve the desired aims. Arguments regarding the desirability of regulating financial reporting are surveyed by Beaver (1981). Bird and Locke (1981) suggest there are no welfare gains from regulating financial disclosure. Empirical evidence regarding the impact of accounting requirements on investors decisions is not conclusive.

In the context of a concern for the accounting methods used to determine the return on a property or number of properties held by a property trust which is open to public subscription, it is important to distinguish between unlisted and listed property trusts. The likely impact of accounting ambiguities on the price of units in a trust may differ as between those with units that may only be sold to the management company of the trust and those with shares listed on the stock exchange.

Listed property trusts are in essence the same as other listed public companies. Shares are traded on the exchange and the "company" may declare dividends. Capitalization changes are rare and in general these trusts exhibit a stability in issued and paid up capital.

Unlisted property trusts are constituted by units which may be purchased or redeemed by the manager at a price determined by formula on valuation. Although units are not listed on an open exchange they remain relatively liquid in the sense that managers are bound by the Trust Deed to redeem units. The Listing Requirements of the Australian Associated Stock Exchanges (August 1984) expressly remove this requirement when a property trust is listed. Article 2F(20) states "that the obligation of the management company to repurchase units from unit holders will be suspended while the units are quoted on the Exchange" and 2A(9) provides that "Official Quotation will only be granted to units in a Property Trust if the National Companies and Securities Commission acting pursuant to the Act has granted an exemption from the provisions relating to buy-back contained in Section 168(1)(b) of the Act". The Act referred to in this quotation is the Companies Act 1981. The price for units in unlisted property trusts is published in the financial press.

In the instance of unlisted property trusts it is the accounting numbers which determine the price at which units are redeemed or sold by the manager. The accounting numbers are directly influenced by the choice of accounting policies which is within the discretion of the manager. Accordingly, the manager can directly influence the unit price. The extent to which managers will wish to inflate/deflate performance may depend largely on the terms of their emolument package. Where management fees are a proportion of profit then profit is more likely to be biased upwards. Investors will be aware of this situation. Managers will need to compensate unit holders for the additional uncertainty they face. Accordingly, it is to be anticipated that the required return on unlisted funds will be higher. Managers will need to expend a greater effort marketing these unlisted property trusts and in general their size is likely to be smaller.

In regard to listed property trusts agency theory suggests there is perhaps less cause for concern if the market conforms to the weak form of the efficient market hypothesis. The share price (unit price) will impound the increased uncertainty in an unbiased manner. To the extent that the distortion in accounting numbers is consistently biased in one direction the share price adjusts in the opposite direction. Where the uncertainty increases the range in which the true number will lie then the variability in the share price itself increases. It is argued by Bird and Locke (1981) that the lack of certainty regarding accounting numbers does not prevent an equilibrium price being reached.

The second return discussed by McIntosh and Sykes (1985) is the capital return which excludes all income receipts and includes only recognized changes in capital value. Those capital changes incorporated in the calculation are clearly distinguished from capital changes which are included as income. The basis for distinction is that of recognized as opposed to realized gains, and it is the former only which forms part of the capital return measure. The difference between these terms is as follows. Realization requires an arm's length transaction, such as a sale, to have occurred in order to determine the ending value of the asset p_t, whereas, recognition relates to a subjectively assessed ending value p''_t. The opening valuation p_{t-1}, for the purpose of recognition may have been objectively determined by purchase or subjectively appraised, perhaps as the previous period's assessed ending value. Thus an increase or decrease in the capital value of a property divided by the opening valuation, for that period, of the ith asset, is referred to as the capital return (CR):

$$CR_{it} = (p''_{it} - p_{it-1})/p_{it-1}.$$

Income return and capital return represent the two components of what is known as the total return (TR). The combining of the realized and recognized sources of return provides an aggregate of the net income stream inclusive of realized profit or loss on sale of property and the recognized gain or loss in capital deemed to have accrued in the period:

$$TR_{it} = [Y_{it} + (p''_{it} - p_{it-1})]/p_{it-1}.$$

All three measures contain elements of subjectivity either as a result of the accounting conventions chosen and/or the valuations deemed applicable. Further adjustments are required if these nominal returns are to be converted to real returns. In many instances, property developers and investors consider it desirable to include explicitly in the calculation of return a procedure to account for the decline in value resulting from inflation. The rationale behind one proposed form of adjustment, known as general price level adjusted accounting, is the maintenance of the purchasing power of the beginning period investment. Henderson and Peirson (1985, p.516.) explain that "investment purchasing power is kept intact when the money capital at the end of the period is sufficient to purchase the same quantity of investment goods and services as could be purchased with the money capital at the beginning of the period".

In the majority of instances, where reference is made to real returns for real estate, it is intended to demonstrate that this form of investment is a good hedge against inflation. In both the United States of America and Britain property investment companies/trusts may choose to report their financial statements in general price level adjusted terms. The Accounting Principles Board in the United States and the Accounting Standards Steering Committee in Britain had proposed such a form of accounting. The use of an inflationary deflator in the calculation of real income as the numerator in calculations of real income return, requires a knowledge of the timing of the income flows throughout the period under consideration. If the net income flows occur evenly within the period or at the midpoint of the measurement interval, then the relevant deflator is one half of the period increase in the inflation index (I"). The real total return (RTR) is, in accordance with these principles, calculated as:

$$RTR_{it} = Y_{it}\,(1 + (I''_t - I''_{t-1})\;W_t) + (p''_{it} - p_{it-1})(I''_t / I''_{t-1}) / p_{it}\;(I''_t / I''_{t-1})$$

where W_t is the average portion of the period over which the net income is earned.

The incidence of taxation may also be incorporated into the calculation of return. This involves a number of complications attributable to the application of different rates to the income and capital gain component. Inglis and Miller (1985) discuss the impact of taxation legislation on the return on real estate in Australia. There are considerable differences between countries as to the taxation of capital gains, rates of taxation and allowable deductions. In some instance it is only realized income which is affected while in others this is not the case. Even within a country the treatment may differ between traders and investors.

It is reasonable in the light of the clientele effect, as argued for shares, that taxation may be reasonably ignored at the aggregate level [Van Horne, Nicol and Wright (1985, ch. 12.)]. Individual investors, be they persons or corporations, select securities which are most desirable given their specific taxation circumstances and the demand and supply consequences will be reflected in the gross returns. The returns on property trusts and shares are treated the same for tax purposes.

Decisions are required as to the appropriate time period over which to measure returns. Assets such as land for rezoning, subdivision and residential building have a long gestation before realizing positive returns. While there is little difficulty in the aggregation of short period returns to obtain a longer period return the reverse is not true. The nature of the "critical events" [Myer (1959)] which give rise to a subperiod component of a longer term return are generally not known with any degree of certainty. Accordingly, arbitrary allocation of say a two year return to quarterly subperiods is not informative.

Accuracy of data on returns is likely to be influenced by the periods chosen. Shares and other regularly traded assets have prices which are readily observed and commonly reported in the financial press. Nonmarketable assets and those which are less homogeneous than frequently traded financial securities are not so readily assigned a price based on an observed market sale. Although there are daily sales of real estate the degree of comparability between such sales and a specific piece of real estate an investor holds will vary from case to case. In the absence of a direct sale of the specific asset it is necessary to appraise the asset's value.

Valuers are commonly engaged for this purpose. The dollar number (valuation) assigned to a property is an estimate and can only be completely verified by sale of the asset. As the time interval between successive valuations is decreased the relative magnitude of the uncertainty is compounded. McIntosh and Sykes (1985, p.242.) argue that it is desirable to "examine property performance over a period of somewhat longer time span than one year to reduce the impact of uncertainties surrounding the estimated market value."

Although the process of real estate valuation is susceptible to economic analysis, little research is reported in this sphere. The "property market" is characterized by heterogeneity and the various economic agents reveal implicit prices of the attributes associated with real estate by the observed prices of differentiated goods. Dale-Johnson (1980, p.2.) notes that such a review is generally founded on the

> basis of a broad range of empirical research with respect to intertemporal and cross-sectional price variations of classes of goods where each good within the class can be described by a vector of objectively measured quantitative characteristics. Differences among the prices of the goods in a group are argued to

> depend on variations of their quantities of characteristics among the goods and hence there exist implied prices of the attributes or characteristics.

Hedonic price is the name frequently applied to the implicit price of each attribute. Griliches (1963) explains the justification of a research strategy which views commodities as bundles of qualities, each of which contributes to the utility derived from the commodity. He suggests that where these dimensions or qualities are quantifiable it is likely that at a point in time different quality combinations will be selling at different prices. Accordingly, it should be possible to estimate the price of these dimensions at the margin. One procedure for achieving this is through cross-section regressions.

The idea of hedonic prices and characteristics is refined by Lancaster (1966) in his study on consumption. Rosen (1974) employs the same underlying logic in his shadow price formulation of consumer theory. Ferri (1977) utilizes the approach in considering changes in monthly housing prices 1965-75.

Dale-Johnson's (1980) study finds a lack of market homogeneity and a significant degree of market segmentation. He considers the interesting problem which remains is whether it is preferable to estimate the price characteristics' relationship within market segments or simply within the market as a whole (1980, p.248.). Unfortunately no findings regarding the efficacy of these two alternative approaches are reported.

Hoag (1980, p.572.) discusses the similarity between the approach of property valuers and fundamental analysts in the share market. Both appraisers and security analysts use fundamental information to establish the value of their respective investments.

He suggests that if "consensus expected returns reflect unbiased estimates of realized returns (rational expectations), then statistical techniques should discern the elements of fundamental characteristic values." The real issue is not so much one of "if" but rather whether valuations reflect unbiased estimates. As mentioned above there may be incentives for trust managers to have consistently biased valuations. Accordingly, Hoag's next proposition appears of doubtful practical propriety. He proposes that where appraised values of properties are available with their fundamental characteristics described then these should be added to the database thus improving the valuation function. Once this valuation function is obtained a value for nontransacting property may be estimated by reference to the valuation function applied to its fundamental characteristics. Hoag argues that the individual compound rate of return can be estimated from the valuation function and this then forms the basis for an aggregate market value and a total return index (p.573.).

Australian research into the application of regression models for statistical valuation has proceeded in the residential housing sector. Both Lockwood (1984) and Reynolds (1985) analyze the possible form of a linear model on Adelaide data. An approach to estimating a linear model for rural valuation in Victoria is made by Salivin (1981).

Model construction is a relatively simple matter when there are few variables involved. The choice of data is of importance in the context of the external validity of the models. Research design has focussed on obtaining valuations and the key characteristic variables as recommended by the valuers. Not surprisingly the results in terms of explanatory power are significant. In several studies variables from the recommended set are found to be correlated with other variables or to be statistically insignificant and in both cases omitted. However, problems arise when price obtainable from sale rather than value as appraised is used as the dependent variable. In these instances some other explanation (characteristic) is required to improve the fit.

Models built on decisionmaker's cues (valuer selected variables) and assessed against decisionmaker's response (valuation) such as is done in the Lockwood (1984) and Salivin (1980) studies are fraught with potential problems. First, there is no certainty that the valuer's decisions are consistent. It is recognized that statistical models will in general outperform the human information processor [Dawes (1971)]. Laboratory type experiments to assess valuer's consistency are not reported in the literature. Second, if valuers are selecting their cues as heuristics (simplifications from the environmental set of characteristic variables) and then following rules of thumb for decision making there will be, as Tversky and Kahneman (1974) indicate, a resulting lack of coincidence between price and value.

The possibility that there is a broad range of attributes or characteristics correlated closely with a property's price is worthy of investigation. Although the use of a data reduction procedure such as factor analysis is viewed by some researchers as data dredging, it does avoid what Libby (1981) indicates is the known tendency of professionals, such as valuers and appraisers, to slip toward the use of heuristics. Langfield-Smith and Locke (1986) discuss these estimation and cognitive aspects of the valuation process within the framework of the Brunswik lens model.

Lack of a currently developed and tested procedure, considered to be both internally and externally consistent, for the development of hedonic indexes suggests it is a desirable avenue for research. For the purpose of the current empirical analysis it is necessary to rely on available data series, while giving due recognition to the arbitrary basis of their construction and the potential inconsistencies and biases they may embody.

The collection of data covering real estate transactions fall into two categories. First, there are the shares in real estate portfolios traded as financial securities either on the stock exchange, for listed property trusts or through management companies, in the case of unlisted property trusts. Figures covering price, turnover and capitalization changes are readily available in the financial press.

The second category of real estate transactions relate to the physical assets. The source of data in respect of these transactions is not a straightforward financial publication. Further, the difficulty is accentuated by the lack of an integrated exchange or clearing house to deal with all transactions. Bid and offer prices for a sample of transactions are available in the daily press and specialist publications as listings of For Sale, To Let, etc., but very scant details are published about the money terms on which trades are actually consummated.

Each individual state in Australia maintains detailed records in the Valuation and Land Tax Departments but these are not readily accessible to the public in the manner of a reference library. Real estate agents and valuers do often obtain access to this information in the course of their work.

South Australia distinguishes itself from the other states in that it has a central computerized database and does permit open access to the records. In each of the other states an annual report is produced by the respective Valuer-General and these contain minimal data relating to individual transactions. In Victoria a Year Book, entitled Property Sale Statistics Victoria, is published and this contains categorized transactions by geographical area.

Alternatives to the official government registries, which do not make the information available, are private organizations which publish real estate statistics. The Real Estate Institute in Australia, and Richard Ellis and Associates provide the two sources of data used in the empirical research reported in subsequent Chapters. Both organizations use sample data and do not rely on official records of government agencies for the compilation of their surveys.

A further complication is the necessity to determine a unit of measurement. Real property is not homogeneous and, at the extreme, each property may be considered unique. This is quite a different situation to financial securities where one Company X Class A share is the same as any other Class A share of that company, and similarly any June 198X Gold Future is the same as any other June 198X Gold Future. In order to permit the meaningful analysis of real property transactions it is necessary to find among these heterogeneous units some common characteristics which may be used to consolidate the individual unique assets into homogeneous classes.

The theory of hedonic prices, discussed above, provides a conceptual approach. In practice the groupings formed by organizations which produce and publish aggregated data are basically arbitrary. They reflect the conventional categories employed by principal participants in the property market such as real estate agents, valuers, developers and institutional investors. Specifically, the commonly ascribed categories are: commercial, retail, industrial, residential, and rural. Further subdivisions are from time to time used in the professional literature.

4. Proxy Return on the Market

The choice of stock exchange indexes in Australia is now limited to those published by the Australian Associated Stock Exchanges and the Sydney Stock Exchange Research Department. Prior to 1958 several share price indexes were calculated by stock exchanges, banks, newspapers, sharebrokers and government departments. The Commercial and Industrial Index commenced in 1875 and has been used to extend the Sydney All Ordinaries Index back to 1875 [Lamberton (1958)]. December 1980 heralded the end of the two remaining index series produced independently by the Melbourne and Sydney Stock Exchanges. This followed the adoption of a report to the exchanges in 1977 from the Institute of Actuaries in Australia [Australian Stock Exchange Indices (1982, p.5.)].

A new series of Australian Stock Exchange Indexes (ASE) commenced in January 1980. There is both a series of "ASE Price Indices" and "ASE Price and Accumulation Indices". The former index is comparable to the Standard and Poors and the New York Stock Exchange Indexes in the United States, and the Financial Times Actuary Indexes in the United Kingdom. The Accumulation index includes not only the price movements (capital gain or loss) but also dividends:

$$\text{Today's Price Index} = \text{Yesterday's Closing Index} \times \frac{\text{Today's AMV}}{\text{Yesterday's adjusted closing AMV}}$$

$$\text{Today's Price and Accumulation Index} = \text{Yesterday's Closing Index} \times \frac{\text{(Today's Closing AMV + Today's Dividend)}}{\text{Yesterday's adjusted closing AMV}}$$

where AMV is aggregate market value; and

adjusted AMV is yesterday's AMV adjusted overnight for delistings and capital alterations.

Ordinary shares for a sample of approximately thirty percent of all companies listed on Australian Exchanges are included in the index but this represents 85 - 90% of share capitalization on the exchanges [ASE (1985, p.1.01.)].

The Statex Actuaries Accumulation index is based on a portfolio of shares in fifty companies which is managed according to a rigid formula. This removes the necessity for any cash to be withdrawn from or paid into the portfolio. It is designed such that:

> The equal weighting and annual update ensure a sensitive index which is not dominated by any one stock, and as the portfolio is chosen objectively from active leading stocks the accumulation index provides a consistently reliable guide to portfolio performance [Australian Associated Stock Exchanges (1980, p.45)].

The Statex Actuaries Accumulation Index is used as a proxy for the market portfolio. Daily values of the index are available in newspapers and the Australian Associated Stock Exchange publishes monthly figures in the <u>Australian Stock Exchange Journal</u>. (This journal is now incorporated into the monthly magazine, <u>Personal Investment</u>).

5. Proxy Return on Risk-Free Asset

The thirteen-week Treasury Note of the Australian Government is adopted as the risk-free asset. Annual yield at time of issue is published each month by the Reserve Bank for the weighted average yield of notes allotted at the last tender of the month.

Monthly data recorded in the Statistical Bulletin are used as the proxy for R_f. When a return on the risk-free asset is required for a period other than 12 months it is obtained by calculation from the annual yield. The nominal period return (NPR) is related to the effective annual return (yield) R as:

$$\log(1 + NPR) = \log(1 + R)/N$$

where N is number of periods in the year, e.g. 12 if monthly return is required.

6. Proxy Return on Real Estate Assets

The R_i or R_p data involves both the financial real estate assets such as property trusts and physical real estate surrogates. Each asset group is discussed in turn.

Listed Property Trusts

The daily share prices are quoted in newspapers and the Australian Stock Exchange Journal publishes the last sale price each month. The last sale price each month is used as the basis for the calculation of the monthly return on the trusts.

Unlisted Property Trusts

The Australian publishes each Monday the price at which the management company is buying back the units in the trust.

Redemption price published on the Monday closest to the end of the month is used to calculate the return for each month.

AMP P Series

The "AMP Investment-Linked Superannuation Statutory Fund No.2" was established in 1968 as a merger of assets previously held in separate AMP operations. The funds are held in six broad categories of investments: Company Shares; Resource Investments; Company Fixed Interest Securities; Public Sector Securities; Interest Bearing Deposits; and Property Investments. As each investment class operates independently of the other five and is reported upon as a separate unit, it is possible to focus on the Property Investment (P series) unit valuations.

The P series commenced in May 1971 and quarterly valuation figures are published by the AMP. In essence the P series is an unlisted property trust in that units are bought and sold by the Fund Manager at a price determined on valuation. Policy in respect of valuation is that properties are valued at least annually and more often when changing circumstances suggest this is prudent [Reber (1981)].

Victorian Valuer-General

Victorian property sales statistics are categorized according to usage type and geographical (local government) area. Sales price data are published annually for all transactions in the preceding 12 months in each of the categories. A price index based on 100 at 1982 is calculated from the median value of sales. Presentation of the index in each class is contingent on there being at least 10 sales of the same land use classification, in the same local government area, for both the current and base year [Valuer-General's Office Victoria (1984, p.xxii.)].

Sales information for the Melbourne statistical division is aggregated to produce a property trend index. It provides an indication of the comparative trends in value since June 1974. The use categories presented are: Commercial; Dwelling; Vacant Residential Group A; Own Your Own Flat; and Industrial. Details of these categories are discussed in the publication (1984, pp.xxiv - xxv.).

Real Estate Institute of Australia

The Real Estate Institute of Australia (REIA) surveys a sample of its members in the six mainland capital cities, viz., Adelaide; Brisbane; Canberra; Melbourne; Perth and Sydney. The results of these questionnaires are published in each of eleven monthly, January to November, editions of Market Facts. Coverage includes a survey of rental demand, vacancy rates, rent levels and data on dwelling sales. Of particular interest are data on the median sales price of established houses in each city. These figures are used as a monthly index from which a return series on houses is calculated for analysis in latter Chapters.

Little information is available regarding the response rate of the surveyed real estate agents. Considerable bias may occur where an agent in a high value location has an especially successful month of completing contracts. The data are not presented in a form easily amenable to scrutiny of their statistical characteristics. Cumulative frequency data of a sufficiently detailed form to permit the testing of hypotheses regarding the distribution of the data are not available. Published graphs contain, for the current and preceding month, a bar chart of percentage of total sales against $10,000 price intervals. A visual inspection of these indicates considerable variation from month to month.

At best the REIA data are indicative. As this organization is the only available source of consistently collected dwelling sales figures, albeit from a "representative" group of agents, its data are used. A yearly consolidation of statistics is published by REIA, known as the Annual Review of the Residential Property Market and this contains explanatory definitions of the terminology employed in the releases.

Jones Lang Wootton

The international firm of property consultants Jones Lang Wootton (JLW) publish a regular series of quarterly indexes of real property prices in Britain. These Indexes form an important component of the firm's Property Performance Analysis System. The Indexes cover the categories of Office; Industrial; Shop and Agriculture. These are each subdivided into Capital and Expected Rental Value and consolidated Capital and Total Return Indexes are also available. All Indexes are based on properties drawn from portfolios of investing institutions where JLW actively advise or act as independent valuers. The latter capacity is the role they fulfil in mainland Australian states for the AMP P series properties discussed above.

Details of the basis for geographical composition and other information are available in the JLW Index Explanatory Notes [Jones

Lang Wootton (1984)]. The Indexes cover the period 1967-77 as an annual series and from June 1977 onwards as a quarterly release. The time-weighted return method, discussed below is the basis for the compilation of the Indexes. A new British property index combining those already produced by JLW and other firms is to be published "under the auspices of the Royal Institution of Chartered Surveyors" [Pilot Study Report (1985, p.1.)]. The objective of this new series is to provide "reliable indices" and it is assumed a broader base will improve the representativeness of the samples.

Richard Ellis

The real estate and property consultant firm Richard Ellis and Associates (RE) have published Part One An Australian Property Index. The first release of the Index is confined to the location of Melbourne and consists of Industrial; Office; and Retail properties. There are Income and Capital component indexes and these are combined for a Total Return Index. The sample from which the Index derives is small, reflecting a unique mix of characteristics including the type of property, age, location, tenancy mix, size, tenure and rent review frequency [Richard Ellis (1984a)]. These unique characteristics will be true of any sample index. The RE figures are compiled from the property portfolios of institutions for which they act as managers, advisers or consultants. In many respects the RE Indexes are prepared in a similar manner to those of JLW in Britain, although the latter contain many more properties. This presumably goes some way to reducing the effect of sampling bias.

There is one major difference between the RE and JLW approach to index compilation. The RE Indexes are based on the money-weighted return method as compared with the time-weighted return method used by JLW. The choice is deliberate and supported on the grounds of being theoretically superior and avoiding the recurring necessity for revaluation of properties at short intervals, as would otherwise be required.

Jones Lang Wootton argue that "the use of time-weighted returns has been the accepted method of comparing various investment media since its recommendation in a paper issued by the Society of Investment Analysts in 1972 and is the method used for the JLW Index" [Jones Lang Wootton (1984, p.7.)]. Alternative approaches are discussed by Milne (1983), although there is no clear conceptual reasoning as to the relative superiority of other methods.

The time-weighted total return (TWR) is calculated as a one period rate of return:

$$\text{TWR} = \frac{\text{Closing Value} - \text{Opening Value} + \text{Income}}{\text{Opening Value}}$$

and this requires regular revaluations of assets. JLW undertake the valuations on a quarterly basis and this is sufficient to incorporate the changes of size into the portfolio. New injections must occur at the beginning of each subperiod or be valued as at both the beginning and end of the period.

The money-weighted total return (MWR) is calculated as:

$$\text{MWR} = \frac{\text{End Value} + \text{Income} - \text{Changes to Investment} - \text{Opening Value}}{\text{Opening Value} + \text{Changes to Investment} \times \text{Proportion of Time}}$$

It is in essence an internal rate of return calculation and equates the flow of receipts to the flow of costs taking into account the timing of those receipts and costs. As such it may be considered an absolute measure of performance and is calculated over the life of the portfolio.

Usage of both the TWR and MWR are defended and criticized by proponents of the alternate measure. In the market for financial assets it is the TWR which is generally used. Problems with the necessity for repeated valuations are not so important where market prices are readily available. For the purpose of the analyses that follow it is important to recognize the RE and JLW Indexes are formulated in a different manner, but this will not provide a consistency problem as they are neither combined nor directly compared.

7. Summary

At a conceptual level the derivation of criteria to which data should conform for CAPM to be estimated is relatively easy. Actual implementation of these aims is more difficult and a major criticism leveled against CAPM studies is the failure of the data employed to meet the requirements deduced from the model. Ideal surrogates for the return on the market and the return on the risk-free asset were discussed above. As has been the case with all earlier empirical studies the actual data available is not perfect and fails to satisfy many of the desirable properties.

In the three preceding Sections details of the actual data used are presented. While it is recognized and accepted the data are not perfect, it is contended that it is as good as any other available from alternative sources. Careful checking of each series in conjunction with the sources was conducted to ensure correction of printing, encoding and collecting errors.

Data discussed in this Chapter are used as input variables for various estimation procedures in Chapters 5-7. Statistical properties of the data are explored and the relationship between the variables are examined in detail.

CHAPTER FIVE

CAPITAL ASSET PRICING MODEL AND THE WEAK-FORM EFFICIENT MARKET HYPOTHESIS

Introduction

The Capital Asset Pricing Model is a statement of how the relative price of assets are determined in equilibrium. Such a model implies various characteristics regarding the market for assets and in particular the efficiency of the market. Copeland and Weston (1983, p.306.) state the point most succinctly as "one should always keep in mind the fact that CAPM and capital market efficiency are joint and inseparable hypotheses. If capital markets are inefficient, then the assumptions of the CAPM are invalid and a different model is required." This Chapter considers the theoretical aspects of this issue and following Locke (1986) tests various hypotheses.

A security is expected to earn an excess return, the difference between its return and the return on the risk-free asset, commensurate to its correlation with the expected excess return on the market:

$$E(R_i - R_f) = b_i \, E(R_m - R_f) \tag{5.1}$$

where $E(R_i - R_f)$ is the expected excess return on security i;

b_i is a parameter; and

$E(R_m - R_f)$ is the expected excess return on the market.

This is equivalent to both of the alternative forms of expression for CAPM used above:

$$E(R_i) - E(R_f) = b_i \, [E(R_m) - ER_f)]; \text{ and} \tag{5.2a}$$

$$E(R_i) = E(R_f) + b_i \, [E(R_m) - E(R_f)] \tag{5.2b}$$

as is apparent from the rules of expectational operators. Specifically, $E(a - b) = E(a) - E(b)$.

The link between information on which expectations regarding returns are formed and the equilibrium relationship between assets requires consideration. The first issue to be addressed is how the market determines the expected value of the return variables. Section 1 provides a formal statement of this relationship in terms of the rational expectations framework.

Section 2 contains a discussion regarding the structure of CAPM and its relationship with the efficient market hypothesis. Further, consideration is given to the implied distributional properties of the variables as required for consistency with the model. Alternative approaches to testing the nature of sample distributions are discussed and empirical evidence reported.

Discussion in Section 3 addresses actual testing of the weak-form of the efficient market hypothesis. In particular, attention focuses on three tests, the filter test, autocorrelation test and the runs test.

Finally, a summary of results is reported.

1. Information and Expectations

The capital asset pricing model is expressed in terms of expected values. It is derived theoretically from an assumption that individual choice is made on the basis of the mean and variance of returns. The first two moments of the subjective probability density function for returns on an asset are of importance at the conceptual level but empirical estimation of the equilibrium equation requires a knowledge of the first moment only as the second is subsumed into the beta coefficient. The first step in empirically estimating CAPM is a replacement of the expectation terms with observable variables. Sheffrin (1983) suggests the rational expectations hypothesis as a means of removing the expectational operators. It provides a "solution to this problem by equating the subjective beliefs of individuals with the actual means and variances of securities that prevailed during the period" (p.137.). Muth (1961), attributed with the original articulation of the rational expectations theory, suggests that expectations, as informed predictions of future events, are essentially the same as the predictions of the relevant economic theory.

Information is, as Muth explains, a scarce good which will not be wasted. Hence, when new information becomes available it will be rapidly impounded into prices in an unbiased manner. Similarly, a publicly announced prediction will not have an impact on prices unless it is based on inside information. Within the finance literature these views have become known as the efficient market hypothesis (EMH). Rubenstein (1975) formally presents a statement of the EMH and argues that security prices fully reflect the information set (Q_t) if the prices so determined are identical to those prices which will occur in an otherwise identical economy where each investor had the information set Q_t.

An alternative statement in terms of the distribution of prices is provided by Fama (1976). It is this approach which is adopted in the ensuing discussion as it offers the advantage of being directly related to probability distributions over prices.

Let

Q_{t-1} = set of information available at time t-1;

Q^m_{t-1} = set of information the market uses to determine security prices at t-1;

P_{jt-1} = price of security j at time t-1; j = 1,2,...,n where n is the number of securities;

$f_m(P_{1t+v}, \ldots, P_{nt+v}|Q^m_{t-1})$ = joint probability density function for security prices at time t+v (v>0) assessed by the market at time t-1 on the basis of the information set Q^m_{t-1}; and

$f(P_{1t+v}, \ldots, P_{nt+v}|Q^m_{t-1})$ = true joint probability density function for security prices at time t+v (v>0) conditional on the information set Q^m_{t-1}.

The set Q_{t-1} contains all information that became available at t-1 and at all previous points of time. A necessary condition for capital market efficiency is that:

$$Q^m_{t-1} = Q_{t-1}. \tag{5.3}$$

No item of information relevant to the estimation of an asset's price is ignored by the market.

Rational expectations, as Mishin (1983) observes, require that security prices in an efficient market reflect all available information "and hence an expectation assessed by the market should equal the true expectation conditional on all available information" (p.61.). Thus, the joint probability density function assessed by the market is the true function. In such a market there are no riskless arbitrage conditions and accordingly:

$$f_m(P_{1t}, \ldots, P_{nt}|Q^m_{t-1}) = f(P_{1t}, \ldots, P_{nt}|Q_{t-1}). \tag{5.4}$$

2. Model Structure and the Efficient Market Hypothesis

The description of how prices are formed, as regards being aware of all information and using it correctly, is inadequate as a basis for formal testing. A statement that the market uses all currently available information to assess the joint distribution of future prices which are, in turn, the basis of currently prevailing prices, is a nontestable proposition. If it is not possible to observe $f_m(P_{1t}, \ldots, P_{nt}|Q^m_{t-1})$ then the validity of Equation 5.4 cannot be verified or, more correctly expressed, cannot be tested. A further specific statement of the nexus between the left-hand and right-hand sides of Equation 5.4 must be proposed.

An equilibrium pricing model provides the link between prices at t-1 and the joint distribution of prices at t as assessed by the market. Tests of market efficiency will of course be joint tests of the equilibrium pricing model and the efficient market hypothesis. The capital asset pricing model provides a statement of equilibrium prices and this model is now used to discuss several tests of the efficient market hypothesis.

It follows from Equation 5.3 that the market using all information in assessing the joint distribution of prices for time t, will correctly estimate the expected return on security i from t-1 to t and that:

$$E_m(R_{it}|Q^m_{t-1}) = E_m(R_{ft}|Q^m_{t-1}) + [E_m(R_{mt}|Q^m_{t-1}) - E_m(R_{ft}|Q^m_{t-1})]\, b_{im}$$

$$= E(R_{it}|Q_{t-1}) = E(R_{ft}|Q_{t-1}) + [E(R_{mt}|Q_{t-1} - E(R_{ft}|Q_{t-1})\, b_i \qquad (5.6)$$

and $\quad b_i|(Q^m_{t-1}) = b_i|(Q_{t-1}). \qquad (5.7)$

This implies that the predictions as to future returns for all securities contained in m which come from the model of market equilibrium will be at least as good as any alternative approach to predicting prices at t with the information available at t-1.

The requirements of Equations 5.6 and 5.7 may be used to derive several testable propositions regarding the EMH. Directly testable hypotheses regarding reaction of the model to information are considered below. It is also possible to test several hypotheses regarding returns in the light of propositions which are consistent with CAPM. This action is desirable in that failure to accept the null hypothesis in each case is tantamount to a rejection of the basic building blocks of this particular equilibrium pricing model.

First, CAPM founded on the mean variance criterion as characterizing investor behavior assumes the distribution of returns are approximately normal [Levy and Sarnat (1984, p.396.)]. Hence the model:

$$E(R_{it}) - E(R_{ft}) = [E(R_{mt}) - E(R_{ft})]\ b_i$$

relies on an assumption that the joint distribution of security returns is multivariate normal. The joint distribution of the return on security i and the return on the market, therefore, is bivariate normal. In Chapter 2 the market model was expressed as:

$$E(R_i) = a_i + b_i\ E(R_m) \tag{5.8}$$

and it was noted that Fama (1976) justifies this formulation from the bivariate normality of the variables involved. Further, it is known that a linear relationship can be expressed between any pair of normal variables. If in the market model:

$$a_i = E(R_f)\ [1 - b_i], \tag{5.9}$$

then the expression which results from the substitution of Equation 5.9 into 5.8 simplifies as:

$$\begin{aligned} E(R_i) &= E(R_f)[1 - b_i] + b_i\ E(R_m) \\ &= E(R_f) + b_i\ [E(R_m) - E(R_f)] \qquad (5.10a) \end{aligned}$$

$$E(R_i) - E(R_f) = b_i\ [E(R_m) - E(R_f)] \tag{5.10b}$$

which is the capital asset pricing model.

Empirical research into the nature of the distribution of returns on shares supports the contention that the normal distribution is a reasonable description for monthly data. The early work of Bachelier (1900) and Osborne (1959) based on successive price changes found daily, weekly, and monthly price changes are approximately normal. Work by Blume (1968) and Officer (1971) utilized returns rather than price changes. Their findings support the view that normality is an appropriate description of the return distribution for both individual securities and portfolios.

Test for Normality

Various procedures are available to test whether a sample set of data is drawn from a normally distributed population. A statistic known as the studentized-range (SR) calculated as:

$SR = [Max(x) - Min(x)]/S_x$

where Max (x) is the maximum value of the variable x in the sample;

Min (x) is the minimum value of the variable in the sample; and

S_x is the sample standard deviation of variable x

is recommended by Fama (1976). This statistic is dependent on the extreme observations in the sample and will therefore be sensitive to outliers. As the sampling distribution for the studentized-range is difficult to estimate, fractiles of the distribution which have been computed are relied upon. Fama and Roll (1971) report that the studentized-range test provides at least as satisfactory result as other procedures which they consider.

A more direct approach is to test the sample against the predefined categories of the known normal distribution. Brown and

Warner (1980) use both a chi-square and Kolmogorov-Smirnov test when considering the frequency distribution of test statistics. In general the latter method is a preferable measure of goodness of fit. The approach, as Siegel (1956, p.47.) describes it:

> is concerned with the degree of agreement between the distribution of a set of sample values (observed scores) and some specified theoretical distribution. It determines whether the scores in the sample can reasonably be thought to have come from a population having the theoretical distribution.

A further advantage offered by this method vis-a-vis the chi-square test is in terms of its power. Unlike the chi-square test, it does not lose information in the process of combining categories. The Kolmogorov-Smirnov procedure is valid in small sample cases when the chi-square test is not applicable. These combined two factors suggest the Kolmogorov-Smirnov is, in a statistical sense, of greater power.

The series of returns calculated from the data described in Chapter 4, are subjected to this Kolmogorov-Smirnov test. The guide manual for the Statistical Packages for the Social Sciences (SPSS) states that "subcommand K-S compares the cumulative distribution function for a variable with a specified distribution, which may be uniform, normal, or Poisson" [Norusis (1983, p.222.)]. The null hypothesis that each series of returns is normal:

> H_o : R_{it} t=1,2, ..., n is drawn from a normally distributed population,

is tested at a 5% significance level.

The choice of a 5% significance level as the bench mark for hypothesis testing is arbitrary. No specific loss function is proposed for this analysis. Hence it is not possible to derive the confidence interval which minimizes the cost of error type 1 and error type 2. Both 95% and 99% confidence intervals are used in finance research, however, the 95% level appears to be the most widely accepted. In the absence of a persuasive argument in favor of the superiority of an alternative this choice is made.

The results are presented in Table 5.1. It is apparent that in the majority of instances the null hypothesis is not rejected. However, there are two securities, the Richard Ellis Indexes, which do not conform to the normal distribution. A type II error where H_0 is rejected entirely as a result of the sample period, when the true population is in fact normally distributed is, in general, thought unlikely with this test. The lack of arm-length transactions and the circular risk and return method employed in valuation are likely explanations. The valuation process whereby comparative valuations are used as a benchmark, as a surrogate for comparative sales, is compounded by the use of money weighted returns as the basis of index construction as this works to smooth the return series over any time interval.

TABLE 5.1

NORMALITY TEST FOR RETURNS
5% SIGNIFICANCE LEVEL

Security	Test Result
<u>Australian</u>	
Financial Securities	
Statex Accumulation All Ordinaries Index	Accept
Statex Accumulation Property Index	Accept
Listed Property Trusts	
ASC Property	Accept
Canberra Commercial	Accept
Canberra Commercial #2	Accept
PML Property	Accept
Stocks & Holdings Property	Accept
General Property	Accept
National Property	Accept
Schroder Darling Property	Accept
Equitable Property #1	Accept
Equitable Property #3	Accept
Stockland Property	Accept
Westfield Property	Accept
Terrace Property	Accept

Unlisted Property Trusts	
AFT2	Accept
AFT3	Accept
AFT4	Accept
AFT5	Accept
AFT6	Accept
Westpac	Accept
Real Assets	
AMP P Series	Accept
Victorian Valuer-General	
Commercial	Accept
Industrial	Accept
Dwellings	Accept
Own Your Own Flat	Accept
Vacant Residential Land - Category A	Accept
Real Estate Institute of Australia	
Adelaide	Accept
Brisbane	Accept
Canberra	Accept
Melbourne	Accept
Perth	Accept
Sydney	Accept
Richard Ellis	
Total Return	Reject
Capital	Reject
United Kingdom	
Financial Securities	
FT All Share Index	Accept
FT Property Index	Accept
Real Assets	
Jones Lang Wootton	
Office Capital	Accept
Shop Capital	Accept
Industrial Capital	Accept
Agricultural Capital	Accept
Total Capital	Accept

The Jones Lang Wootton Indexes, for a slightly shorter period, were tested for normality by Locke (1984) using a Shapiro-Wilks procedure. This involves normalizing each return series and then correlating the raw returns with the normalized returns and determining whether both samples could have been drawn from the same population. The results of formal hypothesis testing at the 5% significance level are confirmatory of those reported in Table 5.1.

Early research by Bachelier and later Osborne assume that successive price changes are independent and identically distributed. This perspective may be transferred to returns; noting that a price change for a period, say 1 to T, is the sum of the price change in each intervening period, whereas the period return is the product of the returns in the period:

$$\Delta p_{1T} = \sum_{t=1}^{T} \Delta p_t \tag{5.11a}$$

$$(1 + R_{1t}) = \prod_{t=1}^{T} (1 + R_t). \tag{5.11b}$$

If the successive returns, R_{it}, are independent and identically distributed, then the natural logarithms, $\ln(1 + R_{it})$, also are independent and identically distributed.

$$\ln(1 + R_{i1t}) = \sum_{t=1}^{T} \ln(1 + R_{it}). \tag{5.11b}$$

The central-limit theorem implies that, where there are many subperiods in the interval 1 to T, the distribution of $\ln(1 + R_{it})$ is approximately normal. It is important to recognize that normality does not imply independence and further tests associated with the weak-form of the efficient market hypothesis are required to investigate that issue.

3. Weak-form Efficient Market Hypothesis Tests

The weak-form of the EMH asserts that "the expected value (or average) of today's price change is completely independent of all prior prices" [Dyckman, Downes and Magee (1975, p.17.)]. This suggests that past security prices do not contain information which would permit an investor to obtain excess returns greater than those commensurate with the portfolio's risk. This view runs counter to those of exponents in an area of security research known as technical analysis, and in particular chartism, founded on the premise that patterns in past prices can be used to forecast future prices. Granville (1969) provides an elaborate exposition of this approach in A Strategy of Daily Stock Market Timing for Maximum Profit. Text books on the subject of security analysis and portfolio management, such as Fischer and Jordan (1979), typically contain a chapter on the topic of technical analysis. Technical analysts, including chartists, believe that security price fluctuations generally form characteristic patterns. Edwards and Magee (1958, p.6.) suggest that certain patterns of formation, levels or areas appear in charts, and these have a meaning which can be interpreted in terms of probable future trend development. The assumptions on which technical analysis is founded, as espoused by Edwards and Magee (p.86.) are summarized by Francis (1980, p.621.) as:

1) Market value is determined solely by the interaction of supply and demand;
2) Supply and demand are governed by numerous factors, both rational and irrational;
3) In disregard of minor fluctuations in the market, stock prices tend to move in trends which persist for an appreciable length of time;
4) Changes in trend are caused by shifts in supply and demand;
5) Shifts in supply and demand, occurring for any reason, can be detected sooner or later in charts of market action; and
6) Some chart patterns tend to repeat themselves.

Although information may be important in the determination of price through demand and supply factors, the market may react to news slowly and impound it in the security price over a period of time. Higher prices are expected to be followed by higher prices for a period until factors change. Picking the turning points is a primary aim of the technicians.

Figure 5.1.1-34 presents a plot of the price or index value against time for the securities under investigation. A visual inspection of the various graphs does not suggest a common recurring trend. The listed property trusts, depicted in Figure 5.1.1-13, record a predominant horizontal progression with a few unusual drops. Unlisted property trusts, shown as Figure 5.1.14-18, reveal a saw-tooth pattern with the exception of the Westpac Trust. No obvious explanation, such as regular dividend distributions, account for these movements. The Victorian and Jones Lang Wootton Indexes, Figure 5.1.19-23 and 5.1.30-34 respectively, reflect a smooth trend. These two series are founded on appraised valuations. Real Estate Institute of Australia data, based on sales, while reflecting an overall upward trend in prices, Figure 5.1.24-39, do embody more ups and downs.

Eye-balling the plots may or may not suggest patterns to different individuals. It is dangerous to extrapolate from such inspections. Ball and Officer (1978) provide an illustration in which eleven price series are charted, six are simulated from a random number generator and five are actual share price data. They demonstrate it is unlikely an individual can distinguish which are random and which are actual prices. Often patterns appear to be present in a past series but this does not infer predictive ability. A more rigorous approach is required.

FIGURE 5.1 TIME-SERIES PLOT OF REAL ESTATE PRICES

FIGURE 5.1.1

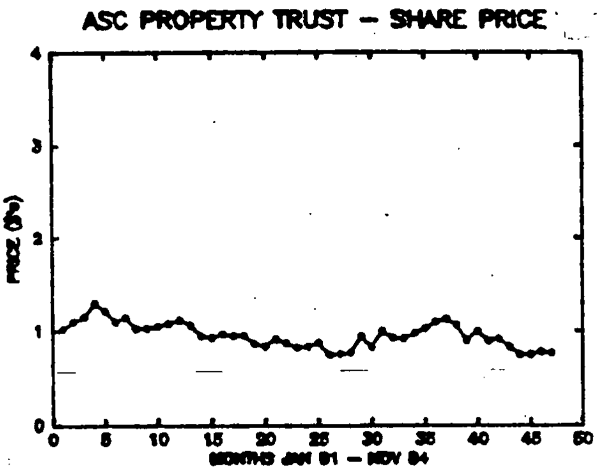


FIGURE 5.1.2

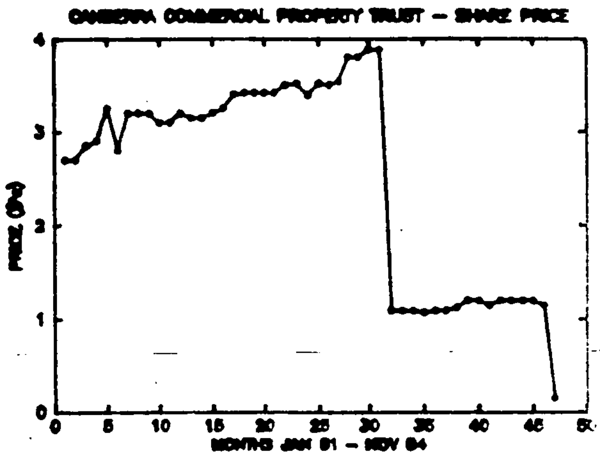


FIGURE 5.1.3

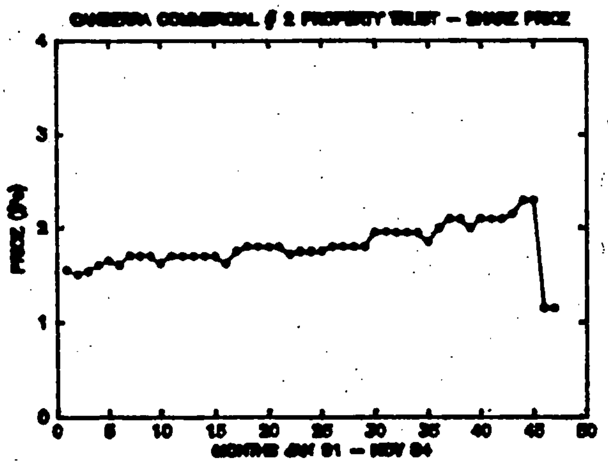


FIGURE 5.1.4

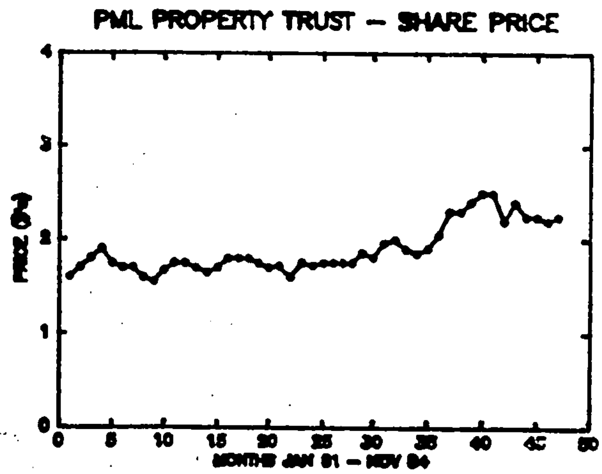


FIGURE 5.1.5

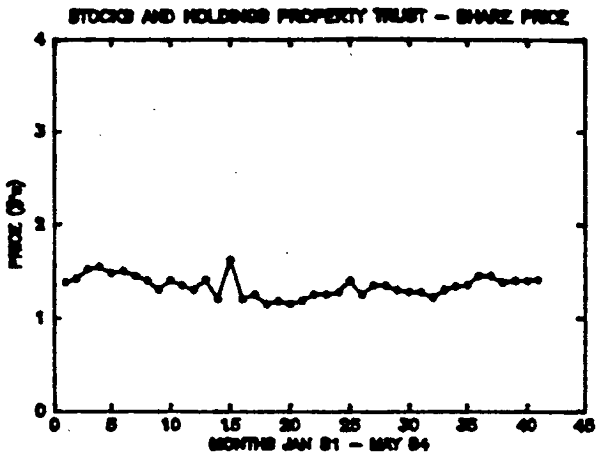


FIGURE 5.1.6

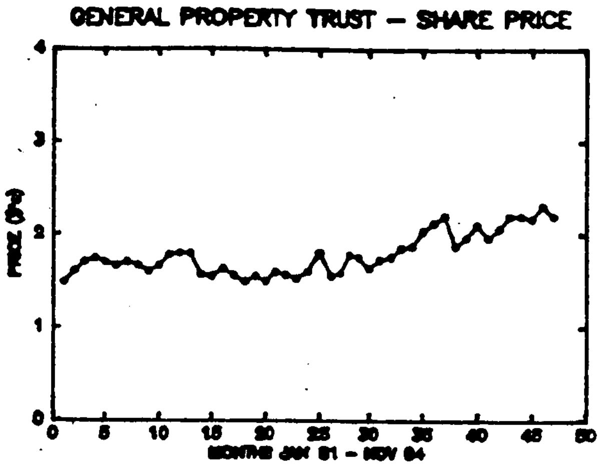


FIGURE 5.1.7

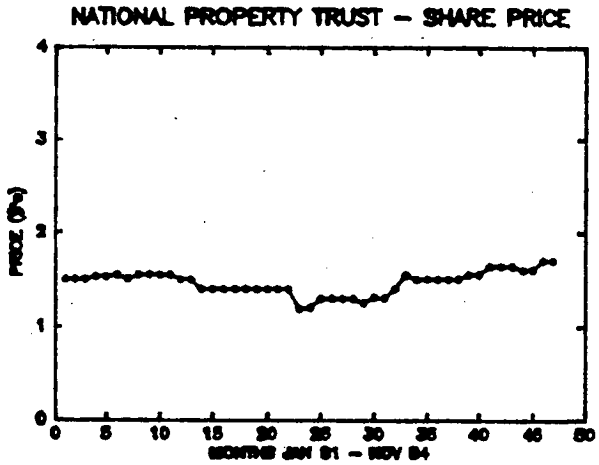


FIGURE 5.1.8

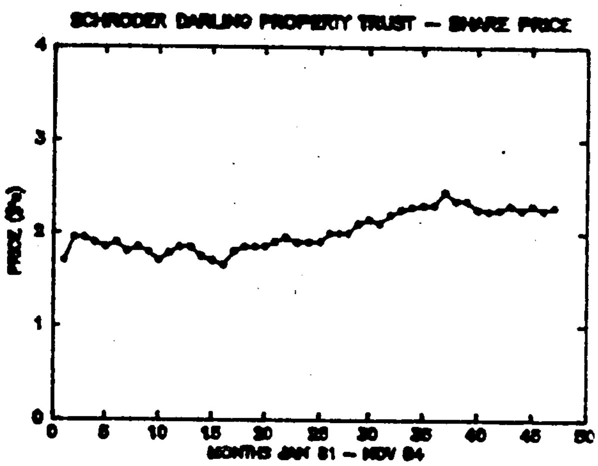


FIGURE 5.1.9

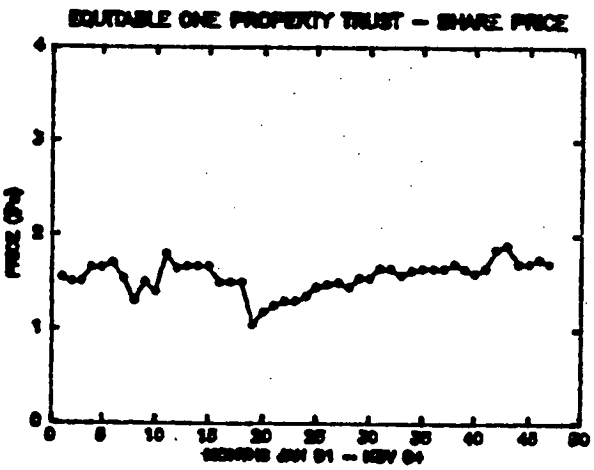


FIGURE 5.1.10

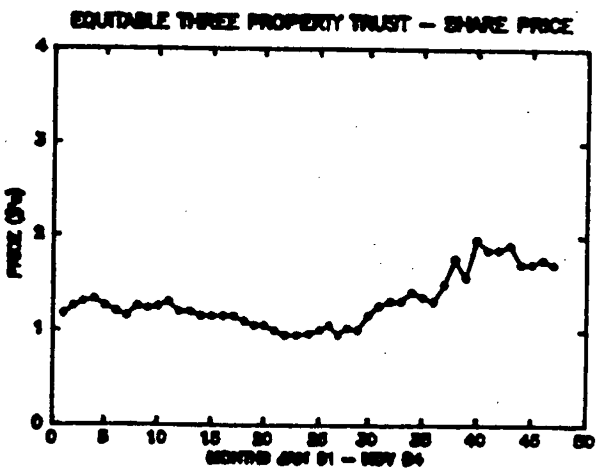


FIGURE 5.1.11

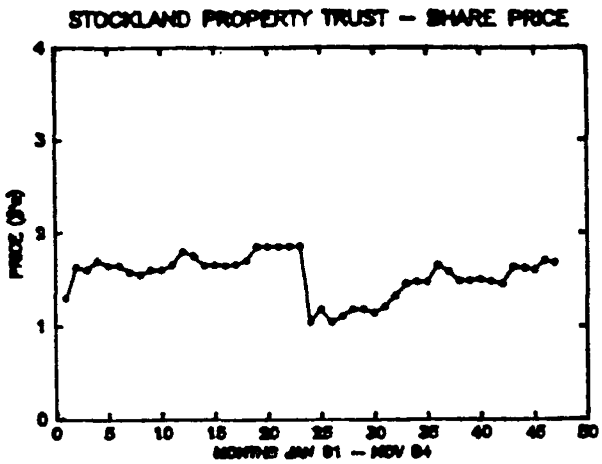


FIGURE 5.1.12

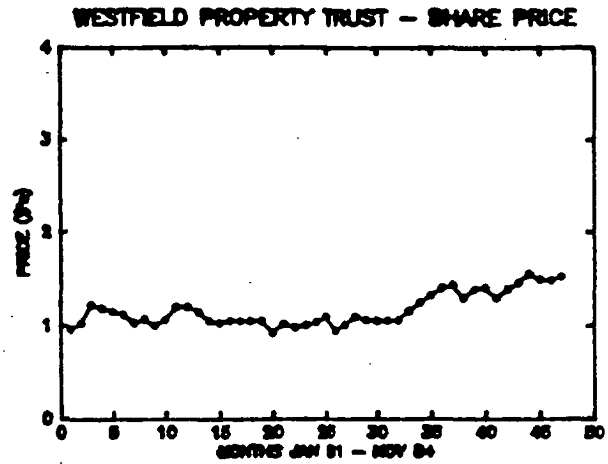


FIGURE 5.1.13

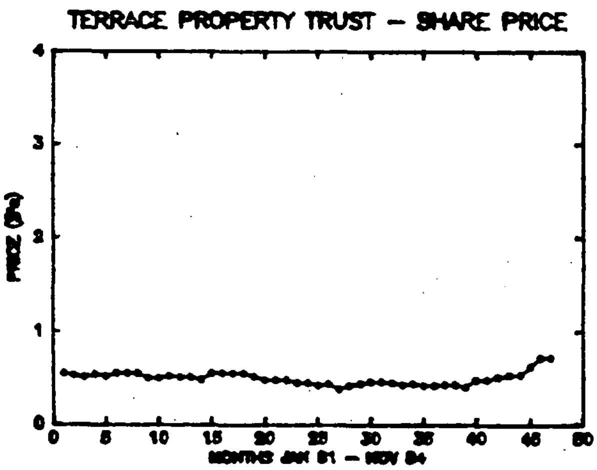
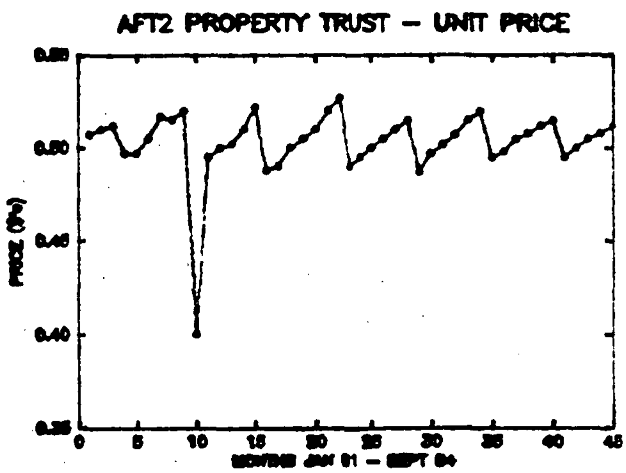


FIGURE 5.1.14



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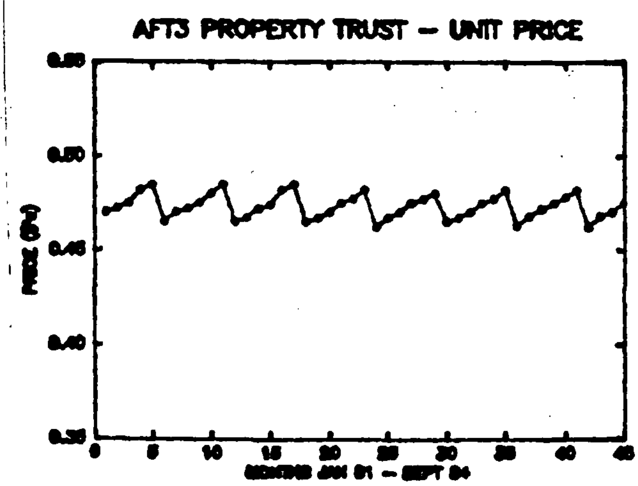

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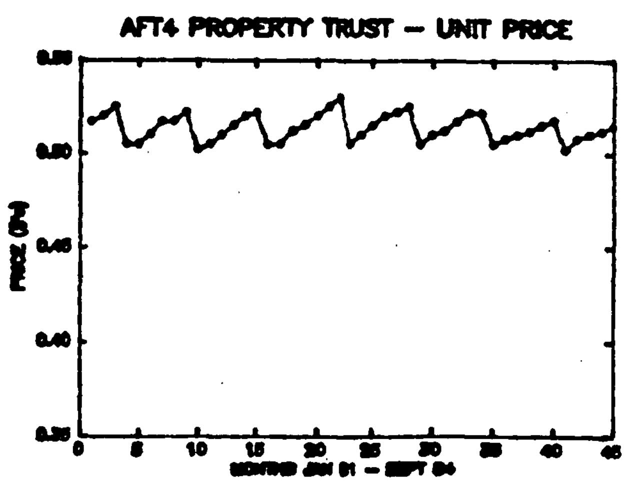


FIGURE 5.1.17

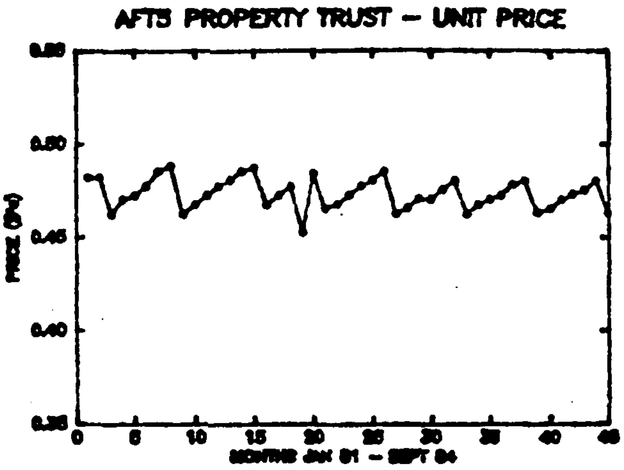


FIGURE 5.1.18

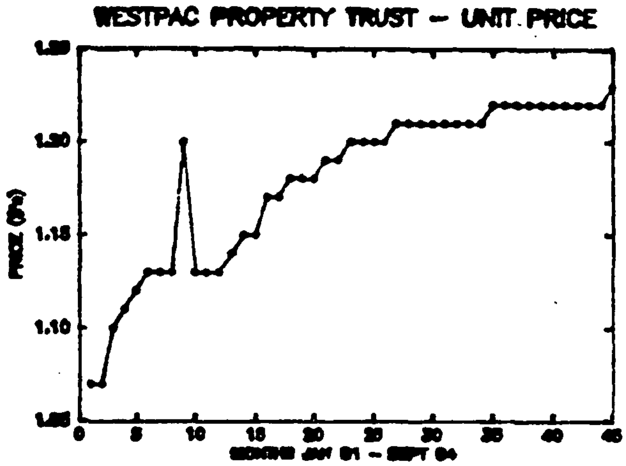


FIGURE 5.1.19

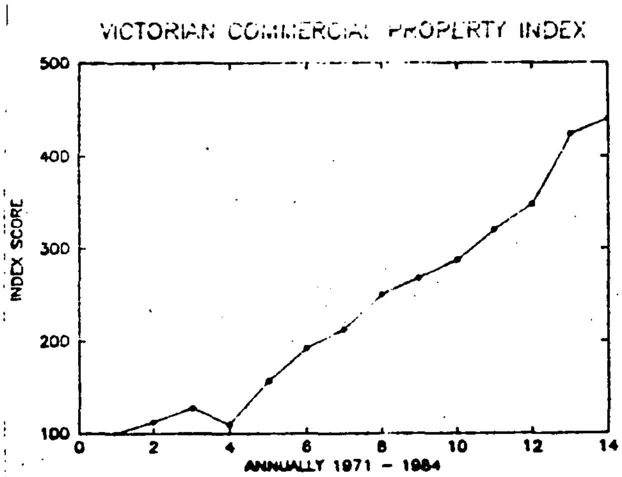


FIGURE 5.1.20

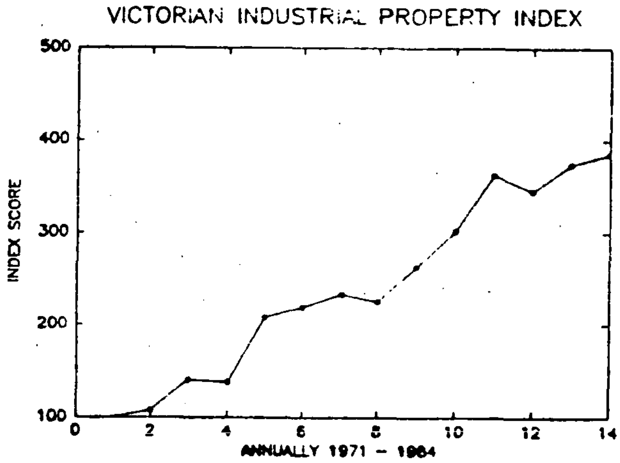


FIGURE 5.1.21

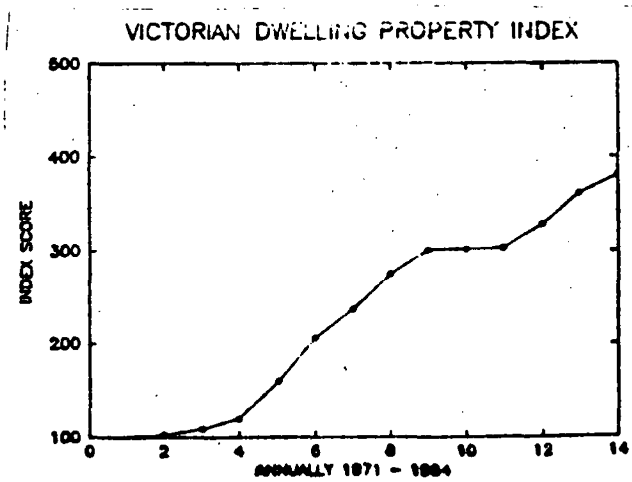


FIGURE 5.1.22

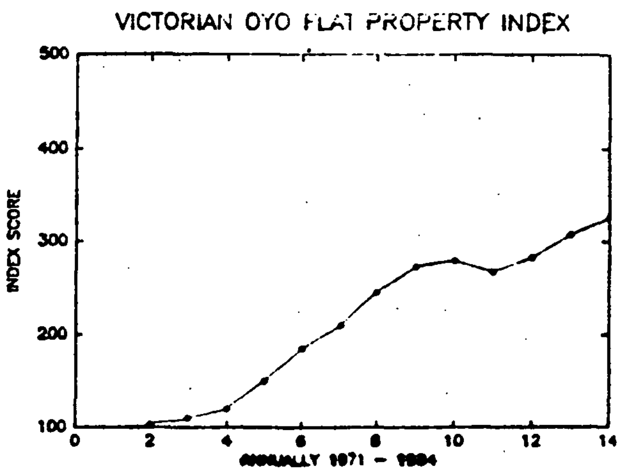


FIGURE 5.1.23

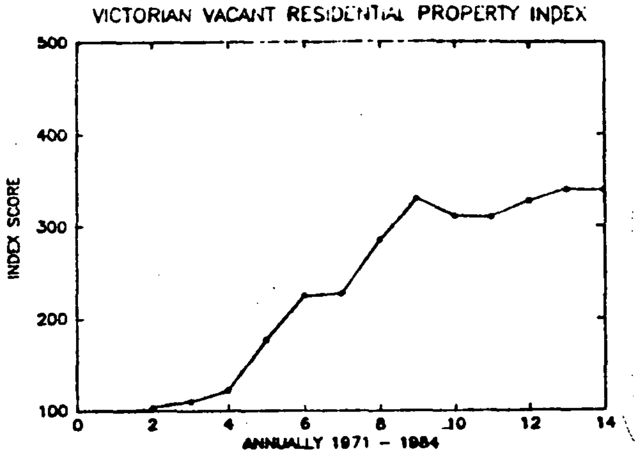


FIGURE 5.1.24

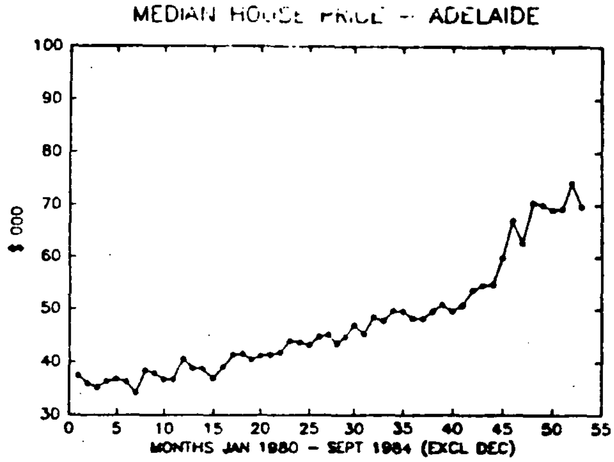


FIGURE 5.1.25

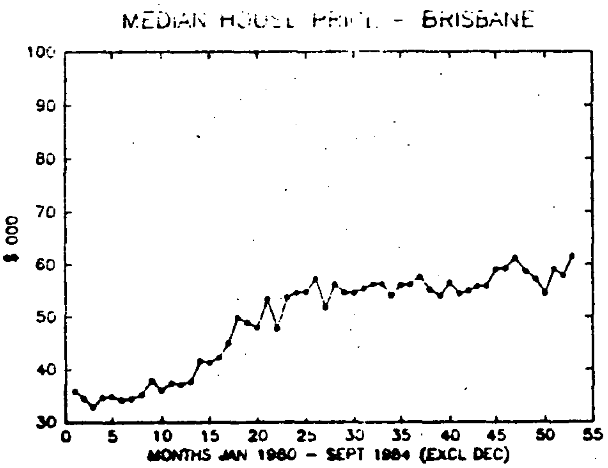


FIGURE 5.1.26

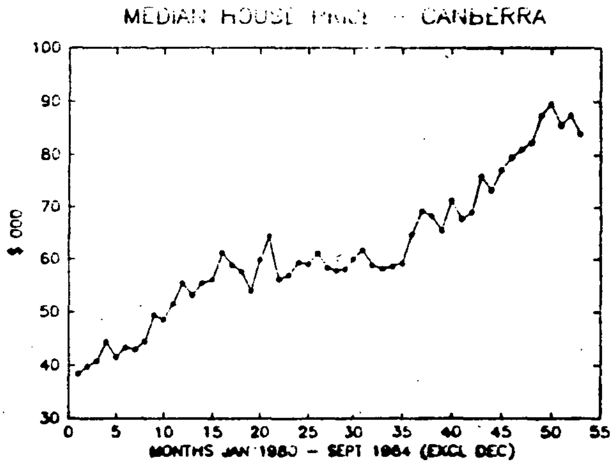


FIGURE 5.1.27

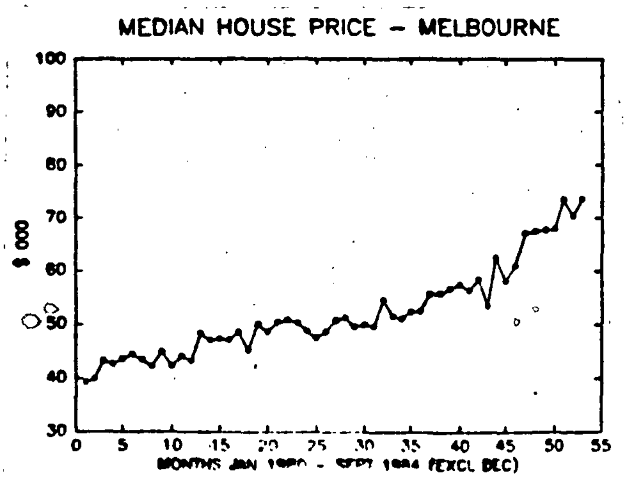


FIGURE 5.1.28

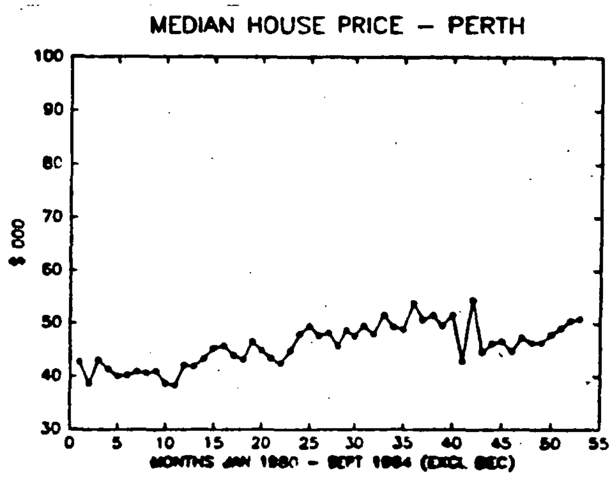


FIGURE 5.1.29

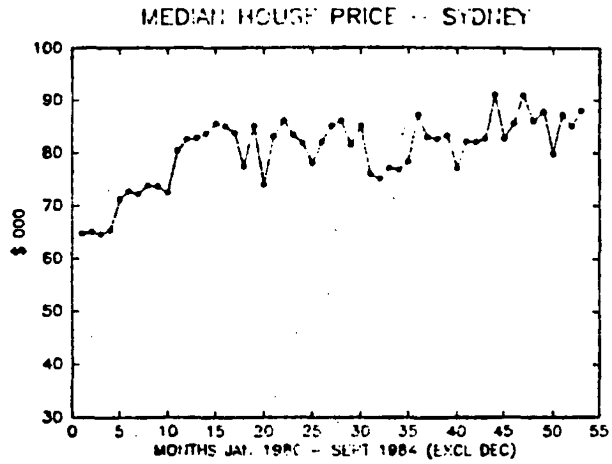


FIGURE 5.1.30

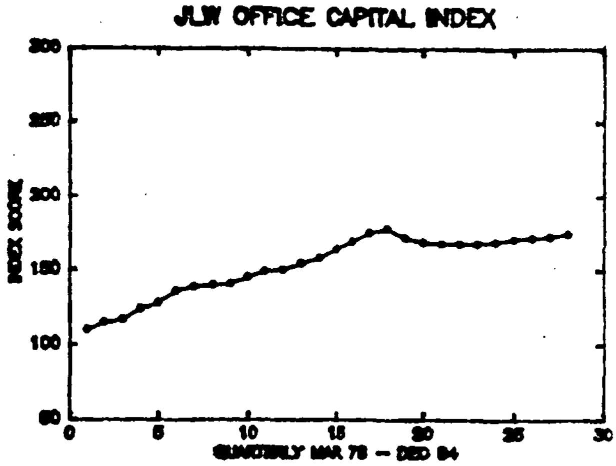


FIGURE 5.1.31

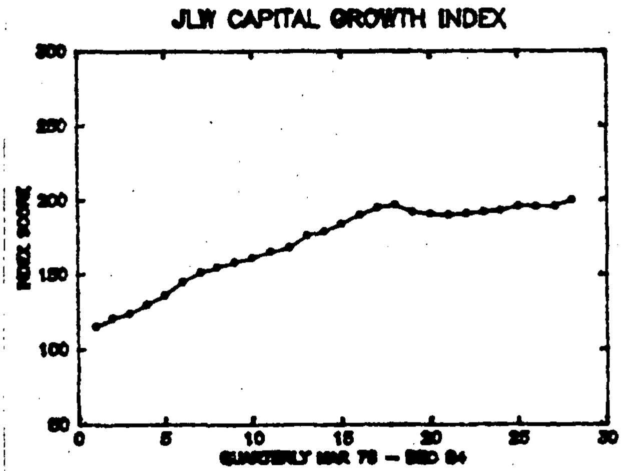


FIGURE 5.1.32

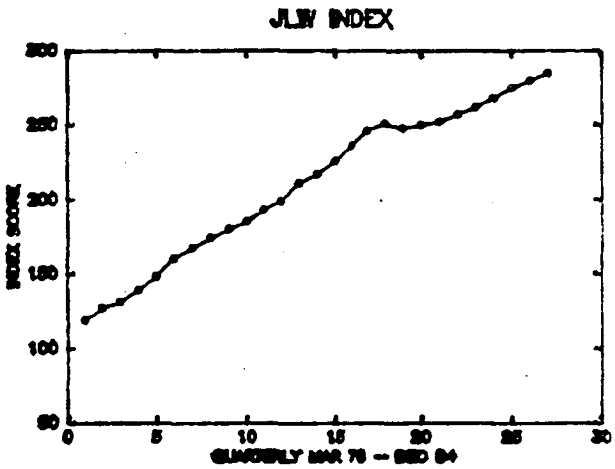


FIGURE 5.1.33

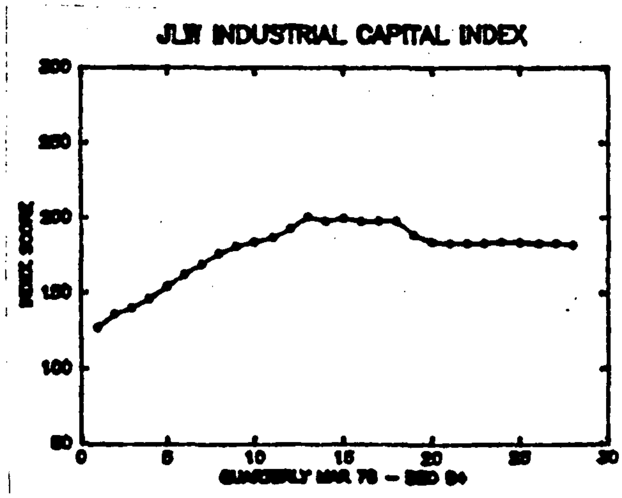
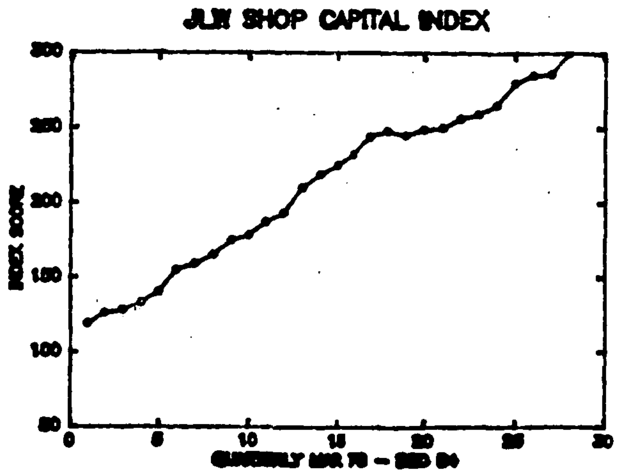


FIGURE 5.1.34



Weak-form tests of the EMH may focus on a subset of Q_{t-1} which is the past values of R_i. In order to derive testable hypotheses regarding the information content of past values of R_i it is necessary to specify characteristics of the return generating model. As discussed above, CAPM as a statement of equilibrium pricing for assets implies certain properties for R_{it}.

First, returns in CAPM are expected to be positive. As the risk free rate of interest R_f is a nonnegative number and m lies on the positively sloped segment of the minimum variance boundary $E(R_{mt} - R_{ft}) \geq 0$. In all cases where the beta coefficient is nonnegative, $E(R_i)$ is also nonnegative. In those instances where beta is less than zero it is conceivable that $E(R_i)$ has a negative value. However, a proposition that there should exist an asset with a negative expected value does not make economic sense. Accordingly, it is reasonable to assume that $E(R_{it}) \geq 0$.

When this characteristic is combined with the requirements of market efficiency it is apparent that for:

$$E_m\,(R_{it}|Q^m_{t-1}) > 0, \tag{5.12}$$

the expected mean of the return distribution as assessed by the market to be positive, the value of p_{it-1} must be set less than $E_m(p_{it}|\;{}^{m}_{t-1}$. Otherwise it would not be true that:

$$E(R_{it}|Q^m_{t-1}) = \frac{E(P_{it}|Q^m_{t-1}) - p_{it-1}}{p_{it-1}} > 0 \tag{5.13}$$

Filter Test

A technician believes it is possible to determine when the return will be negative:

$$E(R_{it}|Q^T_{t-1}) < 0, \tag{5.14}$$

where Q^T_{t-1} is the information available to the technician in the form of a set of past returns. Unless the information set Q^T_{t-1} is outside of Q^m_{t-1}, which seems unlikely, there is a conflict between Equations 12 and 14. This suggests a test of the claim that higher prices are followed by higher prices and vice versa, by comparing a trading strategy based on this approach with a buy and hold strategy.

Alexander (1961, 1964) and Fama and Blume (1966) extensively analyze this possibility with a method known as filter rules. The Y% filter rule is operated in the following manner. When the price of a security increases by Y% it is purchased and held until the price falls from the highest point achieved in the period by Y%. At this juncture the security is sold and a short position maintained until the security price rises Y% above the low point reached in this interval. The magnitude of Y is chosen arbitrarily and may take values such as 1%, 2%, 5% or some other amount.

The empirical research, in general, supports the findings of the early studies by Alexander, and Fama and Blume that trading determined by a filter rule does not achieve superior results to a naive buy and hold approach. Very small filters, i.e. low values of Y, have been found to perform best but when transaction costs, including brokerage and duties, are offset against gains the buy and hold method yields greater returns.

These early studies are not without unresolved technical difficulties. Dryden (1969, p.322.) discusses the Fama and Blume (1966) approach to calculating the rate of return on the buy and hold strategy, in which it is assumed that the long rate of return for a transaction is the negative of its short rate of return. This is not usually the case and Dryden argues that the impact is to bias the research findings in favor of the buy and hold strategy. Ball (1978, p.8.) argues that "Dryden incorrectly treats a short sale as an investment, with an outlay of p_{t-n}. But a short sale involves borrowing, with a <u>receipt</u> of p_{t-n}."

Praetz (1976) argues that the comparison of filter rule returns with buy and hold rule returns is not a fair test. He proves, on the assumption that the price changes are normally and independently distributed, that there is a bias in the expected filter returns which depends on the proportion of time that the filter is operating a short position. The bias is such as to indicate that the "situation is so loaded against filter-man that it is like making him play Russian Roulette with five bullets in a six-shooter" (p.74.).

These general findings are not surprising as prior expectations regarding the randomness of security price movements support that view. Samuelson (1965) proves mathematically that properly anticipated prices fluctuate randomly and he suggests that share price series are martingales. Accordingly, "there is no way of making an expected profit by extrapolating past changes in the future prices, by chart or any other esoteric devices of magic or mathematics" (p.44.).

An alternative test, considered below in the context of another characteristic of CAPM, is to consider the autocorrelation function for the series of returns. If the distribution is indeed random then the autocorrelations will be zero. This point was considered by Fama and Blume (1966, p.240.) who suggest that the study of filter rules is necessary because the dependence in price changes may be of such a complicated form that standard serial correlation approaches may not accurately measure the true dependence. Empirical analysis of the same data as used in the Fama and Blume filter study by Fama (1965) utilizing autocorrelation tests found entirely consistent results between the two methods.

An inability to specify algebraically the distribution of rates of return for all forms of share price movements means it is impossible to prove that the concerns expressed by Fama and Blume are unwarranted. Some further evidence may be provided by means of a simulation experiment. This will involve the simulation of returns from various forms of distribution and subjecting these streams to both filter and autocorrelation analyses. If no conflict emerges between the two techniques those concerns at least remain unsupported.

The conventional filter tests involve both long and short positions. An adoption of the latter position in the Australian context is not one that is legally available [Securities Industry Act (1980, S.68.)]. A joint exposure draft [ASE and NCSC (1985)] of the Australian Associated Stock Exchanges and the National Companies and Securities Commission advocates a change to this position. It appears that a more appropriate test is the comparison of the buy and hold strategy with filter motivated purchases and sales excluding short positions. The netting of transaction costs will still be necessary. Returns on the real property series present a further reason for deleting short sales. As the returns are either quarterly or annual it is even less likely that an investor can take a short position for periods as long as three or twelve months. A computer program was specifically written to investigate whether filter rules generate returns superior to a buy and hold strategy using the real estate data series discussed in Chapter 4.

Table 5.2 presents the result of tests, at various filter levels, for both the conventional buy and hold compared to long and short position filter, and the buy and hold compared with the long position filter. The filter commences at 0.001% and is increased by 0.005% steps. Four values are reported upon. No adjustment is made for transaction costs which obviously increase with the number of trades.

TABLE 5.2

FILTER TEST FOR PRICES

	Conventional				Long			
	.001	.011	.051	.101	.001	.011	.051	.101
Security								
Australian								
Finance Securities								
Statex Accumulation All Ordinaries Index	BH	BH	BH	BH	BH	BH	BH	BH
Statex Accumulation Property Index	BH	BH	BH	BH	BH	BH	BH	BH
Listed Property Trusts								
ASC Property	BH	BH	BH	BH	BH	BH	BH	BH
Canberra Commercial	BH	BH	BH	BH	BH	BH	BH	BH
PML Property	BH	BH	BH	BH	BH	BH	BH	BH
Stocks & Holdings Property	BH	BH	BH	BH	BH	BH	BH	BH
General Property	BH	BH	BH	BH	BH	BH	BH	BH
National Property	BH	BH	BH	BH	BH	BH	BH	BH
Schroder Darling Property	BH	BH	BH	BH	BH	BH	BH	BH
Equitable Property #1	BH	BH	BH	BH	BH	BH	BH	BH
Equitable Property #3	BH	BH	BH	BH	BH	BH	BH	BH
Westfield Property	BH	BH	BH	BH	BH	BH	BH	BH
Terrace Property	BH	BH	BH	BH	BH	BH	BH	BH
Unlisted Property Trusts								
AFT2	BH	BH	BH	BH	F	F	F	F
AFT3	BH	BH	BH	BH	F	F	F	F
AFT4	BH	BH	-	-	F	F	F	F
AFT5	BH	BH	BH	BH	F	F	F	F
AFT6	BH	BH	-	-	F	F	F	F
Westpac	BH	BH	BH	BH	F	F	F	F
Real Assets								
AMP P Series	BH	BH	BH	BH	BH	BH	BH	BH
Victorian Valuer-General								
Commercial	BH	BH	BH	BH	BH	BH	BH	BH
Industrial	BH	BH	BH	BH	BH	BH	BH	BH
Dwellings	BH	BH	BH	BH	BH	BH	BH	BH
Own Your Own Flat	BH	BH	BH	BH	BH	BH	BH	BH
Vacant Residential Land - Category A	BH	BH	BH	BH	BH	BH	BH	BH

Real Estate Institute of Australia								
Adelaide	BH	BH	BH	BH	BH	BH	BH	BH
Brisbane	BH	BH	BH	BH	BH	BH	BH	BH
Canberra	BH	BH	BH	BH	BH	BH	BH	BH
Melbourne	BH	BH	BH	BH	BH	BH	BH	BH
Perth	BH	BH	BH	BH	BH	BH	BH	BH
Sydney	BH	BH	BH	BH	BH	BH	BH	BH
United Kingdom								
Financial Securities								
FT All Share Index	BH	BH	BH	BH	BH	BH	BH	BH
FT Property Index	BH	BH	BH	BH	BH	BH	BH	BH
Real Assets								
Jones Lang-Wootton								
Office Capital	F	F	BH	BH	BH	BH	BH	BH
Shop Capital	BH	BH	BH	BH	BH	BH	BH	BH
Industrial Capital	F	BH	F	BH	BH	BH	BH	BH
Capital Growth	BH	BH	BH	BH	BH	BH	BH	BH
Index	BH	BH	BH	BH	BH	BH	BH	BH

BH indicates Buy and Hold is superior
F indicates Filter is superior

The evidence presented in Table 5.2 suggests that a buy and hold strategy will generate superior returns to those which may be obtained from trading in accordance with a filter rule. This observation is true for the majority of assets with the Unlisted Property Trusts as the exception. Reference to the time-series plots, Figure 5.1.14-17 shows a saw-tooth pattern which involves a steady climb then a one period drop. The filter traded on this to advantage when no short sales were permitted. Acceptance of short positions, as in conventional studies, provides some instances where the filter rule is superior. This occurred in two British categories of physical real estate. In the light of previously expressed concern that physical real estate is not likely to be sold short, coupled with the omission of transaction costs from the study the evidence does not support a hypothesis that filter rules are a superior strategy.

Of course the technician may respond with further strategies based on more complicated rules. Each such rule may be tested in turn to verify the claim that it generates superior returns.

Rejection of each rule may be viewed as a further nail in the coffin of technical analysis, but a more general approach is desirable to address the issue of whether there is information in the series of asset prices.

Autocorrelation Test

The second property regarding returns implied by CAPM is that $E(R_i)$ does not vary from period to period. This is consistent with the model being a fair-game model. The expected value, at time t (E^t), of the return on asset i in future periods is constant. Formally:

$$E^t(R_{it+v}) = \text{constant } v=1,2, \ldots, n, \text{ and} \tag{5.16a}$$

$$E(R_{it+v}|Q_t) = \text{constant} \tag{5.16b}$$

The assessment of a joint probability distribution by the market for security prices at t-1 of $f_m(p_{1t}, \ldots, p_{nt}|Q^m_{t-1})$ suggests a marginal distribution, denoted with an *, at t for j of $\overset{*}{f}_m(p_{jt}|Q^m_{t-1})$ with mean $\overset{*}{E}(p_{jt}|Q^M_{t-1})$. The requirement for efficient use of information ensures that:

$$\overset{*}{f}_m(p_{jt}|Q^M_{t-1}) = \overset{*}{f}(p_{jt}|Q_{t-1}), \tag{5.17}$$

$$\overset{*}{E}_m(p_{jt}|Q^M_{t-1}) = \overset{*}{E}(p_{jt}|Q_{t-1}), \text{ and} \tag{5.18a}$$

$$\overset{*}{E}_m(R_{jt}|Q^M_{t-1}) = \overset{*}{E}(R_{jt}|Q_{t-1}). \tag{5.18b}$$

When the market assesses the price of the ith security at t-1 it does so at a level such that the expected return on the security from t-1 to t is equal to $E(R_i)$ which is constant. Different securities will have different expected returns if their beta coefficients are not the same. The requirement for market efficiency stated as Equations 5.3 and 5.4, together with the equilibrium statement of constant expected return in Equation 5.18 suggests that:

$$E(R_{it}|Q^{M}_{t-1}) = \overset{*}{E}_{m}(R_{it}|Q_{t-1}) = E(R_i) \tag{5.19}$$

Efficiency implies that:

$$\overset{*}{E}(R_{it}|R_{it-1}, R_{it-2}, \ldots) = E(R_i). \tag{5.20}$$

This may be rewritten as:

$$\overset{*}{E}(R_{it}|R_{it-v}) = E(R_i) \quad v \geq 1. \tag{5.21}$$

In a regression of R_{it} on R_{it-v} only the constant term will be significant. This is consistent with the principle of "Granger causality" [Granger (1969, Definition 1)] and may be tested formally against an alternative hypothesis that the coefficient b_v, the autocorrelation coefficient, in Equation 5.22 is statistically significant:

$$E(R_{it}|R_{it-v}) = a_v + b_v\, R_{it-v} \tag{5.22}$$

The hypothesis to test is that:

$$H_0{:}b_v = 0 \qquad v=1,2,3, \ldots , n$$

automatically follows. This is commonly known as the random walk hypothesis and is a widely accepted view of share price behavior.

Kendall (1953), Moore (1964) and Fama (1965) conduct serial correlation tests and report results supporting the acceptance of the random walk model. Granger and Morgenstern (1963) employ spectral analysis as a method for identifying relationships between security price in one period and security price in previous periods. They find no relationships and suggest that this is further confirmatory evidence that the random walk model is applicable. Lack of observable autocorrelation within the return series is also consistent with the proposal of Samuelson, mentioned above, that security prices behave as a martingale. Whether the returns are a martingale or a random walk, noting that a random walk is a martingale but not vice versa, does not directly bear on the issue under consideration. In both instances, past returns cannot be used to obtain superior predictions of future prices.

The autocorrelation statistic is defined to be:

$$b_v = COV(R_{it}\ R_{it-v})/SD(R_{it})\ SD(R_{it-v})$$

and is estimated as:

$$\overset{o}{b}_v = 1/T \sum_{t=1}^{T-v} [(R_{it}-\bar{R}_i)(R_{it-v} - \bar{R}i]/VAR(R_{it})$$

where T is the number of observations in the stationary series. The standard error (SE) of each b_v is estimated as:

$$SE(b_v) = (1/T)^{\frac{1}{2}}$$

or $$SE(b_v) = [1/(T-v)]^{\frac{1}{2}}$$

which is approximately normal in distribution for large samples.

The autocorrelation function is computed for each return series of real estate securities. A 95% confidence interval test is used in each instance and the results of testing:

$$H_o : \overset{o}{b}_v = 0 \qquad v = 1,2,3, \ldots, n$$

are reported in Table 5.3. The size of n varies from 11 to 25 dependent on the number of observations in the return series.

Two observations regarding these results are warranted. First, the financial securities conform to the hypothesized relationship, with the exception of Terrace Property Trust. Second, the real assets are far less uniform.

TABLE 5.3

AUTOCORRELATION TEST FOR RETURNS
5% SIGNIFICANCE LEVEL

Security	Test Result
Australian	
Financial Securities	
Statex Accumulation All Ordinaries Index	Accept
Statex Accumulation Properties Index	Accept
Listed Property Trusts	
ASC Property	Accept
Canberra Commercial	Accept
Canberra Commercial #2	Accept
PML Property	Accept
Stocks & Holdings Property	Accept
General Property	Accept
National Property	Accept
Schroder Darling Property	Accept
Equitable Property #1	Accept
Equitable Property #3	Accept
Westfield Property	Accept
Terrace Property	Reject
Unlisted Property Trusts	
AFT2	Reject
AFT3	Reject
AFT4	Reject
AFT5	Reject
AFT6	Reject
Westpac	Reject
Real Assets	
AMP P Series	Reject
Victorian Valuer-General	
Commercial	Accept
Industrial	Accept
Dwellings	Reject
Own Your Own Flat	Reject
Vacant Residential Land - Category A	Accept
Real Estate Institute of Australia	
Adelaide	Reject
Brisbane	Reject
Canberra	Accept
Melbourne	Reject
Perth	Reject
Sydney	Reject
Richard Ellis	
Total Return	Accept
Capital Return	Accept

<u>United Kingdom</u>	
Financial Securities	
FT All Share Index	Accept
FT Property Index	Accept
Real Assets	
Jones Lang-Wootton	
Office Capital	Reject
Shop Capital	Reject
Industrial Capital	Reject
Agricultural Capital	Reject
Capital	Reject

Runs test

Dyckman, Downes and Magee (1975) explain that the weak-form of the EMH does not require all that is implied by random walk. The random walk model is a sufficient condition for acceptance of the weak-form EMH but a less restrictive sufficient condition can be used. Specifically, the requirement of the hypothesis is that $E(R_{it})$ be completely independent of $E(R_{it-v})$. "The observation that large price changes tend to be followed by more large price changes (but not in a predictable direction) would violate the random walk, but not the weak form of market efficiency" (p.17.).

A Runs-Test, which is a nonparametric test, satisfies this weaker requirement. It affords an additional advantage of not being heavily influenced by outliers which have a significant impact on the calculated correlation coefficient. Only the sign of changes in returns are considered. A first difference operator is applied to the return series and where ΔR_{it} is positive it is represented by a + and where negative by a -.

Siegel (1956) explains that the expected number of runs (U_r) in a random series is obtained by:

$$U_r = (2n_1n_2 + 1)/(n_1 + n_2)$$

where n_1 is the number of +s and n_2 is the number of -s.

Further the standard deviation for the number of runs is calculated as:

$$VAR(U_r) = [(2n_1n_2(2n_1n_2 - n_1 - n_2))/(n_1 + n_2)^2(n_1 + n_2 - 1)]^{\frac{1}{2}}$$

and a test statistic Z_r is a normal variate when $n_1 > 20$ or $n_2 > 20$. Special tables are available in instances where $n_1 \leq 20$ and $n_2 \leq 20$ for the evaluation of Z_r calculated as:

$$Z_r = (r - U_r)/SD(U_r)$$

where r is the actual number of runs.

The results obtained, when each return series is subjected to a Runs-Test at the 5% significance level, are reported in Table 5.4. The rejections uniformly resulted from too few runs.

TABLE 5.4

RUNS TEST FOR RETURNS
5% SIGNIFICANCE LEVEL

Security	
<u>Australian</u>	
Financial Securities	
Statex Accumulation All Ordinaries Index	Accept
States Accumulation Property Index	Accept
Listed Property Trusts	
ASC Property	Accept
Canberra Commercial	Accept
Canberra Commercial #2	Accept
PML Property	Accept
Stocks & Holdings Property	Accept
General Property	Accept
National Property	Accept
Schroder Darling Property	Accept
Equitable Property #1	Accept
Equitable Property #3	Accept
Westfield Property	Accept
Terrace Property	Accept
Unlisted Property Trusts	
AFT2	Reject
AFT3	Reject
AFT4	Reject
AFT5	Reject
AFT6	Reject
Westpac	Reject

Real Assets	
AMP P Series	Reject
Victorian Valuer-General	
Commercial	Accept
Industrial	Accept
Dwellings	Reject
Own Your Own Flat	Reject
Vacant Residential Land - Category A	Accept
Real Estate Institute of Australia	
Adelaide	Accept
Brisbane	Reject
Canberra	Reject
Melbourne	Reject
Perth	Reject
Sydney	Reject
Richard Ellis	
Total Return	Accept
Capital Return	Accept
United Kingdom	
Financial Securities	
FT All Share Index	Accept
FT Property Index	Accept
Real Assets	
Jones Lang-Wootton	Reject
Office Capital	Reject
Shop Capital	Accept
Industrial Capital	Reject
Agricultural Capital	Reject
Capital	Reject

4. Summary

The capital asset pricing model as a statement of how equilibrium prices are determined, assumes that the returns on assets are normally distributed and that the asset market conforms to certain criteria. These latter requirements commonly referred to as the weak-form efficient market hypothesis are necessary in order for CAPM to be a fair-game model of equilibrium pricing for assets. The empirical analyses reported in this Chapter examine the extent to which the sample real estate data, described in Chapter 4, exhibit the necessary characteristics.

Weak-form EMH tests have been discussed in the finance literature for a considerable number of years. Fama (1976) demonstrates that the weak-form tests are compatible with a number of models of market equilibrium. The capital asset pricing model discussed in Chapter 2 is one such model. If this model is to be employed for the applications reviewed in Chapter 3, then the normality of returns and the efficiency of the real estate market must be established.

Consideration of the distributional property of real estate securities and weak-form EMH tests on the same assets provides mixed findings. First, and most obvious, is the result that the various tests applied to the financial securities produce results in accordance with prior expectations. The vast majority of weak-form EMH studies undertaken on shares find no evidence to support a contrary view to the acceptance of the hypothesis. Keane (1983, p.32.), discussing weak-form EMH tests, argues that market efficiency is not a proposition amenable to conclusive proof but that incontrovertible proof is unnecessary. His view is that the burden of proof, to the extent that proof is possible, rests on those advocates who do not subscribe to the weak-form EMH to establish the existence of one or more inefficiencies. Similarly, previous investigations into the distribution of returns for shares have found them to be approximately normal. Prior expectations formed from existing evidence are supported with the findings in this thesis.

The second general observation to be made is that real property did not perform in a uniform manner. With the exception of the two Richard Ellis Indexes the return series are approximately normal. This on first thoughts is satisfying in that the multivariate (bivariate) normality requirements of CAPM are satisfied. Less support for the applicability of CAPM is forthcoming in the results of the weak-form EMH tests. With two exceptions the autocorrelation test and the runs test yielded the same answers. In both instances where there is a difference, viz. the Real Estate Institute of Australia based returns for Adelaide and Canberra, an extension of the confidence interval level of the tests to 90% results in a rejection of both series. The difference is marginal.

The overall implication of these tests with respect to the nonfinancial real estate returns is that CAPM is unlikely to be the best model of the return generating process in that market. The significant amounts of information present in the past series of returns, as evidenced through the autocorrelation test, may be used to improve estimates of return. A simple addition of a lagged dependent variable to the CAPM equation will improve the estimates obtained. A time-series model derived from the autocorrelation function, such as a Box-Jenkins model, provides another approach to building an improved model.

Empirical analyses reported in this Chapter are confirmatory of the prior expectations of many real estate industry authorities. The results support the MacIntosh and Sykes (1984) remarks previously quoted, that CAPM is appropriate for the share market but not for real estate. However, before embracing this view there are two further considerations. First the indications of weak-form efficiency for listed property trusts requires further examination. This is undertaken in Chapter 6. Second, an examination of empirically estimated CAPM for the nonfinancial real estate may prove satisfactory for some purposes. In Chapter 7 evidence is reported on the fits obtained.

CHAPTER SIX

CAPITAL ASSET PRICING MODEL AND THE SEMISTRONG-FORM OF THE EFFICIENT MARKET HYPOTHESIS

Introduction

Empirical investigations into the distribution of rates of return and tests of the weak-form of the efficient market hypothesis on various real estate assets are reported in the previous Chapter. The evidence from Chapter 5 suggests that certain necessary conditions for the meaningful application of CAPM are satisfied by the financial property securities and some of the real property assets that were analyzed. This Chapter extends the consideration of the applicability of CAPM to test the semi-strong form of the efficient market hypothesis.

In particular an announcement effect study conducted on a report dealing with property trusts from the Sydney sharebroking firm Norths [Locke (1985c)] is discussed. The investigation is a joint test of both the market reaction and the underlying model of equilibrium asset pricing. Two alternative methods of analysis are utilized and several subsidiary hypotheses regarding the asset pricing models are investigated.

The material in this Chapter is developed in a number of sections. A formal treatment of the semi-strong form of the efficient market hypothesis and its relationship to CAPM is presented in Section 1. An announcement effect study, which is one form of research design applicable to the investigation of this level of market efficiency, is discussed.

Section 2 contains an exposition of the theory underlying two methods for investigating the impact of new information announcements on security returns. Both the abnormal return and dummy variable method are initially explained as single equation procedures. Potential gains in the efficiency of model estimation may be available from a pooling of cross-sectional and time-series data, and consideration is given to the application of pooling procedures for both methods. Further, the issue of parameter instability, noted in Chapter 2, is considered in the context of these pooling models.

Background information regarding the actual announcement is the subject of the Section 3. How and when information is disseminated to the market is essential for the formulation of a research design to test the impact of the announcement. Various aspects regarding the release of the Norths' information are reviewed.

Section 4 contains a report on the empirical estimation of the models considered in Section 2. Poorness of results encourages further investigation of the underlying asset pricing model. As this component of the analysis proceeds in response to difficulties and problems observed in the empirical estimations undertaken, it is developed in the context of the empirical section rather than treated as part of the theory discussed in Section 2.

A summary of the intentions, findings, and implications of the analysis reported in this Chapter is presented in ~~the~~ Section 4.

1. Semi-Strong Efficient Market Hypothesis

The capital asset pricing model provides a statement of the process whereby asset returns are generated. As discussed in Chapter 5 the CAPM statement of equilibrium assumes a capital market in which information is readily available and impounded into returns. Lev and Ohlson (1982, p.252.) explain the role of information in enabling individuals to make choices between future and current consumption. CAPM as developed in Chapter 2, is an equilibrium model which serves this purpose. Moreover, Beaver (1981b, p.30.) argues that market efficiency is a more general concept than CAPM but nevertheless accepts that it is, as Fama (1970b) suggests, a sufficient condition. Hence a formal statement of the requirements in Equations 5.6 and 5.7, regarding the model of return for all securities i included in the market portfolio m, may be expressed in conditional terms as:

$$E_m(R_{it}|Q^m_{t-1}) = E_m(R_{ft}|Q^m_{t-1}) + [E_m(R_{mt}|Q^m_{t-1}) - E_m(R_{ft}|Q^m_{t-1})]\ b_i$$

$$= E(R_{it}|Q_{t-1}) = E(R_{ft}|Q_{t-1}) + [E(R_{mt}|Q_{t-1}) - E(R_{ft}|Q_{t-1})]\ b_i \quad (6.1)$$

and $b_i\ (Q^m_{t-1}) = b_i\ (Q_{t-1})$ (6.2)

where Q_{t-1} = set of information available at time t-1; and

Q^m_{t-1} = set of information the market uses to determine security prices at t-1.

Predictions of future returns, consistent with rational expectations, for all securities contained in m come from this model of market equilibrium.

The semi-strong form of the efficient market hypothesis "maintains that all public information is already impounded into the value of a security" (Hirt and Block 1986, p.256.). When new information is made available it should be immediately impounded into the value of the security. Tests of this form of the EMH, as Pike and Dobbins (1986, p.149.) explain, attempt to measure the extent to which security prices fully reflect all publicly available information.

Expected return on security i at time t conditional on the information set Q_{t-1} is:

$$E(R_{it}|Q_{t-1}) = [E[(P_{it} + C_{it})|Q_{t-1}] - P_{it-1}]/P_{it-1} \quad (6.3)$$

where P_i and C_i are respectively the price and net cash inflow (eg.

dividend) for security i in the denoted time period.

If new information becomes available in t then investors revise their expectations and the price alters:

If Q_{t-1} is revised to Q_t,

then $E\ (P_{it}|Q_{t-1})$ alters to $E(P_{it}|Q_t) = P_{it}$ if $P_{it} \varepsilon Q_t$

Thus the rate of return generated for the interval t-1 to t may differ from the expected return [Jacob and Petitt (1984, p.236.)]:

$E(R_{it}|Q_{t-1}) \neq R_{it}$

due to an announcement effect.

The common aim of all announcement effect studies is to test whether a disclosure precipitates an adjustment in the price of related securities. Lev and Ohlson (1982, pp.258-283.) provide an extensive review of "some of the more compelling evidence" regarding the information content of announcements. An equilibrium pricing equation is used as the benchmark against which an induced disequilibrium is measured. Investigation of the statistical significance of the change is undertaken to establish whether the information announcement has a material impact on the return of the securities under consideration. These tests are joint tests of both the equilibrium pricing model and the announcement effect. Once a model is chosen as an appropriate description of security pricing in equilibrium, it forms the basis for diagnostic checks and hypothesis testing. If the model is not assumed to be correct then no claim may be made regarding the distribution of the test statistics and accordingly this invalidates the analysis.

The "discovery" of new information through fundamental analysis of a company is not inconsistent with the weak-form of the efficient market hypothesis [Cootner (1962, pp.24-25.)]. In general the evidence recorded in Chapter 5 is supportive of the view that the market for property trust shares is weak-form efficient. This is consistent with the findings of Officer (1975) who suggests that the Australian share market is at least weak-form efficient.

An investigation similar to the examination undertaken below is the Davies and Cane (1978) analysis of the impact on prices when broker recommendations, previously given to clients, are published in the Wall Street Journal. They suggest that there are three possibilities as to the impact of the recommendations on the returns of securities covered in the announcement. First, there is no impact as the recommendations are not new information that is previously unknown to the market but rather a reworking of known facts. If all the data are publicly available elsewhere, then the semi-strong form of the EMH predicts that there will be no reaction as the information is already impounded in the asset prices. Such a stance does not deny the possibility of inside information existing which, once known, will affect a security's price.

Second, the recommendations do carry information and the prices of securities will start to adjust as soon as client investors gain access to the information. These privileged investors act as arbitrageurs by purchasing undervalued securities in anticipation of abnormal returns. The process of acquisition by these investors will continue while the security is undervalued. However, as an investor takes a larger and larger position in such a security or securities the unique risk in the investor's portfolio begins to increase. At some point the anticipated abnormal returns are just adequate reward for the risk which is borne and this may prematurely curtail the arbitrage process. The price adjustment, therefore, may not be complete until the information is widely known.

Third, the client investors acting on the recommendation will purchase or sell the securities until such time as all the information contained in the release to clients is impounded in the price. In this case there will be no further reaction when publication occurs as the arbitrageurs have mulcted all the value of the news. This contrasts with instance one, where there is no value in the information and instance two, where some reaction to publication is anticipated.

2. Method of Analysis

The two most accepted procedures for analyzing the impact of new information on the equilibrium rates of return are the residual analysis technique and the dummy variable formulation. Both methods are explained in turn below as examples of a single equation approach. The potential gains afforded by a pooling of cross-section and time-series regressions are presented in a further subsection. Parameter stability, in the context of the pooling model discussion, also is introduced.

Residual Analysis

The capital asset pricing model:

$$E(R_{it}) = E(R_{ft}) + b_i\,[E(R_{mt}) - E(R_{ft})] \tag{6.4}$$

is founded on an understanding that the only relevant risk consideration is the market risk. The return on an asset, as discussed in Chapter 2, within the CAPM framework is considered a fair-game model conditional on the market risk of the asset. An asset's beta is interpreted as an index of the market risk of the asset. According to a fair-game model there are no expected abnormal returns associated with an asset. The CAPM model, expressed as Equation 6.4, when rewritten in conditional probability form states that the expected return on asset i at time t, conditional upon the estimated beta of the asset, is:

$$E(R_{it}|\mathring{b}_{it}) = E(R_{ft}) + [E(R_{mt}) - E(R_{ft})]\ \mathring{b}_{it} \qquad (6.5)$$

where $\mathring{b}_{it}$ is b_i estimated with Q^m_t.

At time t the actual return R_{it} is observable and the difference between the forecast return $'R_{it}$ generated in accordance with Equation 6.5 is the residual U_{it}:

$$\begin{aligned} U_{it} &= R_{it} - E(R_{it}|\mathring{b}_{it}) \qquad (6.6) \\ &= R_{it} - {'R_{it}}. \end{aligned}$$

The residual at time t is the abnormal return (AR) on the asset for the period t-1 to t, and often is referred directly to by that title.

As stated, in a fair-game model, the expected value of the abnormal return is zero. Thus, CAPM implies that:

$$E(U_{it}) = 0.$$

The running total of abnormal returns over a number of periods, say k periods, is called the cumulative abnormal return (CAR) and is defined as:

$$CAR_{it} = \sum_{t=1}^{k} U_{it}. \qquad (6.7)$$

It is to be expected from CAPM that CAR will not be significantly different from zero because U_{it} are independent and of constant variance.

The impact of an announcement of information, which may alter the price and thus the return obtained on an asset, will be reflected in the cumulative abnormal return. An announcement occurring at time v is assessed by reference to residuals in the period v-r to v+p where r and p are arbitrarily chosen numbers of periods, say 12 months before and 6 months after the event. The estimated regression coefficient from Equation 6.5 is applied to the actual observations R_{ft} and R_{mt} for t = (v-r, ..., v, ..., v+p) to forecast $'R_{i,t}$ according to:

$$'R_{it} = R_{ft} + \overset{o}{b}_i \, (R_{mt} - R_{ft}) \tag{6.8}$$

where $\overset{o}{b}_i$ is estimated from t = 1, 2, ... , v-r-1.

The abnormal return U_{it} in any period as defined in Equation 6.6 is the difference between actual return and predicted return:

$$U_{it} = R_{it} - {'R_{it}} \quad t = (v-r, \ldots, v, \ldots, v+p).$$

Summation of these abnormal returns over the interval v-r to v+p in accordance with Equation (6.7) is the cumulative abnormal return for the interval:

$$CAR_{it} = \sum_{t=v-r}^{v+p} U_{it}.$$

The zero-beta form of CAPM, using R_{zt} in place of R_{ft}, also is used in this form of analysis. Ball (1972) surveys empirical research in accounting and contains a detailed description, inclusive of an illustration, of this zero-beta form. A companion portfolio approach, developed by Black and Scholes (1974), is another procedure whereby CAPM is used to calculate the abnormal returns. The companion portfolio is constructed so that the return earned (R_p) dependent on R_m and R_z is approximately the same as that on the security (R_i). Abnormal return is obtained by the subtraction of the forecasted return on the companion portfolio from the actual return on the security:

$$U_{it} = R_{it} - {}'R_{pt}. \qquad (6.9)$$

Gonedes (1975) and Foster (1977) provide two alternative procedures for the computation of companion portfolios.

Pioneering investigations into the impact of announcement effects by Ball and Brown (1968) and Fama, Fisher, Jensen and Roll (1969) used the market model as a description of the return generating process:

$$E(R_{it}) = a_i + b_i\ E(R_{mt}). \qquad (6.10)$$

The estimated coefficients $\overset{o}{a}_i$ and $\overset{o}{b}_i$ are then used to predict the security return:

$$'R_{it} = \overset{o}{a}_i + \overset{o}{b}_i\ R_{mt} \qquad (6.11)$$

and this is employed for the calculation of the abnormal return as in Equation 6.6.

Recent research, by Ricks and Hughes (1985) and Hughes and Ricks (1984) into market reaction for nondiscretionary accounting changes and a mandated accounting change respectively use the market model. This is also the method Ajinkya and Gift (1984) adopt for their analysis of the market adjustment to corporate managers' earning forecasts. An investigation of five different abnormal return measurement methods by Brown and Warner (1980) observes that all techniques pick up the abnormal performance where the magnitude of the effect is large. The market model is adequate in such instances.

A disturbance such as an announcement, which has an impact on the returns of security i, is reflected in the existence of abnormal returns and hence the cumulative abnormal returns. Good news results in an increase in abnormal return and bad news leads to a fall in abnormal returns. Beaver (1968, p.79.) suggests a transformation of U_{it} that abstracts from the sign and thus overcomes the requirement to have prior expectations regarding the direction of the price change. The square of the residual (U_{it}^2) is one such transformation. If earnings' reports possess information content, then U_{it}^2 should be greater when t=v than during the nonannouncement period. Accordingly, a ratio greater than one of $U_{it=v}^2$ to s_i^2, where the latter term is the average squared residual during the non-report period, indicates information content.

Patell (1976) develops a similar test through a process of several intermediate test statistics. A technique designed to control for beta reliability is suggested by Ziebart (1985) as potentially important when the null hypothesis of no reaction, founded on abnormal returns derived from the market model, is not rejected. He suggests that the standardized abnormal return statistic developed by Patell (1976) should be used to overcome this problem.

In the following empirical analysis, the market model rather than CAPM is used initially. This approach is implemented for three reasons. First, the method is comparable with other contemporary studies investigating announcement effects. Second, previous empirical evaluations of CAPM have found that a constant term significantly improves the estimation of the model. This point is discussed in Chapter 2. Third, if the rate of return on the risk-free security is constant over the period, then the two models are almost the same. Subtraction of a constant from both the independent and dependent variable only alters the slope coefficient. As the actual estimated value of the beta coefficient is not at issue but rather discontinuity in the equilibrium is of primary concern either formulation is sufficient. In those instances where $R_{ft} \neq \bar{R}_f$

for the time interval under consideration then the two models will differ. Finally, the possible differences are explored, with CAPM used to estimate the parameters in several instances for the purpose of comparison.

Dummy Variable

An alternative method is to directly estimate the impact of the disturbance from equilibrium caused by the announcement with a dummy variable (D) which is specific to the disequilibrium time period (v) in the return generating equation. The market model in Equation 6.10, adopted in preference to CAPM for the same reasons as those discussed in relation to cumulative abnormal returns analysis above, is estimated as:

$$R_{it} = \hat{a}_i + \hat{b}_i R_{mt} + \hat{c}_i D_t + \hat{e}_{it} \qquad (6.12)$$

where $D = \begin{cases} 1 \text{ if } t = v \\ 0 \text{ otherwise, and} \end{cases}$

$$e_{it} \sim N(0, var(e_{it})0.$$

The estimated parameters, $\hat{a}_i$ and $\hat{b}_i$ are respectively the constant term in the relationship and an indication of the systematic risk of asset i as usually interpreted in the market model. The estimated coefficient $\hat{c}_i$ captures any unusual change in R_{it} in the period of the announcement. The significance of $\hat{c}_i$ in a statistical sense, is readily ascertainable from the corresponding t-statistic.

Further applications of this method exist to test whether there are unusual effects in the returns in the period prior to the announcement and similarly potential post-announcement effects are testable. One such form of the model can be estimated as:

$$R_{it} = \hat{a}_i + \hat{b}_i R_{mt} + \hat{c}_{i-1} D_{-1t} + \hat{c}_{i1} D_{1t} + \hat{c}_{i+1} D_{+1t} + \hat{e}_{it} \qquad (6.13)$$

where $D_{-1t} = \{ \begin{array}{l} 1 \text{ if } t = v - 1 \\ 0 \text{ otherwise} \end{array}$

$D_{1t} = \{ \begin{array}{l} 1 \text{ if } t = v \\ 0 \text{ otherwise} \end{array}$

$D_{+1t} = \{ \begin{array}{l} 1 \text{ if } t = v + 1 \\ 0 \text{ otherwise.} \end{array}$

Anticipation effects are manifested in D_{-1} and remainder effects are embodied in D_{+1}. These are tested directly by reference to a conventional null hypothesis that the coefficient is equal to zero. The simultaneous hypothesis that all dummy variables are equal to zero is also testable using the F-test for full and reduced models suggested by Neter and Wasserman (1974).

The dummy variable approach offers three principal advantages over the CAR approach. First, the potential length of the estimation period for the model is greater. In the CAR analysis observations in the interval $t = 1,2, \ldots , v-r-1$ are used in the estimation of the equilibrium model. Data for the period $t = v-r, \ldots v+p$ are used in the forecast. The dummy variable procedure employs all observations in the estimation of the model. Second, the ease in application of the linear model, with no requirement for the calculation of forecast returns, abnormal returns, and cumulative abnormal returns, is also considered advantageous. Third, the model is better specified in a statistical sense. Diagnostic tests as to the significance level of parameters have known distributions, in most circumstances, and are more readily undertaken than the analysis of CARs for statistically significant movements.

Pooling Cross-section and Time-Series Data

Potential improvements to the estimated equations obtained using OLS may be achievable. The existence of cross-sectional dependencies in the disturbance terms warrants consideration given the structure of the analysis. Such dependencies often arise as a result of a misspecified model. Omission of a variable is one example and thus an industry influence, if it exists, is not directly accounted for in the model. Collins and Dent (1984, p.49.) recommend generalized least squares (GLS) as a means of overcoming the "contemporaneously cross-correlated returns when there is an industry concentration in the sample". An application of the GLS procedure for correcting the correlation within the residuals is provided by Chang and Lee (1977). They advocate the pooling of cross-section and time-series data in a manner which capitalizes on the information contained in the residuals and employ GLS estimates to evaluate both the time and firm effects. As all the returns are in the property trust industry it is advisable to control for this.

Miller and Scholes (1972) report evidence which suggest that return generating processes, such as Equation 6.11, are subject to heteroscedasticity. They observe a relationship between the variance of the disturbance and the magnitude of returns. A result of this is that the OLS estimators remain unbiased but are no longer efficient. Further investigation by Rogalski and Vinso (1978) concerning the problem of heteroscedasticity in estimating the market model, suggests it to be an issue which cannot be ignored. Application of weighted least squares regression is one means of dealing with the problem. However, a knowledge of the pattern of variation in the disturbance term is necessary in order to choose appropriate weightings. GLS regression provides an opportunity for using this additional information in the disturbance terms.

The possible cross-sectional correlation within errors needs to be considered further. Zellner (1962) proposes a method, to account for the cross-sectional correlation of errors of the firms, known as seemingly unrelated regressions (SUR). Dielman (1980, pp.14-15.) discusses the application of various regression models to announcement effect studies. He explains that OLS estimated parameters are less efficient, in the sense of larger standard errors, than SUR estimated coefficients unless either:

> (1) the regressors of each equation must lie in the same space, in particular, when each individual equation involves exactly the same explanatory variables; or
>
> (2) no correlation exists between disturbance terms in different equations.

Officer (1971, p.46.) suggests that portfolio beta estimates are more reliable, in a statistical sense, than single security betas. This implies it will be beneficial to combine individual trusts to form a portfolio [Pindyck and Rubinfeld (1976, pp.200.)]. An aggregation of the individual market model equations for individual trusts, termed microrelations, to obtain a relationship for the respective groups, known as a macrorelation, raises one significant difficulty. If $a_1 = a_2 =, \ldots, = a_k$ and $b_1 = b_2, = , \ldots, = b_k$ then the macrorelation:

$$\frac{1}{k}\sum_{i=1}^{k} R_{it} = a + bR_{mt} + e_{it} \tag{6.14}$$

may be efficiently estimated by OLS regression. Similarly, for a further group of j trusts it is necessary for each set of coefficients to be equal. Theil (1971, pp. 556-62.) explains the difficulty in aggregation which results in aggregation bias. As individual firms usually have different systematic risk levels, it is expected that a requirement for all betas in the group to be equal will be violated. In an investigation of any two groups of trusts it is intuitively reasonable to expect the true betas of the individual trusts not to be equal. If the true coefficient values are approximately the same, the extent of the aggregation bias will be small.

The single equation procedures and the pooling techniques discussed above assume a stable relationship in equilibrium with fixed coefficients in the market model. As discussed in Chapter 2, evidence consistent with a degree of parameter instability in the empirical estimates of both the market model and the capital asset pricing model has been reported. Various methods are available to estimate the market model while directly accounting for the variability in the coefficients.

Wallace and Hussain (1969) advocate a covariance model which amounts to an acceptance of equality of slope coefficients between trusts but allows for different intercept terms between trusts. The market model, in accord with this view, is expressed in the pooled form as:

$$R_{it} = a + (\sum_{j=1}^{k} b_j)\ R_{mt} + \sum_{i=2}^{k} c_i\ W_{it} + e_{it} \qquad (6.15)$$

$$\text{s.t.} \quad \sum_{i=2}^{k} c_i = 0$$

$$\text{where } W_{it} \begin{cases} 1 \text{ for trust } i \\ 0 \text{ otherwise.} \end{cases}$$

Following Maddala (1971), Nerlove (1971) and Amemiya (1971) the c_i parameter may be viewed as a normal variate of $E(c_i) = 0$ and known variance. This is called an error component model:

$$R_{it} = (a + c_i) + \sum_{j=1}^{k-1} b_j R_{mt} + e_{it}$$

$$\rightarrow \quad R_{it} = a + \sum_{j=1}^{k-1} b_j R_{mt} + W_{it} \tag{6.16}$$

where $W_{it} = c_i + e_{it}$,

which may be estimated by a generalized least squares procedure.

A further step towards generality is to assume the slope coefficients are not necessarily equal between trusts. Swamy (1970) proposes a random coefficient regression (RCR). The market model expressed as a RCR is:

$$R_{it} = (\bar{a}_i + c_i) + (\bar{b}_i + y_i) R_{mt} + e_i \tag{6.17}$$

where $\bar{a}$ and $\bar{b}$ are fixed components and the terms c_i and y_i are random components with zero means.

Before embarking on the use of more and more general models the question of whether there is any theoretical justification, stemming from the economic relationship embodied in the market model, for doing so must be addressed. The possibility of parameter instability is tested for in the following empirical section. If a RCR model is the correct form, then more powerful diagnostic testing would be achieved by estimating such a model. However, there is no intuitive rationale consistent with the market model which results in the formation of priors asserting parameters to be random coefficients.

3. Announcement

The Sydney stock broking firm Norths published, in August 1984, a report entitled Review of Property Trusts 1984. Detailed analyses of individual trusts are provided and this is consistent with the stated aim of providing clients with up-to-date indepth analysis of all property trusts currently available for investment (p.3.). The "Review" is essentially the documentation of a thorough fundamental analysis based on individual trusts, the industry overall and economy prospects. Recommendations are framed regarding individual trusts and a ranking index of trust performance over the previous 12 months is presented. The issue to be considered is whether the "Review" actually contains information, in the sense that returns alter when the market impounds it into security prices.

In several respects this issue is analogous to the Davies and Cane (1978) analysis of the effects of secondary dissemination of stock analysts' recommendations, after primary dissemination to the clients of the analysts. The concern in their research is with whether the market reacts to the publication in the Wall Street Journal of a column called "Heard on the Street" containing analysts' predictions previously given to clients in a prior period of up to three weeks. A distinguishing feature of the Davies and Cane enquiry from the current investigation is that the analysts' advice to clients are not in the form of a several hundred page document sold for a price. There is a possibility that Norths advises clients along the lines of the recommendations subsequently published in the "Review" long before its release. The "Review" which sells to individuals at $125 per copy may be a marketing ploy with few sales expected to occur. The media coverage afforded Norths is probably good advertising.

Kitchener (1984) in a cover article for the magazine Australian Business summarizes many of the main elements of the "Review". She reports the ranking of trusts according to the

Norths Index on a scale from 1 to 10, and also comments on some of the more striking recommendations. A newspaper column by Smiles (1984) presents extensive extracts of the recommendations regarding the individual trusts. Specific recommendations took the form of: "The Cities of Australia Property Trust - This is not recommended at the moment." "Equitable Property Trust No 1 - May appeal to the speculator." Attention also focuses on the ranking of performance of each trust on the 1 to 10 scale.

The various necessary conditions to conduct a test of whether there is information in the "Review" are satisfied. The possibility that the information is available to clients first and then disseminated widely in the financial press after an unknown lag appears to be plausible. An interesting question is whether the pronouncements of a sharebroking firm, assumed to be expert in the area, have information content. Foster (1979) investigates the announcement effect of articles written by Briloff. An important issue considered in that analysis is whether the information is generally available prior to Briloff's statements. Thus, the level of market efficiency is the core matter considered. In the current enquiry there is no need to be concerned with either the data sources employed by Norths or other aspects of the preparation of the "Review". The issue is simply one of whether the market takes notice of the recommendations by adjusting prices accordingly.

4. Empirical Analysis

For the purpose of empirical analysis there are 9 trusts contained in the intersection of the set of trusts subject to recommendations by Norths and in the population of listed trusts operating continuously from January 1, 1981 to March 31, 1985. The latter set included those trusts used in the weak-form EMH tests reported in Chapter 5. Observations at monthly intervals are considered superior for use in this form of study. Morse (1984) compares the use of monthly and daily observations for tests of information content. He concludes that monthly returns are as good as daily returns data especially where there is uncertainty regarding the actual date of release of the announcement. In the current enquiry it is known that the "Review" is published in a specific month.

Further, as property trusts are not generally traded heavily the use of shorter periods, eg. daily, will result in many more nontrade periods. Dimson (1979) discusses the likely biases in beta when shares are traded infrequently. Alternative estimators are proposed and as a result "most of the bias in the conventional beta estimates is eliminated" (p.197.). It is considered that the use of monthly returns avoids the necessity to employ Dimson's estimators or resort to the Scholes and Williams (1977) procedure of combining non-synchronous and synchronous market returns as explanatory variables for trade-to-trade returns.

Table 6.1 presents the ranking, in descending order of performance, assigned by Norths (1984, p.37.) on the basis of the performance index developed by the firm. Further discussion of the index is provided in the next Chapter. Table 6.2 summarizes the recommendations regarding the same sample of listed property trusts. A comparison of the two Tables reveals that those grouped in the upper section, entitled "Favorable", receive achievement ranking scores of 1 and 2, while those in the lower section, entitled

"Unfavorable", receive rankings of 5, 8 and 9. The classification as "Favorable" and "Unfavorable" is determined on the basis of the recommendation made by Norths, and the discrete break in ranking scores. Westfield received a comment of "excellent" and a rank of 2 while ASC ranked 5 was designated as "no action".

TABLE 6.1

RANKING ASCRIBED TO PROPERTY TRUSTS BY NORTH

General Property	1
Schroder Darling	2
Stockland	2
Westfield	2
ASC	5
Canberra Commercial	5
Canberra Commercial #2	5
Equitable #3	8
Equitable #1	9

TABLE 6.2

RECOMMENDATIONS GIVEN BY NORTHS

Trust	Comment in 'Review'
Group 1 - Favorable	
Schroder Darling	"Excellent"
General Property	"Excellent"
Stockland	"Strongly recommended"
Westfield	"Excellent"
Group 2 - Unfavorable	
Canberra Commercial #2	"No action"
Canberra Commercial	"Hold"
ASC	"Hold and wait"
Equitable #1	"Not recommended"
Equitable #2	"Hold"

Cumulative Abnormal Returns Procedure

A conventional cumulative abnormal return approach based on the market model, Equation 6.1, is performed initially. The parameter estimates are obtained from ordinary least square regressions for each trust over the thirty-one monthly returns from February 1981 to August 1983. The abnormal return and cumulative abnormal return are calculated for the twelve months prior to the release of the "Review" and also for the subsequent six months. The Beaver/Patell ratio of U^2_{it}/S_i^2, discussed above, reported in Table 6.3 is in all instances less than one. This supports an acceptance of the null hypothesis of no reaction.

TABLE 6.3

NORMALIZED ABNORMAL RETURNS FOR ANNOUNCEMENT MONTH

	Trust	Variance (S_i^2)	Residual (U_{it})	U^2_{it}/S^2
(1)	General Property	.0844	-.0055	.0044
(2)	Schroder Darling	.1122	-.0085	.0057
(3)	Stockland	.0716	.0015	.0004
(4)	Westfield	.0515	-.0238	.2136
(5)	ASC	.0429	.0053	.0153
(6)	Canberra Commercial	.0829	-.0015	.0003
(7)	Canberra Commercial #2	.0880	-.1267	.0001
(8)	Equitable #3	.0900	-.0175	.0369
(9)	Equitable #1	.0614	-.0751	.0000

A plot of the cumulative abnormal residuals is presented as Figure 6.1. Although there appears to be some reaction it is necessary to determine whether it is statistically significant.

FIGURE 6.1

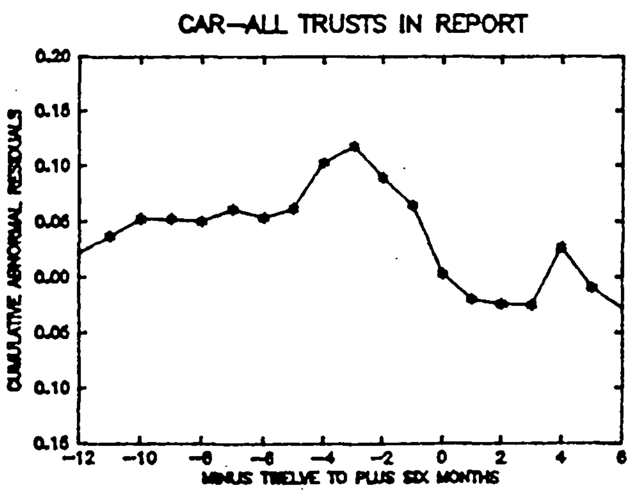


FIGURE 6.2

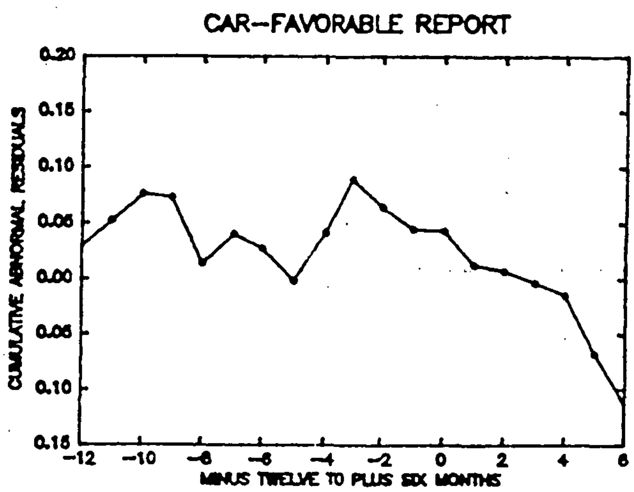


FIGURE 6.3

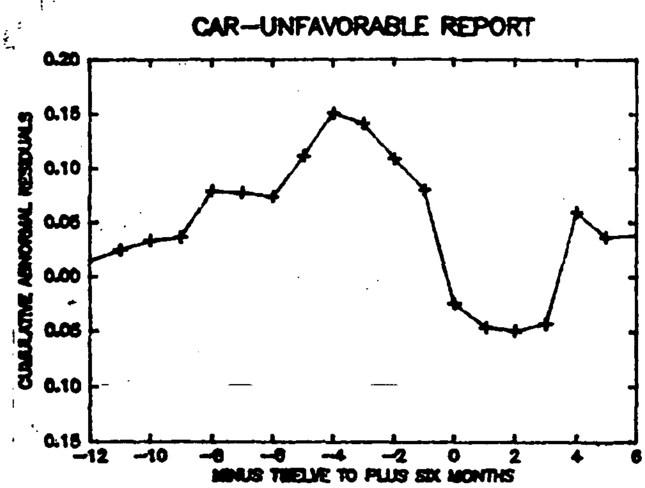
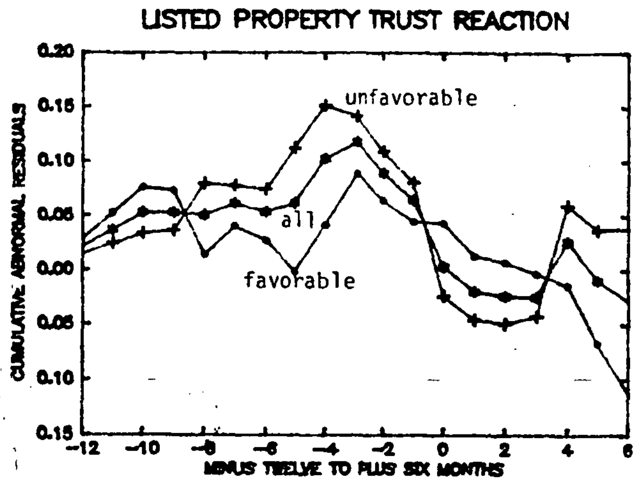


FIGURE 6.4



The depicted CAR includes trusts which receive favorable recommendations and trusts which receive unfavorable recommendations from Norths. As it is likely that the different ratings will have opposite effects on abnormal returns, the pooling of all trusts may result in less obvious evidence of market reactions to the "news".

To overcome this potential canceling out effect the trusts are partitioned into two groups according to the recommendations made by Norths, as previously mentioned and shown in Table 6.2. Group 1 trusts are considered to have received favorable recommendations whereas Group 2 trusts are less favorably endorsed. The effect of misclassification may be to bias the results. As discussed below in the dummy variable procedure several signs are not in the direction anticipated on the basis of Table 6.2. However, at this stage no superior method of classification is known. The CARs for Group 1 and Group 2 are plotted as Figure 6.2 and 6.3 respectively. The three CAR plots are combined in Figure 6.4. The scale used for all three plots is the same. This encourages the making of comparisons and in each instance there appears to be some reaction at time zero.

It is reasonable to presume that the three sets of CARs will differ from each other when compared. The favorable group should experience an upward reaction to the good news, the unfavorable group should experience a decline as a result of the bad news, and the combined group should be somewhere in the middle. There are several ways in which the favorable and unfavorable CARs may be compared with each other to test whether they are different. The inclusion of the combined group would be redundant, as it is the difference between good and bad which is of interest.

A Wilcoxon Matched-Pairs test is a procedure for summarizing the magnitude and direction of difference within pairs [Robson (1973, pp.110-114.)]. The application of this test to the two groups, is a useful means for considering whether the paired CARs differ by a statistically significant amount. The null hypothesis is that the two samples are the same. This is investigated and a two tailed probability value of 0.126 is obtained. Hence, it is not possible to reject the null hypothesis at the 0.05 significance level.

Further supporting evidence is obtained with the Friedman Two-Way ANOVA procedure. In this test the null hypothesis is that the two groups are drawn from identical populations. Calculation of the test statistic with a significance level of 0.491 is supportive of the Wilcoxon results. At the 5% significance level the null hypothesis that the two groups are drawn from the same population cannot be rejected.

Several further nonparametric procedures are appropriate for undertaking comparisons between groups [Siegel (1956)], and there are parametric procedures also available for addressing this question. In particular the t-test is appropriate. This involves a pairwise comparison of the groups' variances and means to test the null hypotheses that there are no significant differences between them. The application of the t-test procedure to the two groups is valid only when the distribution of the variables is normal. A Kolmogorov-Smirnov One-Sample Test is applied to each group's CAR to test the null hypothesis that the observed data could reasonably have come from a normal distribution. At the 5% significance level the null hypothesis cannot be rejected for either of the two groups. The t-test findings are supportive of the results reported above where the non-parametric procedures are used. Again the 5% level of significance is adopted and there is no rejection of the null hypotheses.

On the basis of this evidence the reaction to the release of the "Review" is the same for the subset of trusts receiving favorable reviews and for the subset which receives less favorable recommendations. It is still possible that there is a reaction, and both groups experienced similar reactions. The unfavored group may be heavily discounted in the market and when the "Review" is released investors conclude that these trusts are not as bad as previously thought, thereby increasing their abnormal returns, similar to those of the favored trusts. Alternatively, the favorably mentioned group may be overrated and both groups fall on the release of the "Review".

To assess whether a reaction occurs, the abnormal returns for the two groups are analyzed separately in two time periods. The first period covers the 12 months preceding the "Review" publication and the second period the release month, plus the subsequent 6 months. For both groups the question addressed is whether the abnormal returns in Period 1 are the same as the abnormal returns in Period 2.

The t-test is deemed appropriate as the errors in the market model are presumed to be normally distributed and the abnormal returns are merely forecast errors. The result of the t-test applied to:

$$H_0 = AR\ (t = v-12,\ \ldots,\ v-1) = AR\ (t = v+0,\ \ldots,\ v+6)$$

$$H_1 = AR\ (t = v-12,\ \ldots,\ v-1) \neq AR\ (t = v+0,\ \ldots,\ v+6)$$

is that ARs for the two time periods are not significantly different from each other at the 5% significance level. This is the case for both the "Favorable" and "Unfavorable" groups.

An important issue which requires attention is the effect of clustering [Brown and Warner (1980, pp.232-239.)] on the tests of the null hypothesis of no reaction. Two forms of clustering are present in the current study. First, the announcement event occurs simultaneously for all property trusts. If the residuals from the market model are positively correlated across securities in calendar time, then such clustering will increase the variance of the average residuals and hence lower the power of the tests. Brown and Warner (1980, p.235.) comment that "when abnormal performance is present, the rejection rates when there is clustering are not markedly different from those when there is no clustering."

Second, risk clustering may be present if the sample of property trusts consists of securities which all have higher (lower) than average betas. Simulation research by Brown and Warner (1980) indicates that there will be an effect associated with risk clustering. In particular the danger is one of rejecting the null hypothesis of no reaction when there was no reaction.

Although various methods for controlling the impact of clustering are suggested by Brown and Warner (1980) their implementation appears unwarranted. Clustering is likely to lead to a rejection of the null hypothesis when it should not be rejected. The current study did not reject the null hypothesis without controls hence no further investigation is deemed necessary.

The implication of the analysis reported above is strongly suggestive of there being no market reaction at time v, as reflected in the abnormal returns and cumulative abnormal returns for the period $v-12 \leq t \geq v+6$. A closer analysis of the coefficients estimated for the 3½ month period $1 \leq t \geq v-12$ raises concern regarding the validity of the analysis. Table 6.4 presents the OLS estimates of the market model used as the basis for the calculation of the ARs and CARs. The Durbin-Watson statistic indicates potential autocorrelation problems in Regressions 1, 2, 3 and 6 which fall in the inconclusive range.

TABLE 6.4

MARKET MODEL ESTIMATES (OLS) FOR INDIVIDUAL TRUSTS

(1)	Canberra Commercial #2	$R_t =$	0.0164	+	0.0545 R_{mt}	SEE = 0.586
			(2.023)		(0.378)	DW = 2.52
(2)	Canberra Commercial	$R_t =$	-0.0002	-	-0.4413 R_{mt}	SEE = 0.526
			(-0.0088)		(-1.022)	DW = 1.31
(3)	ASC	$R_t =$	0.0087	+	0.5889 R_{mt}	SEE = 0.176
			(0.6187)		(2.3581)	DW = 2.76
(4)	General Property	$R_t =$	0.0147	+	0.4273 R_{mt}	SEE = 0.084
			(1.5156)		(2.4728)	DW = 1.87
(5)	Schroder Darling	$R_t =$	0.0148	+	0.1915 R_{mt}	SEE = 0.069
			(1.6767)		(1.2205)	DW = 2.00
(6)	Equitable #1	$R_t =$	0.0115	+	0.4223 R_{mt}	SEE = 0.276
			(0.6512)		(1.3505)	DW = 2.61
(7)	Equitable #3	$R_t =$	0.0091	+	0.1246 R_{mt}	SEE = 0.101
			(0.8596)		(0.6588)	DW = 2.00
(8)	Stockland	$R_t =$	0.0107	+	0.4476 R_{mt}	SEE = 0.346
			(0.5443)		(1.2788)	DW = 1.96
(9)	Westfield	$R_t =$	0.0086	+	0.3913 R_{mt}	SEE = 0.136
			(0.6970)		(1.7818)	DW = 1.96

The t-statistic is shown in brackets. $t > 2.04$ is significant at the 5% level.
DW is the Durbin-Watson statistic. $d_u = 1.57$ and $d_l = 1.21$.

The reliability of the majority of the beta estimates is low. Officer (1981, p.46.) suggests "that for many companies, the confidence interval of beta would include the value 1.0; in other words if we set up a null hypothesis that beta was average (ie. b = 1.0) in many cases we could not reject the null hypothesis using 95% confidence intervals." The economic significance of beta equal to 1.0 has considerable appeal especially in terms of cost of capital calculations for project evaluation. Furthermore, it is consistent with the real estate industry view, mentioned in Chapter 1, that property trusts go up and down with the market while real property values are more stable. An alternative hypothesis that the beta is not significantly different from zero appears plausible from the data. This implies that the expected value of R_i is the mean value of R_i over the period. Both hypotheses are tested at the 5% significance level and the results tabulated in Table 6.5. In 3 of the 9 cases beta is not significantly different from 1.0 and in 7 instances it is not statistically different from 0.0. Only General Property Trust fails both null hypotheses while Equitable #1, ASC and Stockland property trusts do not reject either hypothesis.

TABLE 6.5

BETA$_i$ EQUAL TO ONE OR ZERO

5% SIGNIFICANCE LEVEL

	Trust i	$H_o : b_i = 1$	$H_o : b_i = 0$
(1)	Canberra Commercial #2	Reject	Accept
(2)	Canberra Commercial	Reject	Accept
(3)	ASC	Accept	Accept
(4)	General Property	Reject	Reject
(5)	Schroder Darling	Reject	Accept
(6)	Equitable #1	Accept	Accept
(7)	Equitable #3	Reject	Accept
(8)	Stockland	Accept	Accept
(9)	Westfield	Reject	Accept

The generalized least squares estimators, also known as Aitken estimators [after Aitken (1935)], are obtained by a process which reweights the return on the market to account for the heterogeneous variances in the disturbance terms e_i. This adjustment involves normalizing the original observations through division by the standard deviation of the cross-section dispersion for the respective time period. GLS estimates presented in Table 6.6 record no marked improvement in the statistical significance of the parameters. The magnitude of the parameters is basically unchanged. Autocorrelation may continue to be present in Regressions 1, 3 and 6 with respective Durbin-Watson statistics falling in the inconclusive range. An alternative approach is deemed desirable in the light of the limited statistical significance of the estimates.

Classification of the Trusts into "Favorable" and "Unfavorable" groups, provided in Table 6.2 above, is used in forming two equally weighted portfolios as:

$$\frac{1}{k} \sum_{i=1}^{k} R_{it} (F) = \bar{a}_F + \bar{b}_F R_{mt} + \bar{e}_{it}(F) \qquad (6.14)$$

where F denotes "Favorable" classification, and

$$\frac{1}{j} \sum_{i=1}^{j} R_{it} (U) = \bar{a}_U + \bar{b}_U R_{mt} + \bar{e}_{jt}(U) \qquad (6.15)$$

with U denoting "Unfavorable" classification.

The estimation of Equations (6.14) and (6.15) removes the cross-sectional dependencies except between $e_t(F)$ and $e_t(U)$ and may further improve the parameter estimates. The equations, so estimated, are reported in Table 6.7, where it is observed that some improvement in the statistical significance of the parameters is achieved. An estimation of the ARs and CARs, as above, is undertaken for these two portfolios.

TABLE 6.6

MARKET MODEL ESTIMATES (GLS) FOR INDIVIDUAL TRUSTS

(1)	Canberra Commercial #2	$R_t = 0.0164 + 0.0548\ R_{mt}$		SEE = 0.586
		(2.0917)	(0.3908)	DW = 2.52
(2)	Canberra Commercial	$R_t = 0.0002 - 0.4413\ R_{mt}$		SEE = 0.526
		(-0.0091	(-1.0568)	DW = 1.31
(3)	ASC	$R_t = 0.0087 + 0.5889\ R_{mt}$		SEE = 0.176
		(0.6397)	(2.4381)	DW = 2.76
(4)	General Property	$R_t = 0.0147 + 0.4273\ R_{mt}$		SEE = 0.084
		(1.5672)	(2.5567)	DW = 1.82
(5)	Schroder Darling	$R_t = 0.0148 + 0.1915\ R_{mt}$		SEE = 0.069
		(1.7335)	(1.2619)	DW = 2.00
(6)	Equitable #1	$R_t = 0.0115 + 0.4222\ R_{mt}$		SEE = 0.276
		(0.6733)	(1.3963)	DW = 2.61
(7)	Equitable #3	$R_t = 0.0091 + 0.1246\ R_{mt}$		SEE = 0.101
		(0.8887)	(0.6811)	DW = 2.00
(8)	Stockland	$R_t = 0.0107 + 0.4476\ R_{mt}$		SEE = 0.346
		(0.5628)	(1.3222)	DW = 1.96
(9)	Westfield	$R_t = 0.0081 + 0.3913\ R_{mt}$		SEE = 0.136
		(0.7206)	(1.8422)	DW = 1.96

The t-statistic is shown in brackets. $t > 2.04$ is significant at the 5% level.
DW is the Durbin-Watson statistic. $d_u = 1.57$ and $d_l = 1.21$.

TABLE 6.7

MARKET MODEL ESTIMATES (OLS) OF FAVORABLE
AND UNFAVORABLE PORTFOLIOS

Favorable (F)	$R_t = 0.0104 + 0.3097\ R_{mt}$		SEE = 0.086
	(1.7227)	(2.7246)	DW = 1.500
Unfavorable (U)	$R_t = 0.0103 + 0.0939\ R_{mt}$		SEE = 0.088
	(1.6838)	(0.8134)	DW = 2.185

The t-statistic is shown in brackets. $t > 2.04$ is significant at the 5% level.
DW is the Durbin-Watson statistic. $d_u = 1.57$ and $d_l = 1.21$.

The ARs and CARs are tested for normality using the Kolmogorov-Smirnov test discussed above. The results are such as not to reject the null hypothesis of normality at the 5% level. A t-test procedure is applied, similar to above, to test three hypotheses. First,

H_0: CAR (Favorable) = CAR (Unfavorable)

H_1: CAR (Favorable) $\neq$ CAR (Unfavorable)

in which H_0 cannot be rejected at the 5% level. Second,

H_0: AR (F) t = v-12, ..., v-1 = AR (F) t = v, ..., v+6

H_1: AR (F) t = v-12, ..., v-1 = AR (F) t = v, ..., v+6

with the null hypothesis, at the 5% level, not being rejected. Similarly the third test:

H_0: AR (U) t = v-12, ..., v-1 = AR (U) t = v,..., v+6

H_1: AR (U) t = v-12, ..., v-1 $\neq$ AR (U) t = v,..., v+6

results in the nonrejection of H_0.

Findings for these CAR investigations are not, in general, supportive of the proposition that the "Review" contains new information previously unknown to the market. Further testing of the proposition with the dummy variable approach may provide a greater elucidation of the issue.

Dummy Variable Procedure

Equation 6.12 is estimated for each property trust with an OLS regression. An examination of each equation in turn will indicate if the announcement effect dummy is significant. The sign of the coefficient will be positive when a favorable reaction occurs and negative when an unfavorable reaction is precipitated. The estimated regressions are reported in Table 6.8. The results are, in the majority of instances, insignificant in a statistical sense. The signs on the dummy are not consistent with the expectations formed from Table 6.2. Three of the four trusts in the "Favorable" group, denoted F, have a negative dummy coefficient whilst two of the "Unfavorable" group, denoted U, have positive dummy coefficients.

TABLE 6.8

MARKET MODEL WITH DUMMY VARIABLE ESTIMATES (OLS) FOR INDIVIDUAL TRUSTS

(U) Canberra Commercial #2	$R_t =$	0.00541 -	$0.00690\ R_{mt}$	+	$0.06498\ D_t$	SEE = 0.335	
		(0.44481)	(-0.02956)		(0.74257)	DW = 2.014	
(U) Canberra Commercial	$R_t =$	0.00610 -	$0.28446\ R_{mt}$	+	$0.05884\ D_t$	SEE = 0.592	
		(0.37713)	(-0.91738)		(0.50593)	DW = 2.113	
(U) ASC	$R_t =$	0.00361 +	$0.59866\ R_{mt}$	-	$0.13523\ D_t$	SEE = 0.241	
		(0.34991)	(3.0259)		(-1.82239)	DW = 2.820	
(F) General Property	$R_t =$	0.01390 +	$0.43917\ R_{mt}$	-	$0.53688\ D_t$	SEE = 0.125	
		(1.87395)	(3.08670)		(-1.0060)	DW = 2.027	
(F) Schroder Darling	$R_t =$	0.01107 +	$0.14890\ R_{mt}$	-	$0.04631\ D_t$	SEE = 0.866	
		(1.79170)	(1.25558)		(-1.041047)	DW = 2.098	
(U) Equitable #1	$R_t =$	0.01675 +	$0.17866\ R_{mt}$	-	$0.13820\ D_t$	SEE = 0.323	
		(1.40276)	(0.77996)		(-1.60850)	DW = 2.449	
(U) Equitable #2	$R_t =$	0.02211 +	$0.07406\ R_{mt}$	-	$0.00200\ D_t$	SEE = 0.364	
		(1.7435)	(0.3044)		(-0.1969)	DW = 2.373	
(F) Stockland	$R_t =$	0.00853 +	$0.39641\ R_{mt}$	-	$0.00920\ D_t$	SEE = 0.390	
		(0.64993)	(1.57414)		(-0.09710)	DW = 1.981	
(F) Westfield	$R_t =$	0.09298 +	$0.30025\ R_{mt}$	+	$0.32464\ D_t$	SEE = 0.177	
		(1.05113)	(1.76948)		(0.51008)	DW = 1.905	

The t-statistic is shown in brackets. $t > 1.96$ is significant at the 5% level.
DW is the Durbin-Watson statistic. $d_u = 1.63$ and $d_l = 1.46$.

The cross-sectional correlation within errors, discussed above, may be present in this model. Use of the method developed by Zellner (1962), to account for the cross-sectional correlation of errors between firms, is adopted by Ricks and Hughes (1985) in their assessment of market reactions to non-discretionary accounting changes. They suggest that seemingly unrelated regressions yield GLS estimators which are asymptotically more efficient than the OLS estimators obtained from the single equation systems.

Comparison of the two sets of regressions as presented in Tables 6.8 and 6.9 show the results are the same. This should not be surprising, although it is contrary to an expectation formed on the remarks of Ricks and Hughes (1985). The independent variables R_m and D are the same in all regressions and accordingly the OLS, GLS and SUR estimators will be equal [Judge et al (1982, pp.319-321).]

The parameter estimates are similar to those obtained from OLS regressions and there is a only minor improvement in the significance of parameters. The sign on the dummy variable remains inconsistent with those anticipated. It is only in the ASC regression that all parameter estimates are significant and the sign is of the anticipated polarity. The evidence remains weak and it is inadvisable to draw strong conclusions in favor of, or against, the proposition of information content on the basis of these equations. This is similar to the change from OLS to GLS reported in Tables 6.4 and 6.6.

TABLE 6.9

MARKET MODEL WITH DUMMY VARIABLE ESTIMATES (SUR) FOR INDIVIDUAL TRUSTS

(U) Canberra	R_t =	0.00541 -	0.00690 R_{mt}	+ 0.06498 D_t	SEE	= 0.335
Commercial #2		(0.44481)	(-0.02956)	(0.74257)	DW	= 2.014
(U) Canberra	R_t =	0.00610 -	0.28446 R_{mt}	+ 0.05884 D_t	SEE	= 0.592
Commercial		(0.37713)	(-0.91738)	(0.50593)	DW	= 2.113
(U) ASC	R_t =	0.00361 +	0.59866 R_{mt}	- 0.13523 D_t	SEE	= 0.241
		(0.34991)	(3.0259)	(-1.82239)	DW	= 2.820
(F) General	R_t =	0.01390 +	0.43917 R_{mt}	- 0.53688 D_t	SEE	= 0.125
Property		(1.87395)	(3.08670)	(-1.0060)	DW	= 2.027
(F) Schroder	R_t =	0.01107 +	0.14890 R_{mt}	- 0.04631 D_t	SEE	= 0.866
Darling		(1.79170)	(1.25558)	(-1.041047)	DW	= 2.098
(U) Equitable #1	R_t =	0.01675 +	0.17866 R_{mt}	- 0.13820 D_t	SEE	= 0.323
		(1.40276)	(0.77996)	(-1.60850)	DW	= 2.449
(U) Equitable #2	R_t =	0.02211 +	0.07406 R_{mt}	- 0.00200 D_t	SEE	= 0.364
		(1.7435)	(0.3044)	(-0.1969)	DW	= 2.373
(F) Stockland	R_t =	0.00853 +	0.39641 R_{mt}	- 0.00920 D_t	SEE	= 0.390
		(0.64993)	(1.57414)	(-0.09710)	DW	= 1.981
(F) Westfield	R_t =	0.09298 +	0.30025 R_{mt}	+ 0.32464 D_t	SEE	= 0.177
		(1.05113)	(1.76948)	(0.51008)	DW	= 1.905

The t-statistic is shown in brackets. t > 1.96 is significant at the 5% level.
DW is the Durbin-Watson statistic. d_u = 1.63 and d_l = 1.46.

Hughes and Ricks (1984, p.110.) suggest that the return generating process be described in terms of an equally weighted portfolio of sample firms. The advantage claimed for this approach is that tests of the average reactions are "sensitive to both contemporaneous cross-dependencies in the disturbances, and cross-sectional heteroscedasticity in those disturbances". In the context of the present enquiry the "Favorable" and "Unfavorable" groups as presented in Table 6.2 form the basis for two equally weighted portfolios. The returns are assumed to be generated as:

Favorable $$\frac{1}{k}\sum_{i=1}^{k} R_{it} = \bar{a}_F + \bar{b}_F R_{mt} + \bar{c} D_t + \bar{e}_t \qquad (6.16)$$

Unfavorable $$\frac{1}{j}\sum_{i=1}^{j} R_{it} = \bar{a}_U + \bar{b}_U R_{mt} + \bar{c} D_t + \bar{e}_t \qquad (6.17)$$

Estimation of Equations 6.16 and 6.17 using an OLS regression does not provide any substantial evidence of an announcement effect. Results in equation form are reported as Table 6.10. It is apparent the dummy variable is not statistically significant for either the Favorable or Unfavorable group, and the former regression appears to exhibit autocorrelation.

TABLE 6.10

ORDINARY LEAST SQUARES PORTFOLIO REGRESSIONS

Favorable	0.0107	+	0.3212 R_{mt}	- 0.0192 D_t	SEE = 0.085
	(1.7450)		(2.7303)	(-0.4346)	DW = 1.478
Unfavorable	0.0108	+	0.1120 R_{mt}	- 0.0303 D_t	SEE = 0.087
	(1.7376)		(0.9398)	(-0.6774)	DW = 2.223

The t statistic is shown in brackets. $t > 1.96$ is significant at the 5% level.
DW is the Durbin-Watson statistic. $d_u = 1.46$ and $d_l = 1.63$.

Parameter Stability

The poor quality of all estimated regression equations, in terms of the significance of the explanatory variable, is a cause for concern. If there are significant changes in the beta or intercept terms during the period under consideration then this will contribute to the poor results. Several tests are applied consistently to all the regressions for the purpose of detecting any structural shift in the models.

A Chow test (Chow, 1960) is undertaken to check if a structural shift has occurred in the four time periods over which the model is estimated. The sample periods are first the full data set from February 1981 through to March 1985, second the subperiod from February 1981 to July 1984, third the subperiod from February 1981 to August 1983, and fourth the period from the report publication in August 1984 through to March 1985. The hypothesis tested, in each instance, is that the observations can be considered as coming from the same population. The null hypothesis that the samples are drawn from the same population cannot be rejected at the 5% significance level.

The poor estimates obtained by both OLS and GLS for the period up to twelve months preceding the release of the report may be the real problem. Failure to obtain a significant parameter estimate over short periods is likely but thirty observations should be enough. Accordingly, it appears desirable that the parameter estimates are checked for the whole period. Scrutiny of the standardized residuals is one means of checking for instability in the model. The OLS standardized residuals for each trust are presented as Figure 6.5A to 6.5I. Although a number of points fall outside the plus or minus two standard deviation region there is no obvious clustering to suggest instability.

FIGURE 6.5A

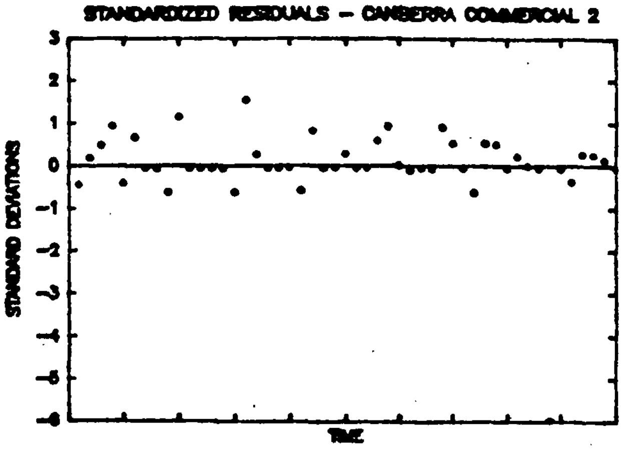


FIGURE 6.5B

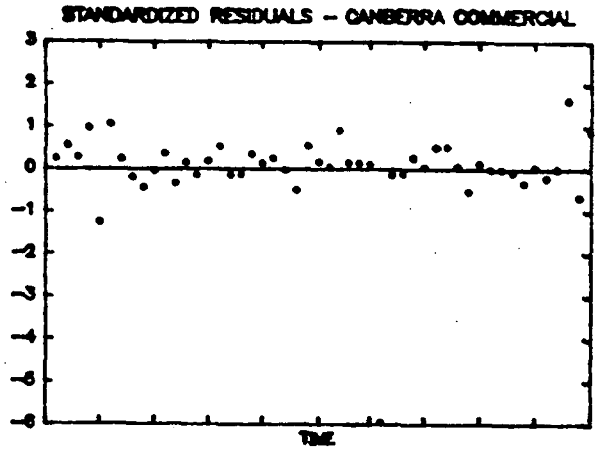


FIGURE 6.5C

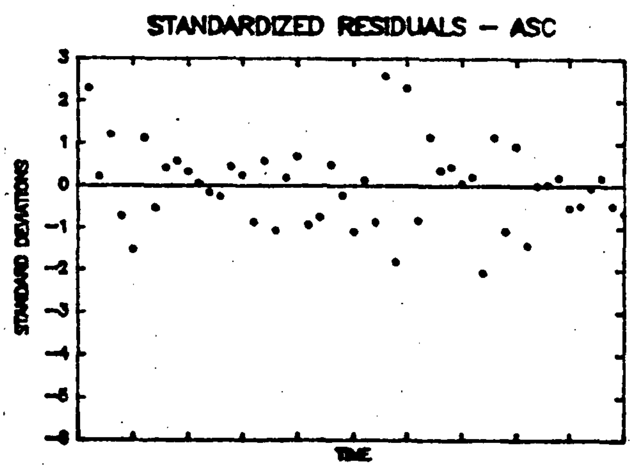


FIGURE 6.5D

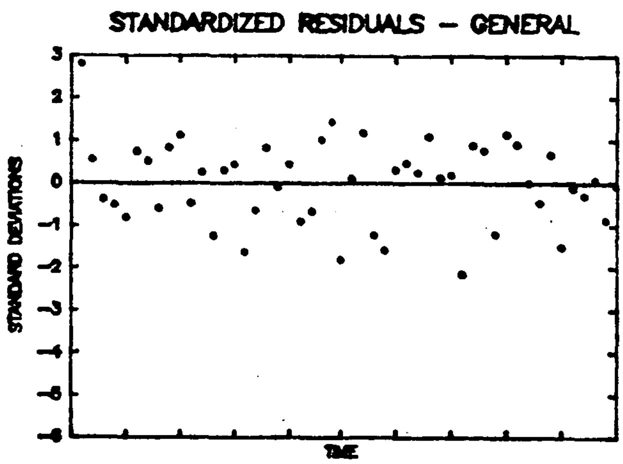


FIGURE 6.5E

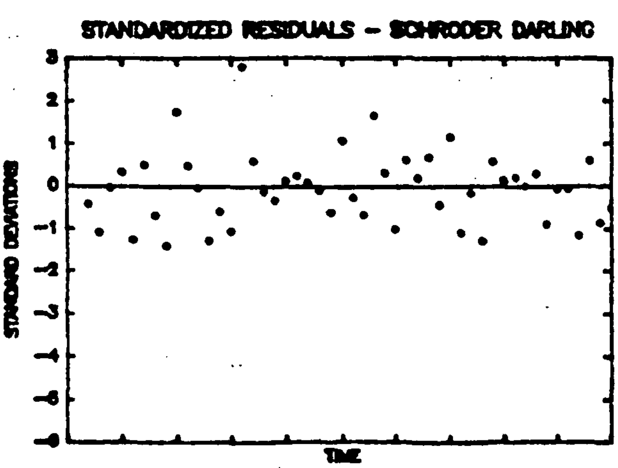


FIGURE 6.5F

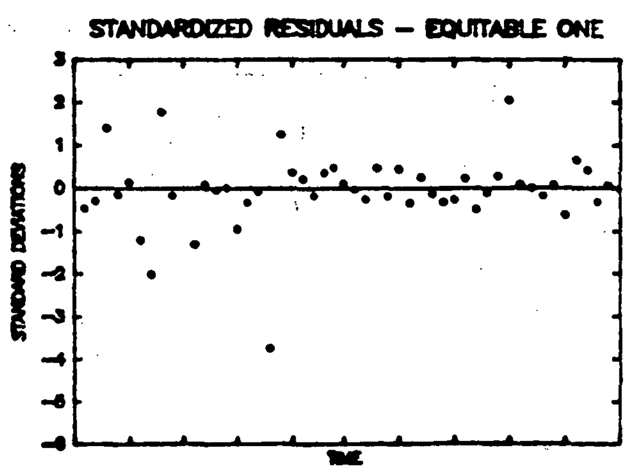


FIGURE 6.5G

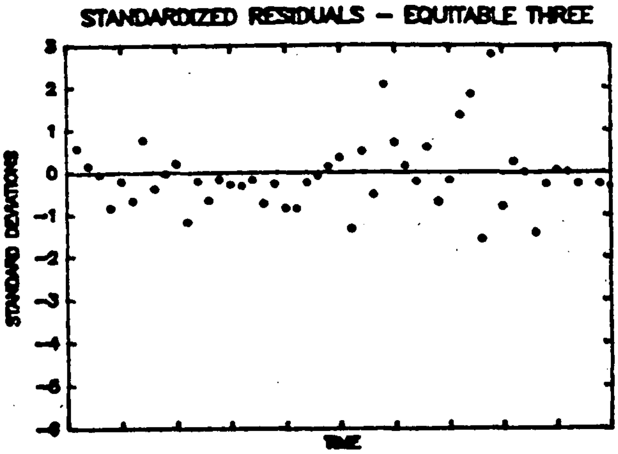


FIGURE 6.5H

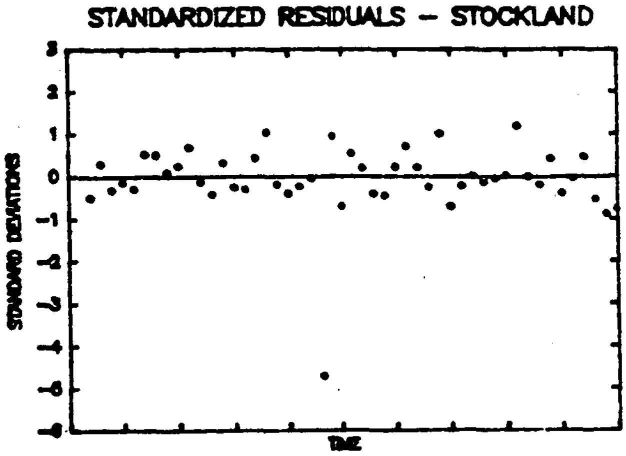
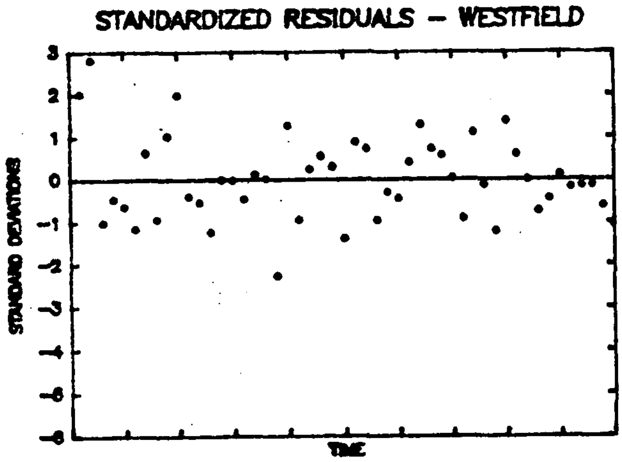


FIGURE 6.5I



Visual inspection of these plots of standardized residuals may or may not suggest to the viewer that clustering exists. To investigate further the possibility that there remains within the disturbance terms useful information, the autocorrelation and partial autocorrelation functions of the standardized residuals are examined. Slight evidence of autocorrelation is indicated and this is consistent with the reported Durbin-Watson statistics. An AR1 regression is estimated for each trust and the residuals again scrutinized by an autocorrelation and partial autocorrelation procedure. The AR1 estimation results in a small improvement which further enforces a view that the market model does not fit the data well.

When considered over the whole time period, an analysis of residuals tends not to be sensitive to gradual changes in the regression parameters. An alternative procedure is to estimate the residuals (U_t) recursively and to analyze the cumulative sums (cusums) of the sample U_t against time [Brown, Durbin and Evans (1975)]. This recursive estimation is undertaken in both a forward and backward manner, and the results interpreted.

TABLE 6.11

TIME VARIANCE TESTS

	BACKWARD		FORWARD	
	CUSUM	CUSUM SQ.	CUSUM	CUSUM SQ.
Canberra Commercial #2	.996139*	.231405	.934695	.167012
Canberra Commercial	.750495	.211252	.505545	.265005*
ASC	.562533	.331141*	.724194	.395213*
General Property	.276317	.423305*	.369466	.411924*
Schroder Darling	.467593	.354009*	.532083	.327841*
Equitable #1	.574832	.212322	.750464	.171105
Equitable #3	.672726	.389219*	.406796	.380774*
Stockland	.380424	.378427*	.528229	.373314*
Westfield	.285502	.769183*	1.52710*	.652461*

Cusum Test 5% significance level = 0.948
Cusum Square Test 5% significance level = 0.23835
* denotes significant at 5% level

The cusum and cusum square tests [Evans (1973, pp.5-6.) are used to test the hypothesis that there are no changes over the whole period. The results of these tests, undertaken in the forward and backward direction following Kahn (1974), are reported in Table 6.11. The evidence is not conclusive in either the rejection of the null hypothesis or its acceptance. This is consistent with the earlier evidence of insignificant parameter estimates. There appears to be no definite and identifiable structural changes occurring within the time period under consideration, but rather a high level of variance in the regression which results in less reliable coefficient estimates.

An Alternative Model

The application of econometric methodology to address research issues is founded on an acceptance of the underlying model and diagnostic testing of the model. In the empirical investigation undertaken above, the market model is assumed to portray accurately the true equilibrium return generating model. If this is not the case then the analysis is not valid.

The capital asset pricing model provides an alternative statement of equilibrium returns. Estimation of Equation 6.4 as:

$$(R_{it} - R_{ft}) = b_i (R_{mt} - R_{ft}) + e_i$$

constrained to a zero intercept yields statistically significant results as reported in Table 6.12. This is surprising in the light of the market model estimates discussed above and further investigation is needed. It is likely the R_{ft} term in the model is responsible for all the significance. Accordingly, this explanation is to be tested.

TABLE 6.12

CONSTRAINED CAPM ESTIMATES (OLS) FOR INDIVIDUAL TRUSTS

Canberra	b =	0.999	SEE = 0.468
Commercial #2	t =	88.627	DW = 1.974
Canberra	b =	1.000	SEE = 0.811
Commercial	t =	67.414	DW = 2.039
ASC	b =	1.001	SEE = 0.290
	t =	112.790	DW = 2.600
General	b =	0.992	SEE = 0.175
Property	t =	144.150	DW = 1.808
Schroder	b =	0.996	SEE = 0.194
Darling	t =	137.163	DW = 2.053
Equitable #1	b =	0.993	SEE = 0.452
	t =	89.629	DW = 2.406
Equitable #2	b =	0.987	SEE = 0.480
	t =	86.459	DW = 2.258
Stockland	b =	0.996	SEE = 0.441
	t =	91.035	DW = 1.727
Westfield	b =	0.996	SEE = 0.241
	t =	122.987	DW = 1.808

t > 2.04 is significant at the 5% level
DW is the Durban-Watson Statistic. $d_u = 1.577$ and $d_l = 1.21$
DW statistics is unreliable when no constant is included

Equation 6.4 may be rewritten as:

$$R_{it} = b_i R_{mt} + (1 - b) R_{ft} + e_i \qquad (6.18)$$

and this may be estimated with zero intercept and unconstrained coefficients as:

$$R_{it} = b_i R_{mt} + d_i R_{ft} + e_i. \qquad (6.19)$$

The coefficient d_i should be approximately equal to $1-b_i$ and both parameters should be significant. Table 6.13 presents the estimated regressions and it is apparent that d_i is not equal to $1-b_i$. A

F-statistic is reported for the test that the constrained and unconstrained equations are the same [Johnston (1984, p.207.)]. At the 5% significance level the null hypothesis that the restrictions are true is rejected. The critical F value is 4.04.

TABLE 6.13

UNCONSTRAINED CAPM ESTIMATES (OLS) FOR INDIVIDUAL TRUSTS

				F
Canberra	b = 0.032	d = 0.005	SEE = 0.339	18.27
Commercial #2	t = 0.141	t = 0.546	DW = 2.013	
Canberra	b = -0.249	d = 0.006	SEE = 0.595	17.43
Commercial	t = -0.832	t = 0.449	DW = 2.117	
ASC	b = 0.518	d = 0.001	SEE = 0.258	5.95
	t = 2.627	t = 0.141	DW = 2.655	
General	b = 0.408	d = 0.011	SEE = 0.127	18.14
Property	t = 2.945	t = 1.764	DW = 2.057	
Schroder	b = 0.122	d = 0.008	SEE = 0.089	56.63
Darling	t = 1.057	t = 1.678	DW = 2.108	
Equitable #1	b = 0.075	d = 0.018	SEE = 0.365	15.62
	t = 1.203	t = 1.203	DW = 2.399	
Equitable #2	b = 0.391	d = 0.018	SEE = 0.365	15.12
	t = 0.321	t = 1.751	DW = 2.370	
Stockland	b = 0.391	d = 0.007	SEE = 0.390	6.28
	t = 1.611	t = 0.663	DW = 1.987	
Westfield	b = 0.321	d = 0.008	SEE = 0.178	16.99
	b = 1.956	t = 1.098	DW = 1.907	

t > 2.04 significant at the 5% level
DW is the Durban-Watson Statistic. d_u = 1.577 and d_1 = 121
DW statistics is unreliable when no constant is included
$F_{1,48}$ 5% = 4.04

The evidence suggests CAPM does not provide clearly better estimates with which to test the announcement effect. The market model and CAPM, as demonstrated in Chapter 2, are effectively the same model and thus this finding is expected.

5. Summary

The analysis of an announcement effect associated with the release of a Review of Property Trusts 1984 by the sharebroking firm Norths is discussed above. Two different approaches to the investigation are reported and both failed to detect any discernable market reaction to the publication of the report. This is consistent with the semi-strong form of the efficient market hypothesis which requires that all publicly available information is impounded in the price of the assets. To the extent that Norths' "Review" contains a reworking and restatement of known facts, albeit in a comprehensive unified volume, no reaction is anticipated.

Tests of announcement effects are predicated on a choice of the equilibrium model. Accordingly, the approach to considering the semistrong-form EMH is, of necessity, a joint test of the equilibrium model. Both methods utilized in the investigation are founded on the widely used market model. Although previous use of these methods, as reported in the literature, is satisfactory in the sense of the statistical significance of estimated equations, this is not the case for the current research.

Application of more sophisticated estimation procedures failed to improve the statistical significance of the estimated equation. Further investigations into the potential instability of the equations do not suggest parameter instability as the cause of the poor estimates. Rather the low explanatory power is associated with considerable noise in the residuals but it appears to be white noise, containing no additional information, i.e. pure randomness.

In conclusion the empirical evidence reported in this Chapter does not support a proposition that the Norths' "Review" contained new information. Although the explanatory power of the equilibrium models are low the results are consistent with prior expectations. The large degree of randomness in the returns limits the confidence which may be attributed to CAPM in this context but does not suggest the model is misspecified.

CHAPTER SEVEN

CAPITAL ASSET PRICING MODEL AND THE STRONG-FORM OF THE EFFICIENT MARKET HYPOTHESIS

Introduction

The capital asset pricing model provides a statement of the equilibrium relationship between the expected return on an asset and the risk of the asset. A linear equation as, derived in Chapter 2, of the form:

$$E(R_{it}) = E(R_{ft}) + b_i \, [E(R_{mt}) - E(R_{ft})] \qquad (7.1)$$

incorporates both the return and the risk. As all assets may be considered in terms of this formulation it follows that in equilibrium all assets plot along the security market line (SML), being the name given to the graphical presentation of CAPM in expected return/beta space.

In an efficient market, where all available information is impounded into the security prices, there will exist an equilibrium between the expected return and risk. Hence, the return performance of individual assets is a function of bearing market risk. As risk increases, the expected return increases by a commensurate amount. The possibility of abnormal performance is attributable to a disequilibrium or a correctly anticipated change in equilibrium. The first possibility is at conflict with the model while the second implicitly assumes superior information.

Section 1 of this Chapter considers the possibility of superior information in the context of the efficient market hypothesis. Specifically, it is shown that this issue involves a joint test of the strong-form EMH and CAPM. Performance assessment models derived from CAPM which are appropriate for the testing of a joint hypothesis of the strong-form EMH and the applicability of CAPM are discussed in Section 2.

Empirical estimation of these various models is reported in Section 3. Technical issues in regard to the data and the statistical significance of estimated equations are explained as required. In particular, the recurring difficulty of poor model fit appears as a major issue to be considered.

Various procedures for the assessment of real estate performance are suggested in the financial media and professional literature. Several approaches are evaluated, in Section 4, against the capital market theory presented in Sections 1 and 2. While there appear to be expediency grounds for favoring some approaches, in terms of time and minimal effort, their ad hoc nature does not recognize a relationship between return and risk.

Section 5 summarizes the theoretical, practical and quantitative aspects of the research reported in this Chapter. Viewed in conjunction with the evidence concerning the lower levels of market efficiency, weak-form and semistrong-form EMH, it provides a basis for drawing conclusions regarding the applicability of CAPM to real estate assets.

1. Strong-form Efficient Market Hypothesis

The strong-form of the efficient market hypothesis maintains "that all information will be impounded in security prices in such a way as to leave no opportunity for extraordinary returns based on any information" [Dyckman, Downes and Magee (1975, p.30.)]. This level of efficiency is more demanding than the two lesser levels considered in Chapters 5 and 6. Nevertheless, a common concern to all three forms of the EMH is the way in which information is impounded into the expected return for assets.

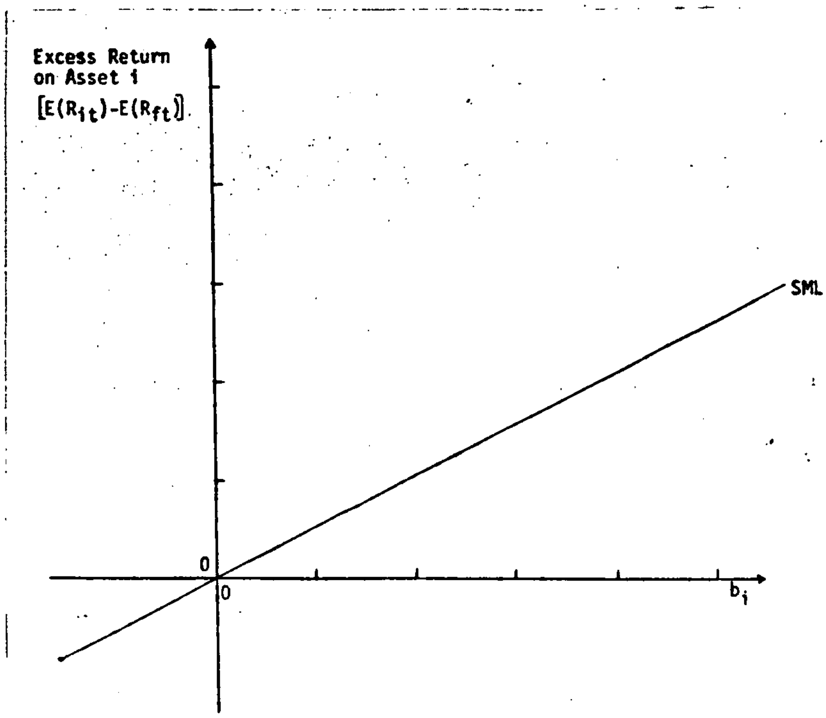
Empirical testing of the EMH requires a formal statement regarding the return generating function. It is from the model of asset pricing that testable propositions concerning the EMH are derived. The capital asset pricing model is assumed, for the purpose of this current research, to accurately represent how equilibrium asset prices are determined. Accordingly, tests devised are joint tests of the strong-form EMH and CAPM.

The capital asset pricing model as stated in Equation 7.1 may be re-expressed in terms of excess returns. When the excess return form:

$$E(R_{it} - R_{ft}) = b_i\,[E(R_{mt} - R_{ft})] \tag{7.2}$$

is drawn in expected excess return and beta space, as depicted in Figure 7.1, the intercept with the axes is at the origin (0,0). All assets lie along the security market line. As the beta of an asset increases the level of expected return also increases to compensate for the increased risk. Risk in this context is the market risk of the asset, that risk which cannot be diversified away, and beta serves as an index of this risk.

FIGURE 7.1 SECURITY MARKET LINE



The strong-form EMH implies that there are no opportunities to earn abnormal returns by early access to information which when widely known will cause the returns for the period to alter. Insider trading refers to situations where persons referred to as insiders have prior access to generally unknown information and trade on it in an attempt to earn abnormal returns. Little information is available regarding insider trading, which is prohibited by law in many countries with developed securities markets, and those who are participating in it do not actively publish data on their activities. Jaffe (1974) undertook a study of returns obtained by corporation management and directors from trading in the shares of the company they are associated with. On average a negative abnormal return is reported for heavy selling by "insiders" and positive abnormal returns for heavy buying by "insiders". The study also found that similar returns are achievable by trading according to the insider notification given to the Securities and Exchange Commission (SEC). In the United States, where Jaffe conducted the study, those persons deemed to be "insiders" must notify the SEC of trades consummated. The existence of abnormal returns in the Jaffe study is evidence of strong-form inefficiency.

Investment fund performance provides an opportunity to investigate the extent to which managers can earn abnormal returns on the portfolios under their charge. If it is assumed that fund managers obtain early access to "inside" information as corporations attempt to attract their investment, then the performance of funds provides a means of testing the strong-form EMH. Consistent abnormal returns generated by a fund are indicative of access to superior information and hence is an indication of strong-form inefficiency.

Several studies consider the question of whether abnormal returns are earned by mutual funds. In general the evidence suggests that returns to unit holders are no greater and in many instances are less than the level of returns which are commensurate with the actual risk borne. Further discussion of several studies is presented below in the context of an examination of the procedures by which performance is measured.

2. Performance Evaluation

In equilibrium, when all assets are priced according to CAPM, each security earns a normal return. There are no abnormal returns. Consider the capital asset pricing model for any two assets i and j:

$$E(R_{it} - R_{ft}) = b_i\ [E(R_{mt} - R_{ft})] \text{ and}$$

$$E(R_{jt} - R_{ft}) = b_j\ [E(R_{mt} - R_{ft})].$$

If $i \neq j$ and time period t is taken as the same instance, then $E(R_{mt} - R_{ft})$ is equal in both relationships. Thus, dividing both equations by the respective betas implies an equivalence between the two expressions:

$$E(R_{it} - R_{ft})/b_i = E(R_{mt} - R_{ft}) = E(R_{jt} - R_{ft})/b_j \tag{7.3}$$

and this is true for all securities i and j.

Treynor (1965) suggests that the ratio of excess return to beta be used as a performance index for assets. This is variously known as the reward-to-volatility ratio and as Treynor's performance index (PI_T). In equilibrium:

$$PI_T = E(R_{it} - R_{ft})/b_i \tag{7.4}$$

will be the same for all i assets. Empirical estimation of this relationship requires the removal of the expectation operators by replacing the expected values with observable values. Hence, the reward-to-variability ratio is calculated as:

$$\overset{o}{PI}_T = (R_{it} - R_{ft})/\overset{o}{b}_i \qquad (7.5)$$

where R_{it} is the actual return obtained by asset i in period t;

R_{ft} is the observed return on the proxy for the risk-free asset; and

$\overset{o}{b}$ is the estimated beta for asset i.

Further discussion regarding these variables is undertaken below.

In equilibrium, where the risk adjusted mean rate of return on an asset or portfolio is in accord with CAPM, it follows that:

$$\overset{o}{PI}_T = (R_{it} - R_{ft})/\overset{o}{b}_i = R_{mt} - R_{ft} \qquad (7.6)$$

where R_{mt} is the observed rate of return on the proxy for the market portfolio in period t. Deviations from equilibrium may occur such that:

$$\overset{o}{PI}_T = (R_{it} - R_{ft})/\overset{o}{b}_i = R_{mt} - R_{ft} + a_{it} \qquad (7.7)$$

where a_t is the deviation from the predicted value. The value of a_{it} may be either negative or positive depending on whether the asset in question underperformed or outperformed the market respectively. Thus the calculation of the Treynor Index, according to Equation 7.5, provides a means of ranking the performance of portfolios. The portfolio with the largest PI_T performed best and others less well in descending order. For all portfolios where the index score is greater than the excess return on the market:

$$PI_T > (R_m - R_f)$$

it is apparent that abnormal returns are earned.

The expected rate of return on a risky-asset, such as the proxy for the market portfolio, is greater than the rate of return on the proxy for the risk-free asset. The expected excess return on the market, $E(R_m - R_f)$, is positive. Excess returns on all other risky assets will be positive. Conceptually it is possible, within the CAPM framework, for securities with negative excess returns and negative betas to exist; $E(R_i - R_f) < 0$ and $b_i < 0$. Care must be taken, as either a result of a temporary disequilibrium in the market or of sampling errors, that the combination of $E(R_i - R_f) > 0$ and $b_i < 0$ not be used in the calculation of the reward-to-volatility ratio. The problems involved in empirical estimation are considered below.

In Equation 7.7 the ratio of the excess return on asset i to its beta is equal to the excess return on the market plus the abnormal return which may be negative, zero or positive:

$$(R_{it} - R_{ft})/\overset{o}{b}_i = R_{mt} - R_{ft} + a_{it}.$$

Multiplication of Equation 7.7 by $\overset{o}{b}_i$ to give:

$$R_{it} - R_{ft} = \overset{o}{b}_i\,[R_{mt} - R_{ft}] + \overset{o}{b}_i\,a_{it} \qquad (7.8)$$

and then the replacement of $\overset{o}{b}_i\,a_{it}$ with J_i gives:

$$R_{it} - R_{ft} = J_i + b_i\,[R_{mt} - R_{ft}]. \qquad (7.9)$$

Empirical CAPM, as discussed in Chapter 2, is identical to Equation 7.9. The coefficient J_i is:

(1) zero when the asset is priced according to the equilibrium model;

(2) greater than zero when positive abnormal returns are earned; and

(3) less than zero when negative abnormal returns are suffered.

Direct estimation of this model provides a measure of abnormal performance over the estimation period.

Jensen (1968) proposes that a time-series regression which is unconstrained as to a zero intercept, of the excess returns on asset i with the excess returns on the market is a useful performance index. The estimated equation is of the form:

$$(R_{it} - R_{ft}) = \mathring{J}_i + \mathring{b}_i (R_{mt} - R_{ft}) + \mathring{e}_{it} \qquad (7.10)$$

where $E(\mathring{e}_{it}) = 0$; and

$\mathring{J}_i$ is the estimated value of J_i.

The Jensen performance index PI_J is therefore the value of the intercept term:

$$PI_J = J_i. \qquad (7.11)$$

The larger the vertical intercept, the greater is the abnormal rate of return achieved by the portfolio.

Both the Treynor and Jensen Indexes are founded on the notion that all assets in equilibrium lie on the security market line. The relationship between return and risk is in terms of market risk. When the portfolio to be assessed is not held as a component of a well diversified portfolio, the total risk rather than market risk must be considered. The return earned on an asset is commensurate with the level of market risk borne, but investors who hold assets either singularly or as part of a larger undiversified portfolio bear the total risk of the asset(s).

Sharpe (1966) proposes this as an important consideration to be taken into account when designing a performance measure for mutual funds. If the investors in mutual funds hold only those shares, then the relevant risk borne by these investors is the variability in the fund's rate of return.

The expected return on an efficient portfolio expressed in terms of the capital market line, as discussed in Chapter 2, is:

$$E(R_p) = E(R_f) + E(R_m - R_f) \; SD(R_p)/SD(R_m) \tag{7.12}$$

where $SD(R_p)$ is the standard deviation of the efficient portfolio;

R_f is the risk free rate;

R_m is the rate of return on the market portfolio; and

$SD(R_m)$ is the standard deviation on the market portfolio.

As the slope of the CML increases so too does the utility of the investor. Accordingly, if the mutual funds are efficient portfolios then the Sharpe reward-to-variability ratio as a performance index (PI_S) calculated:

$$PI_s = E(R_p - R_f)/SD(R_p) \tag{7.13}$$

is appropriate. However, a straight line may be drawn between any risky asset i and the risk-free security such that:

$$E(R_j) = E(R_f) + E(R_i - R_f) \; SD(R_j)/SD(R_i) \tag{7.14}$$

where R_j is an attainable rate of return as a result of combining the risky-asset i with the risk-free assets; and

$SD(R_j)$ is the standard deviation for the attained combination portfolio j.

Hence the Sharpe index may be expressed for any asset i as:

$$PI_S = E(R_{it} - R_{ft})/SD(R_i) \tag{7.15}$$

Calculation of PI_S requires the empirical estimation of the mean rate of return for the risky-asset under consideration and the proxy for the risk-free asset over the period of interest. The sample standard deviation for the rate of return on the risky asset also must be estimated. Arditti (1971) demonstrates an extension to the Sharpe formula considered to be more appropriate when returns are skewed. This involves additional descriptive statistics which are necessary because of the nonnormality of returns.

The Jensen and Treynor indexes are closely related and derived directly from CAPM. Sharpe's approach although related employs a different quantitative measure of risk. Friend and Blume (1970) provide a full discussion of the formal relationship between these three measures.

The impact that measurement errors, associated with the use of proxies for the true rate of return on the risk-free asset and on the market, will have on the three performance measures is unclear. This additional uncertainty results from a lack of knowledge as to the relationship between the proxy variables and the true value.

Roll (1969), Jen (1970) and others note that the accepted practice of using the rate of return on a short-term government security as proxy for the risk-free rate of interest introduces a problem of measurement errors. This issue is investigated in the context of CAPM by several researchers. Friend and Blume (1970) consider that the idea of investors being able to borrow and lend at the one risk-free rate is unrealistic and the result is to cause the estimated beta coefficient to be negatively correlated with the alpha coefficient. Brennan (1971) replaced R_f with R_b, which is the weighted average of the borrowing and lending rates in the market, and shows that the relationship between return and market risk for assets remains linear.

Lee and Jen (1978, p.301.) postulate:

$$R_{ft} = R_{Tt} + \mathring{U}_t \tag{7.16}$$

where R_{Tt} is a treasury bill rate used as a proxy for R_{ft}; and

$\mathring{U}_t \sim N(0, VAR(U))$ and is i.i.d.

From this position they demonstrate the Jensen Index is affected by measurement errors in the proxy for the risk-free rate. Similarly, this will hold for the Treynor Index which is also founded on the empirical estimation of CAPM.

The Sharpe Performance Index utilizes the excess return on the asset and the standard deviation of the excess returns as variables in the calculation. Measurement error in the proxy for R_f will flow through to the calculated excess returns. If Equation 7.16 is accepted as reasonable, then the excess return (RR) on asset i is:

$$
\begin{aligned}
RR_{it} &= R_{it} - R_{ft} \\
&= R_{it} - (R_{Tt} + \mathring{U}_t). \qquad (7.17)
\end{aligned}
$$

As $\mathring{U}_t$ is a stochastic variable the sample standard deviation of excess returns used as the denominator in the reward-to-variability ratio will be larger and hence reduces the performance index.

Use of the stock market index as a proxy for the market also introduces potential problems, resulting from measurement errors, for the Treynor and Jensen Indexes. Roll (1977) argues that, in the absence of knowledge as to true return on the market, the use of a proxy R_m at best means that CAPM is testing whether the chosen market proxy is ex ante efficient. Lee and Jen (1978) consider the issue of measurement errors in R_m. They suggest, that a means of accounting for errors which result from a narrowness in the share index compared with the true market index is the relationship:

$$R_{mt} = R'_{mt} + g + f_t \qquad (7.18)$$

where R'_{mt} is the NYSE average used as a proxy for R_{mt}, the true rate of return of the market. The g and f_t terms are a constant and a random measurement error of R_{mt} respectively, and f_t is distributed with zero mean and finite variance (p.304.). Using this formulation they deduce that the Jensen Performance Index will be affected by measurement error. They go so far as to suggest that "the use of the ordinary least squares method should also be reconsidered and the error-in-variable approach used wherever possible" (p.309.).

Roll (1978) extends his concern regarding the measurement errors involved in the proxy for R_m, arguing that the attendant errors may result in decision errors. Specifically, the suggestion is that both the Treynor and Jensen indexes are not performance indexes but rather tests of whether the market proxy is ex ante efficient. The resulting debate between Mayer and Rice (1979), Roll (1979) and Peterson and Rice (1980) reveals that there are theoretical problems in the use of the two indexes. However, at the practical level the evidence suggests that, while the same market proxy is used the performance indexes are consistent over time. Peterson and Rice (1980, p.1255.) observe: "Despite their theoretical short-comings, the portfolio evaluation tools tested are widely used in practice. We have shown in this note that little serious injustice is committed in the process."

Further difficulties arise in the calculation of all three performance indexes as a direct result of using sample statistics as parameters in the calculations. The ex ante excess return on a risky-asset must be positive except for the negative beta assets mentioned above. Unless the return on a risky asset is greater than the return on the risk-free security, no investors will hold it. Thus the return must rise to attract investors. However, it is possible to observe periods when the excess return on an asset is negative. This is due to sampling variations rather than measurement errors induced by the use of a proxy for the risk-free asset.

If sampling variation can result in negative excess-returns, then it also can result in excess returns that are too large in some periods. Sensible comparisons of portfolios subject to such perverse sample outcomes can only be obtained with the application of significance tests. Jobson and Korkie (1978) derive performance measurement moments, asymptotic distributions and propose test statistics for the Sharpe and Treynor Performance Indexes. A simulation procedure is used to investigate the power of the various significance tests. They conclude that a transformed version of the Sharpe Performance Index is the most preferred approach when at least 36 observations are used.

3. Empirical Estimation

Decisions are required regarding the definition of return and length of the time period over which performance is to be assessed before the calculation of any indexes is possible. For the purpose of the empirical examples which follow, the conventional single period return measure, presented in Chapter 2, is used. Both capital and income returns are included in the period return on asset i as:

$$R_i = (P_{it} - P_{it-1} + C_{it})/P_{it-1} \tag{7.19}$$

where P_i is the price;

C_i is net cash flow; and

t as a subscript indicates the time period.

Application of this formula is straightforward given the data sources used. These, as discussed in Chapter 4, are unit prices, indexes of property value and share market prices and dividends.

A period of twelve months is chosen as the performance interval. McIntosh and Sykes (1985), as previously mentioned, argue that short periods do not reasonably reflect the market movements for real property. Choice of a longer period reduces the number of comparisons possible. Given the limited number of observations for some series, a period of twelve months is selected as a reasonable compromise.

Returns for a range of property assets, including the listed property trusts and the various real property series are presented in Table 7.1. A lack of comparability between the various groups of assets occurs as a result of the different time periods over which the returns are measured. In order to facilitate a direct comparison, the numbers are all converted to an annual rate as shown in Table 7.2.

There is considerable variability over-time for individual assets and between securities. Within particular categories of assets such as listed property trusts it is not readily apparent that movements over-time are all in the same direction.

TABLE 7.1

RATES OF RETURN OF REAL ESTATE ASSETS

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index: monthly	-.0088	-.0123	.0409	-.0013
Statex Accumulation Property Index: monthly	.0232	.0047	.0343	.0148
Property Trusts: monthly				
ASC Property	.0206	-.0123	.0410	.0262
Canberra Commercial	.0263	.0117	-.0421	.0118
Canberra Commercial #2	.0263	.0121	.0246	-.0297
Equitable Property #1	.0222	-.0068	.0252	.0213
Equitable Property #3	.0084	-.0143	.0358	.0359
General Property	.0274	-.0003	.0335	.0047
Schroder Darling	.0206	.0102	.0265	-.0055
Stockland	.0444	.0337	.0326	.0165
Westfield	.0285	-.0110	.0309	.0090
Unlisted Property Trusts: monthly				
AFT2	.0002	-.0001	-.0004	.0003
AFT3	-.0008	.0007	-.0004	.0039
AFT4	-.0008	.0002	.0002	-.0008
AFT5	-.0008	.0006	.0005	-.0011
AFT6	-.0007	.0004	.0002	-.0007
Westpac	.0018	.0049	.0050	.0015
Real Assets				
Victorian Valuer General: annual				
Commercial	.2201	.0377	.1761	.1671
Industrial	.0841	.0284	.0039	.0621
Dwellings	.0989	.0526	.1145	.2429
Own Your Own Flat	.0581	.0569	.1846	.1818
Vacant Residential	.0382	.0029	.0914	.2108
Jones Lang Wootton: quarterly				
Total Return	.0436	.0147	.0176	.0235
Capital	.0474	.0181	.0157	.0318
Industrial Capital	.0104	-.0217	.0000	-.0027
Capital Growth	.0313	.0015	.0026	.0090
Office Capital	.0303	.0004	.0000	.0088
Real Estate Institute of Australia: monthly				
Adelaide	.0035	.0089	.0099	.0215
Brisbane	.0276	.0058	.0037	.0063
Canberra	.0039	.0028	.0241	.0113
Melbourne	.0178	.0031	.0221	.0310
Perth	.0016	.0151	.0008	.0113
Sydney	.0067	-.0065	.0188	.0095
Richard Ellis: annual				
Total Return	.1995	.1678	.1981	.2250
Capital	.1076	.0840	.1028	.1244

TABLE 7.2

ANNUALIZED RATES OF RETURN OF REAL ESTATE ASSETS

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index	-.1108	-.1580	.6177	-.0157
Statex Accumulation Property Index	.3168	.0579	.4989	.1928
Property Trusts				
ASC Property	.2772	-.1580	.6196	.3640
Canberra Commercial	.3655	.1498	-.6403	.1512
Canberra Commercial #2	.3655	.1552	.3386	-.4208
Equitable property #1	.3015	-.0847	.3481	.2878
Equitable property #3	.1056	-.1858	.5252	.5268
General property	.3832	-.0036	.4850	.0579
Schroder Darling	.2272	.1295	.3688	-.0680
Stockland	.6842	.4884	.4696	.2170
Westfield	.4010	-.1403	.4408	.1135
Unlisted Property Trusts				
AFT2	.0024	-.0012	-.0048	.0036
AFT3	-.0096	.0084	-.0048	.0478
AFT4	-.0096	.0024	.0024	-.0096
AFT5	-.0096	.0072	.0030	.0133
AFT6	-.0084	.0048	.0024	-.0084
Westpac	.0218	.0605	.0617	.0182
Real assets				
Victorian Valuer General				
Commercial	.2201	.0377	.1761	.1671
Industrial	.0841	.0294	.0039	.0621
Dwellings	.0989	.0526	.1145	.2429
Own Your Own Flat	.0581	.0569	.1846	.1818
Vacant Residential	.0382	.0029	.0914	.2108
Jones Lang Wootton				
Total Return	.1861	.0601	.1723	.0974
Capital	.2035	.0744	.0643	.1334
Industrial Capital	.0423	-.0897	.0000	-.0109
Capital Growth	.1312	.0060	.0105	.0364
Office Capital	.1268	.0016	.0000	.0356
Real Estate Institute of Australia				
Adelaide	.0428	.1122	.1255	.2908
Brisbane	.3964	.0719	.0453	.0783
Canberra	.0478	.0342	.3308	.1443
Melbourne	.2358	.0378	.2999	.4425
Perth	.0194	.1970	.0096	.1443
Sydney	.0834	-.0808	.2504	.1202
Richard Ellis				
Total Return	.1995	.1678	.1981	.2250
Capital	.1076	.0840	.1028	.1244

The excess return on each asset, using the rate of return on the thirteen-week Treasury Note as a proxy for R_{ft}, is presented in Table 7.3. In the case of the British Jones Lang Wootton series, the rate of return on the risk-free asset is approximated by the Gilt series of returns. Comparisons between these various series are not directly possible as the period over which excess returns are calculated differs. Subtraction of a constant R_f should not alter the ordering from Table 7.2 except that the Australian and British proxies for R_f differ. The difference between the British and Australian R_f reflects differing expectations regarding inflation in the two countries and this is impounded into movements in the exchange rate. Dufey and Giddy (1978, Ch. 2) discuss the relationship between nominal interest rates and exchange rates.

Table 7.4 records the annualized excess return on each asset. Similar to the position reflected in Table 7.2, there is no obvious consistent pattern in either cross-sectional or time-series results. Perhaps the Australian real estate fared a little better than the British categories which reflect an even greater preponderance of negative excess returns.

TABLE 7.3

EXCESS RETURNS OF REAL ESTATE ASSETS

	1981	1982	1983	1984
Statex Accumulation All Ordinaries				
Index: monthly	-.0212	-.0248	.0248	-.0135
Statex Accumulation Property Index	.0108	-.0078	.0221	.0026
Property Trusts: monthly				
ASC	.0082	-.0248	.0288	.0140
Canberra Commercial	.0139	-.0008	.0299	.0177
Canberra Commercial #2	.0139	-.0004	.0124	-.0419
Equitable Property #1	.0098	-.0193	.0130	.0091
Equitable Property #3	-.0040	-.0268	.0236	.0237
General Property	.0150	-.0128	.0213	-.0075
Schroder Darling	.0082	-.0023	.0143	-.0177
Stockland	.0320	.0212	.0204	.0043
Westfield	.0161	-.0235	.0187	-.0032
Unlisted Property Trusts: monthly				
AFT2	-.0122	-.0126	-.0126	-.0092
AFT 3	-.0132	-.0118	-.0126	-.0083
AFT 4	-.0132	-.0125	-.0102	-.0202
AFT 5	-.0132	-.0119	-.0117	-.0133
AFT 6	-.0107	-.0121	-.0102	-.0129
Westpac	-.0106	-.0076	-.0072	-.0107
Real assets				
Victorian Valuer-General: annual				
Commercial	.0870	-.1170	.0568	.0547
Industrial	-.0490	-.1253	-.1154	-.0503
Dwellings	-.0342	-.1021	-.0048	.1305
Own Your Own Flat	-.0750	-.0978	.0653	.0694
Vacant Residential	-.0949	-.1518	-.0279	.0984
Jones Lang Wootton: quarterly				
Total Return	.0088	-.0536	-.0511	-.0300
Shop Capital	.0126	-.0502	-.0530	-.0217
Industrial Capital	-.0244	-.0900	-.0687	-.0562
Capital Growth	-.0035	-.0668	-.0661	-.0045
Office Capital	-.0045	-.0679	-.0687	-.0447
Real Estate Institute of Australia: monthly				
Adelaide	-.0089	-.0036	-.0023	.0093
Brisbane	.0152	-.0067	-.0085	-.0059
Canberra	-.0085	-.0097	.-119	-.0009
Melbourne	.0054	-.0094	.0099	.0188
Perth	-.0108	.0026	-.0114	-.0009
Sydney	-.0057	-.0190	.0066	-.0027
Richard Ellis: annual				
Total Return	.0664	.0131	.0788	.1126
Capital Return	-.0255	-.0707	-.0165	.0120

TABLE 7.4

ANNUALIZED EXCESS RETURNS OF REAL ESTATE ASSETS

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index	-.2862	-.3418	.4044	-.1746
Statex Accumulation Property Index	.1376	-.0977	.2999	.0317
Property Trusts				
ASC	.1030	-.3418	.4059	.1815
Canberra Commercial	.1802	-.0096	.4240	.2343
Canberra Commcerial #2	.1802	-.0048	.1594	-.6366
Equitable Property #1	.1241	-.2578	.1677	.1148
Equitable Property #3	-.0491	-.3736	.3230	.3246
General Property	.1957	-.1649	.2878	-.0938
Schroder Darling	.1030	-.0280	.1858	-.2343
Stockland	.4594	.2862	.2742	.0528
Westfield	.2113	-.3214	.2489	-.0390
Unlisted Property Trusts				
AFT2	-.1566	-.1622	-.1622	-.1162
AFT3	-.1705	-.1512	-.1622	-.1043
AFT4	-.1705	-.1608	-.1295	-.2712
AFT5	-.1705	-.0231	-.1498	-.1718
AFT6	-.1498	-.1552	-.1295	-.1663
Westpac	-.1348	-.0952	-.0899	-.1362
Real assets				
Victorian Valuer-General				
Commercial	.0870	-.1170	.0568	.0547
Industrial	-.0490	-.1253	-.1154	-.0503
Dwellings	-.0342	-.1021	-.0048	.1305
Own Your Own Flat	-.0750	-.0978	.0653	.0694
Vacant Residential	-.0949	-.1518	-.0279	.0984
Jones Lang Wootton				
Index	.0356	-.2323	-.2205	-.1255
Shop Capital	.0514	-.2164	-.2295	-.0897
Industrial Capital	-.1012	-.4116	-.3045	-.2445
Capital Growth	.0141	-.2952	-.2918	-.0182
Office Capital	-.0182	-.3006	-.3045	-.1911
Real Estate Institute of Australia				
Adelaide	-.1122	-.0440	-.0276	.1175
Brisbane	.1984	-.0834	-.1069	-.0732
Canberra	-.1069	-.1228	.1526	-.0109
Melbourne	.0667	-.1188	.1255	.2504
Perth	-.1376	.0317	-.1457	-.0109
Sydney	-.0706	-.2535	.0821	-.0329
Richard Ellis				
Total Return	.0664	.0131	.0788	.1126
Capital Return	-.0255	-.0707	-.0165	.0120

Standard deviations of the rates of return are recorded in Table 7.5. It is not possible to compute the standard deviation each year for the annual data. Accordingly, the table omits those assets for which annual observations only are available. There is, once again, a considerable variation in this statistic for individual assets between years. This is not surprising given the variability of returns from one year to the next exhibited in Table 7.1.

TABLE 7.5

STANDARD DEVIATION OF RETURNS FOR REAL ESTATE ASSETS

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index : annual	.0470	.0553	.0489	.0512
States Accumulation Property Index: annual	.0404	.0235	.0354	.0324
Property Trusts: annual				
ASC	.0732	.0523	.1026	.0736
Canberra Commercial	.0749	.0242	.2028	.0373
Canberra Commercial #2	.0749	.0494	.0338	.1517
Equitable Property #1	.1276	.1021	.0283	.0655
Equitable Property #3	.0512	.0238	.0748	.1121
General Property	.0499	.0455	.0689	.0586
Schroder Darling	.0589	.0480	.0342	.0252
Stockland	.0996	.1316	.0658	.0456
Westfield	.0888	.0592	.0518	.0507
Unlisted Property Trusts : annual				
AFT2	.0207	.0223	.0320	.0258
AFT3	.0194	.0200	.0120	.0120
AFT4	.0153	.0185	.0193	.0175
AFT5	.0206	.0231	.0325	.0207
AFT6	.0619	.0204	.0192	.0149
Westpac	.0169	.0270	.0058	.0034
Real assets				
Jones Lang Wootton: annual				
Index	.0131	.0228	.0066	.0066
Shop Capital	.0279	.0261	.0096	.0252
Industrial Capital	.0234	.0192	.0045	.0031
Capital Growth	.0127	.0221	.0052	.0106
Office Capital	.0055	.0316	.0049	.0034

Real Estate Institute of Australia: annual				
Adelaide	.0341	.0349	.0243	.0705
Brisbane	.0664	.0448	.0284	.0468
Canberra	.0727	.0313	.0572	.0336
Melbourne	.0551	.0427	.0604	.0447
Perth	.0378	.0459	.0124	.0297
Sydney	.702	.0486	.0567	.0576

The Sharpe Reward-to-Variability Performance Index calculated from Tables 7.3 and 7.5 is presented in Table 7.6. The actual period excess returns are utilized, rather than the annualized excess returns. This choice is consistent with the use in the denominator of standard deviations calculated from actual period rates of return. While calculation of annualized rates of return is straightforward, the same relatively simple transformation cannot be applied to the second moment.

From Table 7.6 it is apparent that the assets vary considerably in performance over time. Within the various groups, there is a marked change in ranking from year to year. The assets which have the largest performance index in one year do not have the largest or in most instances anything approaching the largest score in the adjoining year(s).

TABLE 7.6

SHARPE'S REWARD-TO-VARIABILITY PERFORMANCE INDEX (PI_s)

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index	-.4511	-.4485	.5869	-.2637
Statex Accumulation Property Index	.2673	-.3319	.6243	.0802
Property Trusts				
ASC	.1120	-.4742	.2807	.1902
Canberra Commercial	.1856	-.0331	.1474	.4745
Canberra Commercial #2	.1856	-.0081	.3669	-.2762
Equitable Property #1	.0768	-.1890	.4594	.1389
Equitable Property #3	-.0781	-1.1261	.3155	.2114
General Property	.3006	-.2813	.3091	-.1280
Schroder Darling	.1392	-.0479	.4181	-.7024
Stockland	.3213	.1611	.3100	.0943
Westfield	.1813	-.3970	.3610	-.0631
Unlisted Property Trusts				
AFT2	-.5894	-.5650	-.3938	-.3566
AFT3	-.6804	-.5900	-1.0500	-.6917
AFT4	-.8627	-.6757	-.5285	-1.1543
AFT5	-.6408	-.5152	-.3600	-.6425
AFT6	-.6923	-.5931	-.5313	-.8658
Westpac	-.6272	-.2815	-1.2414	-3.1471
Real Assets				
Jones Lang Wootton				
Index	.6718	-2.3509	-7.7424	-4.5455
Shop Capital	.4516	-1.9234	-5.5208	-.8611
Industrial Capital	-1.0427	-4.6875	-15.2667	-18.1290
Capital Growth	-.2756	-3.0226	-12.7115	-0.4245
Office Capital	-.8182	-2.1487	-14.0204	-13.1471
Real Estate Institute of Australia				
Adelaide	-.2610	.1032	-.0947	.1319
Brisbane	.2289	-.1496	-.2993	-.1268
Canberra	-.1169	-.3099	.2080	-.0268
Melbourne	.1429	-.2201	.1639	.4206
Perth	-.2857	.0566	-.0919	-.0303
Sydney	-.0812	-.3909	.1164	-.0469

The excess return figures shown in Table 7.3 are used for the compilation of the Treynor Reward-to-Volatility Index tabulated as Table 7.7. The choice of excess returns based on actual intervals rather than annualized excess returns as the numerator is simply to facilitate comparison with the Sharpe Index. Use of the alternative figures provides an opportunity for comparison over a larger range of assets but there are insufficient observations on which to estimate beta.

The procedure adopted is to use the four years of data which involves 47 observations (1 x 11 + 3 x 12) for the two Statex series and the property trusts, 16 observations (4 x 4) for the Jones Lang Wootton series and 44 observations (4 x 11) for the Real Estate Institute of Australia series, to calculate a Bayesian beta for each asset. It is considered that 11, 4 or 12 observations on a per annum basis are too few as a basis for estimating beta. The implicit assumption is made that beta remains stable over the period. In light of the earlier discussion regarding estimated betas not being statistically different from zero, the Bayesian betas presented in Table 7.8 suffer from the same problem. The estimating equations are not very satisfactory.

TABLE 7.7

TREYNOR'S REWARD-TO-VOLATILITY PERFORMANCE INDEX (PI_T)

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index	-.0212	-.0248	.0287	-.0135
Statex Accumulation Property Index	-.0723	-.0846	.0979	-.0461
Property Trusts				
ASC	.0208	-.0630	.0732	.0356
Canberra Commercial	Na	.0020	Na	Na
Canberra Commercial #2	.2271	-.0065	.2026	-.6846
Equitable Property #1	.0838	.1650	.1111	.0778
Equitable Property #3	-.0438	-.2932	.2582	.2593
General Property	.0405	-.0345	.0575	.0373
Schroder Darling	.0606	-.0170	.2056	-.1307
Stockland	.0915	-.0606	-.0583	-.0123
Westfield	.0483	-.0706	.0562	-.0096
Unlisted Property Trusts				
AFT2	.2490	.2575	.2575	.1878
AFT3	.2767	.2474	.2642	.1740
AFT4	.3483	.3298	.2691	.5330
AFT5	.2677	.2414	.2373	.2698
AFT6	-.2053	-.2123	-.1789	-.2263
Westpac	.7260	.5205	.4932	.7329
Real Assets				
Jones Lang Wootton				
Index	Na	1.1832	1.1280	.6623
Shop Capital	Na	1.1205	1.1830	.4844
Industrial Capital	.5316	1.9608	1.4967	1.2257
Capital Growth	.0776	1.5055	1.4656	.0998
Office Capital	.0976	1.4729	1.4902	.9696
Real Estate Institute of Australia				
Adelaide	-.5298	-.2143	-.1369	.5536
Brisbane	Na	.1314	.1667	.1157
Canberra	.2881	.3288	Na	.0305
Melbourne	Na	.6714	Na	Na
Perth	.1768	Na	.1866	.0147
Sydney	3.5625	11.9375	Na	1.6875

Na: not applicable due to positive excess returns and a negative beta

TABLE 7.8

BAYESIAN BETAS OF REAL ESTATE ASSETS

	Beta
Statex Accumulation Property Index	.29313
Property Trusts	
ASC	.39353
Canberra Commercial	-.06957
Canberra Commercial #2	.06117
Equitable Property #1	.11696
Equitable Property #3	.09136
General Property	.37071
Schroder Darling	.13541
Stockland	.34972
Westfield	.33304
Unlisted Property Trusts	-.04900
AFT2	-.04774
AFT3	-.04774
AFT4	-.03794
AFT5	-.04929
AFT6	.05697
Westpac	-.01460
Real Assets	
Jones Lang Wootton	
Index	-.04525
Shop Capital	-.04484
Industrial Capital	-.04585
Capital Growth	-.04511
Office Capital	-.04609
Real Estate Institute of Australia	
Adelaide	.01679
Brisbane	-.05103
Canberra	-.02947
Melbourne	-.01396
Perth	-.06112
Sydney	-.00164

The computation of the Jensen Index, reported in Table 7.9, suffered from more severe difficulties than those experienced in calculating the Treynor Index. Specifically, the almost total lack of reliability attributable to the estimated equations when only 4 years of observations are used is aggravated by decreasing the time-series sample to 11 or 12 observations. The explanatory power of the equations are minimal, the Durbin-Watson statistic indicates the likely existence of autocorrelation in the majority of instances and the parameter estimates are not significant. Accordingly, the results presented in the table are at best questionable.

TABLE 7.9

JENSEN'S PERFORMANCE INDEX (PI_J)

	1981	1982	1983	1984
Statex Accumulation Property Index	-1.2140	-0.6302	-.5640	-1.1521
Property Trusts				
ASC	-0.8573	-0.5448	-.0961	-0.9306
Canberra Commercial	-1.6662	-0.9948	-1.6328	-1.2802
Canberra Commercial #2	-1.0071	-0.8604	-1.0620	-1.9435
Equitable Property #1	-0.3892	-0.5124	-0.8284	-2.3820
Equitable Property #3	-1.3215	-1.1702	-0.9834	-1.7580
General Property	-1.1967	-0.6632	0.1415	-0.9553
Schroder Darling	-1.1303	-0.4708	-1.0541	-1.3923
Stockland	-1.4090	-1.1692	-0.1541	-0.6055
Westfield	-0.5968	-0.5787	-0.5486	-0.8790
Unlisted Property Trusts				
AFT2	-1.1744	-1.1986	-1.4199	-0.7488
AFT3	-1.1440	-0.9966	-0.9717	-1.1927
AFT4	-1.2367	-1.1787	-1.2110	-0.9126
AFT5	-1.2976	-1.0810	-1.0450	-1.3408
AFT6	-1.2564	-0.9930	-0.9622	-1.0969
Westpac	-1.4482	-1.0202	-1.0196	-1.1757
Real Assets				
Real Estate Institute of Australia				
Adelaide	-0.5859	-0.8073	-1.2404	-0.5820
Brisbane	-1.2776	-1.1006	-0.7658	-1.0944
Canberra	-0.5743	-1.0020	-1.1389	-0.6043
Melbourne	-1.2711	-0.9576	-1.0697	-1.7428
Perth	-0.4706	-1.3042	-0.9106	-1.4244
Sydney	-0.9816	-1.0126	-1.3978	-1.5059

As these calculated numbers, for the three indexes, are all that is available it is worthwhile for completeness to compare these measures of performance. This undertaking is done in the light of the dubious values assigned to assets as their respective index scores. Table 7.10, which runs for 4 consecutive pages, contains a ranking of assets according to each index in each of the four years.

The British Jones Lang Wootton series are not included in the comparison with the Australian assets but are ranked within that group. It is apparent that the rankings in each year are quite different between indexes. This is formally tested using the Kendall coefficient of concordance statistic (W). Formally, the test is that:

H_o : the ranking of assets according to PI_S, PI_T and PI_J are the same;

H_A : the ranking of assets according to PI_S, PI_T and PI_J are not the same.

TABLE 7.10

REAL ESTATE ASSET RANKING BY PERFORMANCE INDEX - 1981

	PI_S	PI_T	PI_J
Statex Accumulation All Ordinaries Index	17	16	-
Statex Accumulation Property Index	3	18	13
Property Trusts			
ASC	10	15	6
Canberra Commercial	5	Na	22
Canberra Commercial #2	5	8	8
Equitable Property #1	11	11	1
Equitable Property #3	12	17	19
General Property	2	14	12
Schroder Darling	9	12	9
Stockland	1	10	20
Westfield	7	13	5
Unlisted Property Trusts			
AFT2	18	7	11
AFT3	21	5	10
AFT4	23	3	14
AFT5	20	6	18
AFT6	22	19	15
Westpac	19	2	21
Real Assets			
Jones Lang and Wootton			
Index	a	Na	-
Shop Capital	b	Na	-
Industrial Capital	e	a	-
Capital Growth	c	c	-
Office Capital	d	b	-

TABLE 7.10 continued

Real Estate Institute of Australia			
Adelaide	15	20	4
Brisbane	4	Na	17
Canberra	14	4	3
Melbourne	8	Na	16
Perth	16	9	2
Sydney	13	1	7

Na: not applicable due to positive excess returns and a negative beta

ASSET RANKING BY PERFORMANCE INDEX - 1982

	PI_S	PI_T	PI_J
Statex Accumulation All Ordinaries Index	16	15	-
Statex Accumulation Property Index	13	19	5
Property Trusts			
ASC	14	11	4
Canberra Commercial	4	7	9
Canberra Commercial #2	3	8	7
Equitable Property #1	8	4	2
Equitable Property #3	15	14	14
General Property	10	10	5
Schroder Darling	5	9	1
Stockland	1	6	13
Westfield	13	12	3
Unlisted Property Trusts			
AFT2	19	6	21
AFT3	20	7	12
AFT4	22	4	20
AFT5	18	8	16
AFT6	21	20	10
Westpac	11	3	15
Real Assets			
Jones Lang and Wootton Index	c	d	-
Shop Capital	a	e	-
Industrial Capital	e	a	-
Capital Growth	d	b	-
Office Capital	b	c	-
Real Estate Institute of Australia			
Adelaide	6	13	6
Brisbane	7	5	12
Canberra	11	3	10
Melbourne	9	2	8
Perth	2	Na	15
Sydney	12	1	11

Na: not application due to positive excess returns and a negative beta

TABLE 7.10 continued

ASSET RANKING BY PERFORMANCE INDEX - 1983

	PI_S	PI_T	PI_J
Statex Accumulation All Ordinaries Index	1	7	-
Statex Accumulation Property Index	2	13	5
Property Trusts			
ASC	10	14	2
Canberra Commercial	13	Na	22
Canberra Commercial #2	5	9	15
Equitable Property #1	3	512	7
Equitable Property #3	7	4	11
General Property	9	16	1
Schroder Darling	4	8	14
Stockland	8	15	3
Westfield	6	17	4
Unlisted Property Trusts			
AFT2	19	5	21
AFT3	22	3	9
AFT4	20	2	18
AFT5	18	6	13
AFT6	21	19	8
Westpac	23	1	12
Real Assets			
Jones Lang and Wootton			
Index	b	e	-
Shop Capital	a	d	-
Industrial Capital	e	a	-
Capital Growth	c	c	-
Office Capital	d	b	-
Real Estate Institute of Australia			
Adelaide	16	18	19
Brisbane	17	11	6
Canberra	10	Na	17
Melbourne	12	Na	16
Perth	15	10	10
Sydney	14	Na	20

Na: not applicable due to positive excess returns and a negative beta

TABLE 7.10 continued

ASSET RANKING BY PERFORMANCE INDEX - 1984

	PI_S	PI_T	PI_J
Statex Accumulation All Ordinaries Index	15	17	-
Statex Accumulation Property Index	8	18	11
Property Trusts			
ASC	4	12	7
Canberra Commercial	1	Na	14
Canberra Commercial #2	16	21	21
Equitable Property #1	5	10	22
Equitable Property #3	3	6	20
General Property	14	11	8
Schroder Darling	20	19	16
Stockland	7	15	3
Westfield	12	16	5
Unlisted Property Trusts			
AFT2	17	7	4
AFT3	19	8	13
AFT4	22	4	6
AFT5	18	5	15
AFT6	21	20	10
Westpac	23	2	12
Real Assets			
Jones Lang and Wootton			
Index	c	c	-
Shop Capital	b	d	-
Industrial Capital	e	a	-
Capital Growth	a	e	-
Office Capital	d	b	-
Real Estate Institute of Australia			
Adelaide	6	3	1
Brisbane	13	9	9
Canberra	9	13	2
Melbourne	2	Na	19
Perth	10	14	17
Sydney	11	1	18

Na: not applicable due to positive excess returns and a negative beta

The Kendall-test statistic W and significance level is presented in Table 7.11. If the significance level is equal to or less than 0.05, then the null hypothesis cannot be rejected at the conventional 5% level. As can be seen the alternative hypothesis is accepted in all instances.

The lack of concordance between the Treynor and Jensen Indexes is not expected as each is a linear transformation of the other. The explanation lies in the different interval lengths over which the asset betas are calculated. The Jensen Index is calculated for one year at a time while the Treynor Index uses a beta estimated from four years of observations.

The concordance within specific indexes over the four years is also scrutinized using the Kendall-test statistic. As reported in Table 7.10 above the ranking according to each individual index varies considerably from year to year. The lack of intertemporal concordance is confirmed in the results presented as Table 7.12.

TABLE 7.11

CONCORDANCE OF PERFORMANCE INDEXES

Year	W	Significance
1981	.1735	.9877
1982	.4107	.6464
1983	.6607	.1849
1984	.4750	.5030

TABLE 7.12

INDEX CONCORDANCE 1981-84

Index	W	Significance
Sharpe	.2228	.5682
Treynor	In	In
Jensen	.3373	.1692

In: insufficient observations for calculation

4. Non-CAPM Performance Measures

If the market is not considered to be efficient, then the CAPM approach to performance assessment cannot be shown as theoretically superior to all alternative measures. The absence of an equilibrium pricing model means that it is not possible to deduce conceptually an appropriate model. Members of the real estate industry implicitly reject the notion of an efficient property market by adopting the stance on performance measures which they hold. Published data on property performance, emanating from within the "real estate industry" and the financial press, do not adopt CAPM based measures. In the majority of instances reliance is placed only on return, variously defined, and no quantitative notion of risk is employed. Some qualitative discussions of risk aspects related to individual assets do appear in the financial media.

A popular approach for evaluating the performance of an asset is to consider how much an initial investment, of say a thousand dollars or some multiple thereof, has accrued to by the end of the period. This approach may be considered reasonable when the comparison of performance is between assets of similar risk. Koch (1983) uses this approach in evaluating the performance of property trusts. However, the initial starting period differs for individual trusts thus the increment, ending value minus beginning value, relates to non-standard intervals.

Peters (1985) uses a similar approach as the first component of an analysis. Next, assumptions are made regarding dividend, interest or net rental receipts and these are added periodically to the investment and reinvested at the same rate of interest over time. The rate of return over the total of the intervals is calculated as an effective annual rate. This in effect averages out subperiod variations in return, invalidating the possibility of a true comparison of like with like. Further, Peters compares unlike assets including: Gold; Australian Savings Bonds; 180 Day Bank Bills; and Shares (Actuaries Accumulation Index) among others. The risk differential on these various securities is ignored and no adjustment is made to account for this aspect in the performance evaluation.

Additional problems arise in dealing with both the capital appreciation and the income flow elements if taxation is taken into consideration. The usual approach is to consider gross returns. Investment Measurement Services, a joint operation of the consulting actuarial firms, Palmer, Trahair, Owen and Whittle/Towers, Perrin, Forster and Crosby with E S Knight and Co produce investment performance reports. The criterion used for monitoring property trust performance is based on the investment performance for each dollar contributed. The dollar investment performance is based on "the performance on $100,000 invested at the beginning for the surveyed period and the units realised at the end (allowing for brokerage, commission, initial charges to the investor and the difference between buying and selling prices etcetera)" [The Weekend Australian (1983, p.17.)].

The United Kingdom Society of Investment Analysts (1974) advocates three monthly periods as appropriate for performance measurement purposes. The Society suggests that comparisons for performance evaluation purposes should be undertaken against a notional fund which has similar compositions. "The use of the notional fund is a fairly similar concept for testing the equity portion of a portfolio by comparing the change in value of a notional fund which invests only in units of, for example, the F.T.A. All Share Index" (p.8.). Again this represents an implicit attempt to compare like with like but does not explicitly attempt to value the risk premiums.

Sack (1983, p.390.) suggests the three month period is too short and comments that "Real estate requires patience and cannot be evaluated on the basis of quarter-to-quarter operating results."

He advocates a one to two year period and proposes that changes in value are important. Value is determined from income according to:

$$\text{Value} = \frac{\text{Stabilized net income}}{\text{Capitalization rate}} \tag{7.20}$$

where the:

> capitalization rate is obviously akin to yield on bonds and is selected by the appraiser on the basis of her or his reading of the market. Stabilized net income is kin to dividends or interest payments, except that it has been adjusted for temporary aberrations in the rental market or rental and for differences between rents received under current leases and market rents that could be achieved if those leases expired.

Cole, Guilkey and Miles (1986, p.426.) note "that all appraisals should contain discounted cash flow analysis but some appraisers still rely upon the capitalized value of stabilized net operating income."

Surveys published by the British firms of Michael Laurie and Partners in conjunction with the Economists Intelligence Unit, and those of Rowe and Pitman utilize an annual return statistic. The latter in their 1984 report consider dividends per share and dividend growth, in some detail, for property companies vis-a-vis the rent index. All such comparisons continue to ignore risk. Although several methods are used for return calculation, of varying degrees of sophistication, the measures do not consider risk.

One noticable endeavor to account directly for risk is the Jones Lang Wootton surveys of property performance. In the 1982 "Property Investment Performance Over 20 Years" the standard deviation is published. This, at a minimum, permits the calculation of the coefficient of variation (CV) according to:

$$CV_{it} = SD(R_i)/R_{it} \tag{7.21}$$

where $SD(R_i)$ is the standard deviation of the rates of return on security i; and

R_i is the rate of return for the period.

Although a relatively simple measure, which is not founded on any theory of asset pricing, the coefficient of variation does permit a ranking to be made. Table 7.13 reports the coefficients of variation for the assets subjected to the performance index calculations in the previous Section. The ranking of assets within groups on a year by year basis reflects considerable instability. Some assets tend to remain stable over the four years while others vary by sizable amounts.

TABLE 7.13

COEFFICIENT OF VARIATION

	1981	1982	1983	1984
Statex Accumulation All Ordinaries Index	-5.3409	-4.4959	1.1956	-39.3846
Statex Accumulation Property Index	1.7414	5.0000	1.0028	2.1892
Property Trusts: monthly				
ASC	3.5534	-4.2520	2.5024	2.8092
Canberra Commercial	2.8479	2.0684	-4.8171	3.1610
Canberra Commercial #2	2.8479	4.0826	1.3740	-5.1077
Equitable Property #1	5.7477	-15.0147	1.1230	3.0751
Equitable Property #3	6.0952	-1.6643	2.0894	3.1226
General Property	1.8212	-151.6667	2.0567	12.4681
Schroder Darling	2.8592	4.7059	1.2906	-4.5818
Stockland	2.2432	3.9050	2.0184	2.7636
Westfield	3.1158	-5.3818	1.6764	5.6333
Unlisted Property Trust				
AFT2	103.5000	-223.0000	-80.0000	86.0000
AFT3	-24.2500	28.5714	-30.0000	3.0769
AFT4	-19.1250	92.5000	96.5000	-21.8750
AFT5	-25.7500	38.5000	65.0000	-18.8182
AFT6	24.1429	51.0000	96.0000	-21.2857
Westpac	9.3889	5.5102	1.1600	2.2667
Real Assets				
Jones Lang Wootton: quarterly				
Index	.3005	1.5510	.3750	.2809
Shop Capital	.5886	1.4420	.6115	.7925
Industrial Capital	2.2500	-0.8848	Undefined	-1.1481
Capital Growth	.4058	14.7333	2.0000	1.7778
Office Capital	.1815	79.00	Undefined	.3864
Real Estate Institute of Australia: monthly				
Adelaide	9.74	5.03	2.45	3.28
Brisbane	2.41	7.72	7.68	7.43
Canberra	18.64	11.18	2.37	2.97
Melbourne	3.10	13.77	2.73	1.44
Perth	23.63	3.04	155.13	2.63
Sydney	10.48	-7.48	3.02	6.06

Sydney sharebroking firm Norths, the announcement effect of whose "Review" is discussed in Chapter 6, produces a performance index for property trusts. The approach adopted differs from the purely return based assessments in that a number of other variables are also taken into consideration. Norths report (1984, p.37.) that:

> We have attempted to rate all or most of the property trusts - listed and unlisted on a scale from 1 to 10 and have considered a variety of factors when arriving at the rating. These factors included the calibre of the management team, the size of the trust, quality of properties, leases, and also past performance where applicable.

The actual weightings ascribed to each of these factors are unknown and it is impossible to ascertain the consistency with which the weights are applied in the evaluation of each trust.

For comparative purposes Table 7.14 presents, for the trusts covered in the analysis above and in Norths' "Review", rankings according to the various indexes. As is readily apparent there is a general lack of concordance between these indexes. This is formally tested using the Kendall-test statistic and the null hypothesis that the rankings are the same is rejected for the group as a whole and for pairwise comparisons.

TABLE 7.14

1984 ASSET RANKING BY PERFORMANCE INDEX

	Norths	CV	PI_S	PI_T	PI_J
ASC	5	2	3	4	3
Canberra Commercial	5	5	8	8	5
Canberra Commercial #2	5	6	1	Na	8
Equitable Property #1	9	3	4	2	9
Equitable Property #3	8	4	2	1	7
General Property	1	8	7	3	4
Schroder Darling	2	6	9	7	6
Stockland	2	1	5	5	1
Westfield	2	7	6	6	2

5. Summary

The capital asset pricing model is an equilibrium statement of the relative prices of assets. All securities in equilibrium earn a return commensurate with their market risk. In diagrammatic terms this is expressed as a requirement, that all assets plot on the security market line. This relationship provides a benchmark against which the performance of an asset or portfolio of assets may be assessed. If returns above or below the SML, called abnormal returns, are obtained in a period, then these represent an amount beyond that expected for a security of that particular level of market risk. This abnormal return is either positive, suggesting a better than equilibrium return or negative representing a less than expected return.

In this Chapter it was mentioned that abnormal returns may occur as stochastic events. In such instances of temporary disequilibrium the abnormal return, for individual securities and portfolios, measured in successive periods will fluctuate from positive values to negative values in a random manner. Long-term disequilibrium, of a consistent form, implies that the market is inefficient. Specifically, the form of inefficiency is attributable to some traders in the market having access to superior information. Formally, this is discussed in the context of strong-form inefficiency of the market.

Investigation of the performance of assets in order to rank them in terms of their capacity to generate an abnormal return requires performance measures consistent with the underlying statement of equilibrium. Three performance measures derived from CAPM are explained and empirically demonstrated. The evidence presented in the tables incorporating these performance indexes is conflicting. Statistical tests comparing the three indexes revealed a low level of concordance between them.

Consideration was also given to various alternative measures of performance which appear particularly in the financial press. The major criticism of those methods is the lack of explicit concern with risk as a parameter in their compilation. For this reason they are, in general, thought to be unsatisfactory either as a ranking procedures or as evidence suggesting the market may be beaten. An exception to this group is the index composed by Norths mentioned previously in Chapter 6.

Risk is included in the North Index but details specifying how it is actually incorporated are unknown. The ranking awarded a sample of property trusts does not correspond to the ranking under the CAPM derived measures. This is not surprising. The market did not appear interested in the rankings at the time of the release of the "Review", as discussed in Chapter 6, and it appears that the market prefers its own assessments. The appraisal based measures of performance and valuation do not seem to influence the market. This matter is considered further in Chapter 8.

The evidence provided suggests that neither financial real estate nor physical real estate assets earn consistent positive abnormal returns. When risk is incorporated into the analysis the physical real estate returns do not compare in an especially favorable light with their financial counterparts.

The inability of any asset or portfolio to consistently generate positive abnormal returns does not run counter to the strong-form EMH. A final point to be made is again to note the low statistical significance which may be attributed to the results. Nevertheless, the consistent difference between financial and physical real estate returns, when adjusted for risk, is consistent with the original observations which motivated the research direction of this thesis.

CHAPTER EIGHT

CAPITAL ASSET PRICING MODEL AND REAL ESTATE EVALUATION

Introduction

A widely observed, but unresolved, difference between the capitalized share value of listed property trusts and the net tangible assets of those trusts provided motivation for enquiring further into the discrepancy. Specifically, the research approach adopted was to evaluate the applicability of one extensively used model of asset pricing to both financial real estate assets and physical real estate assets. The rationale for that procedure lay in the assumption that the property trust shares are a financial representation of the underlying real asset. Accordingly, the same factors should determine value and in equilibrium there should be a close correlation between them. Thus, the enquiry proceeded as a thorough analysis of the applicability of CAPM to these two forms of real estate securities in the context of the associated requirements of market efficiency.

An explanation suggested, in several conversations with valuers and persons involved in the real estate industry, is that property values reflect a long run perspective while the share market reflects short term changes in expectations. If this is an accurate assessment, then it is to be expected that differences will emerge as between the share price of property trusts and the underlying asset valuations.

1. Financial and Physical Real Estate Valuation

Unlisted property trusts reflect a unit valuation based on this long-term perspective of market value. Unit prices are determined as a function of the trust's asset valuations and thus go up and down with revaluations of property held by the trust. Correlation of the returns on unlisted property trusts with returns on listed property trusts confirms the view that they do not move together. A pairwise comparison of each unlisted property trust with each listed trust indicates a very low degree of correlation.

Three measures of correlation are used to test:

Ho: that the return on unlisted property trust j is uncorrelated with the return on listed property trust i, over the same period of forty four months.

The Kendall correlation coefficient and Spearman correlation coefficient, both nonparametric statistics, and Pearsons correlation coefficient, a parametric statistic, are used. A significant degree of concordance is exhibited between the three coefficients. It is appropriate, therefore, to rely on the more powerful parametric statistic as the returns are known to be normally distributed.

It is apparent from Table 8.1, where the Spearman correlation coefficients and respective probability values are reported, that there is a low degree of correlation between the returns of listed and unlisted property trusts. The null hypothesis of no correlation cannot be rejected at the 5% significance level. This supports the industry view, using the term loosely, that the value of listed property trusts move differently to the "market" valuations of the underlying assets as appraised by the professional valuers. However, there are a number of problems which remain before this simplistic explanation may be fully embraced.

TABLE 8.1

CORRELATION COEFFICIENTS OF LISTED AND UNLISTED PROPERTY TRUSTS

	Canberra Commercial	Equitable #1	Equitable #3	General Property	ASC	National Property	Schroder Darling	Stockland	Westland
AFT2	.0225	-.0066	.1238	.0049	-.1851	.1774	.0048	.0213	.0056
	p= .442	p= .483	p= .212	p= .487	p= .115	p= .125	p= .488	p= .445	p=. 486
AFT3	.0473	-.0171	-.0489	.1191	.0871	.0497	-.0635	.2280	-.0076
	p= .380	p= .456	p= .376	p= .221	p= .287	p= .374	p= .341	p= .068	p= .480
AFT4	.0017	-.0429	.1149	.0483	-.2088	.1660	.0064	.0021	.0450
	p= .496	p= .391	p= .229	p= .378	p= .087	p= .141	p= .484	p= .495	p= .386
AFT5	-.0509	.2701	.2247	-.1218	.0988	-.1425	.1038	-.1188	-.3501
	p= .371	p= .038	p= .071	p= .215	p= .262	p= .178	p= .251	p= .221	p= .010
AFT6	.0467	-.0223	-.0303	.1142	.1567	.0303	-.2146	.2417	-.0142
	p= .382	p= .443	p= .423	p= .230	p= .155	p= .423	p= .081	p= .057	p= .464
WESTPAC	.0514	.1739	-.1124	-.1414	-.0034	-.1533	-.0083	-.0222	-.1029
	p= .370	p= .130	p= .234	p= .180	p= .491	p= .160	p= .479	p= .471	p= .253

The stock market index, employed as a proxy for the market, does exhibit variability over time. This is the result of fluctuations in the demand and supply schedules, embodying the aggregate expectations of participants in the market at particular instants of time. The extent to which these observed variations are the result of amended short-run expectations is unknown. However, the economic value of an asset is the present value of expected future income accruing to the holder of the asset, and it is reasonable to assume that in a competitive and active market the prices are an accurate reflection of present value. Changes in price reflect a change in the assessment of the security's present value.

As present value is the discounted value of future cash receipts an upward or downward movement may relate to changed expectations regarding quite distant prospects. All that may be reasonably suggested is that the financial market, where trades are regularly occurring, may move quickly to impound changes in expectations. The real property market, where trades take a long period in which to be completed, may be slower to reflect altered expectations.

Listed property trusts do not move with the market. As demonstrated with numerous regressions, the correlation between returns on individual trusts and the return on the market index is almost zero. The uniformly low estimates of beta are reported for ordinary least squares, generalized least squares, and seemingly unrelated regressions. On the evidence available it is not reasonable to conclude that listed property trusts fluctuate with market movements.

The fundamental conflict as to how the property valued in terms of its cash flows and shares valued on the same data may have different values is not easily resolved. Mayo (1985) discussing the desirability of purchasing REIT shares which are at discount against net tangible assets, directs attention to the cash flows involved. He notes that the dividends of REITs tend to fluctuate unlike the dividends of many firms. Perhaps the valuation of shares is overly difficult with fluctuating dividends and thus unreliable. Three points need to be considered. First, the reasons why REIT dividends might fluctuate more widely than other firms and whether this is also true for Australian property trusts. Second, the bearing dividends have on the determination of the value of a share.

Third, depending on the outcome of enquiries on the first and second point it may be necessary to empirically verify the initial statement in the Australian context.

Shevlin (1982) investigates the applicability of a number of dividend models in Australia. He concludes that companies do pursue a target dividend rate. In terms of an international comparison the rate is lower than in the United States but it does vary up and down in response to changes in earnings levels more quickly. Although profits may go up and down over time the dividends, in terms of cents per share, will tend to remain stable.

This form of dividend smoothing is not available to REITs which are required to payout all profit in order to maintain their status as exempt from income taxation. Provisions in the Australian taxation legislation which relate to the status of property trusts have recently altered. The promulgation, in September 1985, of amendments to sections 102R and 102S effectively remove the exemption from all new property trusts and all existing property trusts as of July 1, 1988. Within the period 1980-85 a situation of no liability for taxation when income was fully distributed existed for property trusts. Mention of this situation is made in the annual report of the property trusts [Stockland Trust's Annual Report for 1985 p.24. and PA Property Trust's Annual Report 1985 p.8 are examples]. The position is similar to that prevailing for REITs.

The comparative variability of property trust dividends against other industry groups is studied by Locke and Langfield-Smith (1986b). Random samples are drawn from each industry grouping, based on the Australian Associated Stock Exchange classification, and the variance of dividends by company are computed. These are then ranked by matched pairs to see which industry sample had the largest number of high variance dividends. Fourteen industry groups are used and property trusts obtain a rank of seventh which is the middle of the range. A strong conclusion that dividends in property trusts fluctuate relatively more than for other firms is not supported by the findings in that study.

There appears to be little encouragement for the proposition that the difficulties faced by investors in calculating the intrinsic value of property trust shares is so large that the market prices are an unrealistic consensus of real value. The empirical evidence is to the contrary, and suggests that both property trust dividends and income do not fluctuate widely. The relative smoothness of the income to property owners is reflected in the low betas of property trusts. The earnings of property trust shareholders are not influenced by the ups and downs of the market.

Figures for prime office rents, in the six mainland capital cities, reported in Property Review (October, 1985 p.26.) indicate considerable growth in the period 1980-85. Yield on prime office buildings in those years, according to JLW figures [Property Review (July, 1986 p.7.)], remain relatively stable. Capital values appreciated considerably in the years 1980-85 as a direct result of these two factors.

Rent per square meter and yield percent on prime Sydney real estate are shown in the second and third columns of Table 8.2. Next, the present value of the rent of one square meter per year for fifteen years at a required rate of return equivalent to the prime yield is calculated. These present values may be usefully compared with a second set of present value numbers obtained when the yield on fifteen year Treasury Bonds is used as the discount rate. As shown in the table there is a significant difference in the present value attributed to the rentals under different discount rates.

TABLE 8.2

SYDNEY PRIME REAL ESTATE VALUES

Year	Rent[1]	Yield (%)[1]	PV	15 Year[2] Treasury Bonds (%)	PV
1980	190	5.5	1972	11.75	1613
1981	260	5.0	2699	13.15	1977
1982	355	6.0	3447	16.40	2165
1983	380	6.5	3573	15.00	2533
1984	400	6.0	3885	14.10	2837
1985	430	6.0	4176	13.60	3167

1. Source: JLW Research published in Property Review, (October 1985 and July 1986).
2. Source: Reserve Bank of Australia Bulletin (December 1985).

The difference between the valuation of the real property and the financial asset may well lie in the choice of the discount rate. If valuers are appraising the present value of real property at yields in the range of 5-7%, then these are likely to be larger than the capitalized share valuation. An explanation of the apparent different rates must lie in the riskiness of the two forms of securities. There are no obvious differences in the taxation treatment for profits on the securities which suggests a comparison of the returns is inappropriate.

Shares are risky and it is unlikely that they will return a long term yield less than the risk-free rate. Exceptions such as negative beta securities runs counter to the industry view that the price of property trust shares fluctuate with market disturbances. Empirical estimates of beta reported in this thesis do not support the negative beta view.

The slowness with which property trades occur in the market suggests that relative to financial assets they have higher liquidity risk. However, there is no premium observable. The lower rate cannot be simply explained. Potentially, investors ignore the delay in obtaining the desired price and believe the risk to be very low. Accordingly a discount rate lower than for the financial asset is used.

2. CAPM and Market Efficiency

The required rate of return on physical real estate and the financial real estate surrogate should be the equivalent if one asset is a substitute for the other. If there is one market for all assets, then an equilibrium pricing model which explains the relative prices of some assets should explain the relative prices for all assets. The capital asset pricing model is purported to be general and to cover all assets. It follows, therefore, that CAPM may be utilized to determine the required rate of return on assets as explained in Chapter 3. Systematic risk is the only factor which explains the difference in yields between assets.

An application of this reasoning to the anomaly between valuations of listed property trusts and their physical real estate assets suggests that the financial security is more risky than the physical asset. A moment's consideration indicates that there is something odd in the sum of the proportional shares not equalling the whole. Resort to some notion of synergism does not appeal. Beta estimates for listed property trusts are not greater than those for the physical real estate assets. The more likely source of a reasonable explanation lies in CAPM not being appropriate for relative pricing of both physical real estate assets and financial real estate assets.

The capital asset pricing model is a perfect market model with strong requirements regarding informational efficiency. These requirements are embodied in what is referred to as the efficient market hypothesis. Without informational efficiency there is no equilibrium of a form which is encapsulated in CAPM. It was appropriate, therefore, to investigate the informational efficiency of both the financial and physical real estate markets.

Prior studies of the share market suggest that the weak-form and semistrong-form EMH are acceptable. The physical real estate market had not been subjected to that form of analysis and the prior expectations are not of the same ilk.

Harvey (1981, p.17.) stresses the important role played by information in reaching equilibrium. He observes that:

> Since the market is essential to the functioning of the price system a defective market mechanism will impair the efficiency with which resources are allocated through the price system. We therefore have to ask: How efficient is the real property market in registering the effect on price of changes in demand and supply?

In particular, Harvey remarks that there are a number of influences which work against the free flow of information. Market segmentation is thought to occur such that there is not one property market but rather several separate markets e.g. urban housing and Scottish grouse moors. While this is obviously a British illustration the same may be suggested for holiday shacks and industrial sites. The difficulty with the full dissemination of information is reflected in the returns earned by the various real property assets. Harvey (1981, p.20.) argues that "Where knowledge of market conditions is defective, the price signals work at less than full efficiency, and adjustments in supply and demand are sluggish." He goes on to note that "by and large, prices do respond, albeit somewhat sluggishly, to changes in market conditions".

The existence of slow adjustment to prices is compatible with the position of technical analysts and runs counter to the necessary conditions of market efficiency required by CAPM. Assertions regarding these matters are empirically testable. Chapters 5, 6 and 7 analyzed the efficiency of the market, for both financial and physical real estate assets.

3. Empirical Evidence Regarding CAPM and Market Efficiency

The empirical analyses conducted were designed to systematically test the level or degree of market efficiency exhibited by the various real estate assets represented in the sample data set. Initially, the database may have been considered as consisting of financial and physical real estate assets. The former group constituted by the AMP fund, listed and unlisted property trusts and the latter by the Victorian Valuer-General, Richard Ellis, Jones Lang and Wootton and Real Estate Institute of Australia series. Within the former group the price of listed property trust shares are determined in the open market and for the latter category the REIA data are market sales prices. AMP P Series, unlisted property trusts and the remaining physical real estate series are valued according to appraised market value.

Initial tests conducted on the data series were designed to detect the extent to which past information is impounded in the currently prevailing price of the asset. These tests, collectively referred to as weak-form EMH tests, partitioned the data series into two groups. Group 1 contained the listed property trusts which satisfied these tests. Group 2 contained the other series which generally failed to satisfy the tests. This second group, therefore, includes two financial real estate series, the valuation based series of physical real estate and the market selling price series of physical real estate.

Acceptance of the weak-form EMH with regard to listed property trusts is consistent with prior research in the area of share market efficiency. Rejection of the null hypothesis for all other series is consistent with the Harvey (1981) perspective.

There was apparent in the past series of prices of the weak-form inefficient assets, sufficient information to suggest that adjustment towards an equilibrium price was continuing. Besides affording the opportunity to use predictive time-series models to forecast future prices it is evidence of a pricing rule which is inconsistent with CAPM. The empirical evidence reported in Chapter 5 clearly indicates that CAPM is not likely to be applicable for the range of real estate assets considered, with the exception of listed property trusts.

A further level of market efficiency, referred to as the semistrong-form EMH, was next investigated with regard to listed property trusts. While the statistical significance of the estimated relationships are low the results confirm prior expectations regarding Australian share markets. The listed property trusts exhibited behavior consistent with the semistrong-form EMH.

Level three of the EMH, known as the strong-form, was considered in the context of all the real estate assets in the data set. Two observations can be made with regard to the analysis reported in Chapter 7. First, the listed property trusts do not display a capacity to continually outperform the market. Second, the estimation of CAPM on the remaining series provided uniformly poor results.

Performance assessment work does require the explicit incorporation of risk into the computations. Evidence reported indicates the majority of the real estate series are normally distributed and hence the standard deviation may be used as a quantitative measure of risk. The coefficient of variation, therefore, offers a statistic which may be used to obtain an ordinal ranking.

Such a measure is not a ratio scale statistic and no inferences can be drawn in terms of relative absolute performance i.e., to infer that one asset performed twice as well as another asset.

Application of the reward-to-variability ratio, employing the standard deviation as the denominator, appears prima facie to be reasonable. While the calculation of the excess return, by deduction of the risk-free return, is straightforward the capital market line foundations of the Sharpe Index are not satisfied. The evidence of weak-form inefficiency for the real estate assets, listed property trusts excepted, implies that they are not efficient assets or portfolios in the sense of being on the efficient frontier.

4. Final Remarks

The research presented in this thesis represents an investigation of the applicability of CAPM to real estate analysis. Motivation for this work arose from the observation of an anomaly in the market pricing of assets. The law of one price did not seem to hold. A general model of equilibrium pricing for assets should hold across the whole range of assets in the market.

Empirical research found that the majority of real estate data does not satisfy the necessary conditions required for it to be consistent with CAPM. The reasons why the data do not exhibit the necessary statistical properties is rooted in the fundamental characteristics of the market from which they are drawn. The real estate market as depicted, by the available sample data, is not efficient.

The major contribution of this thesis is in the systematic collection and testing of data which has not been previously undertaken. Presumably, if the data were readily available in the form of an "exchange" tape, then this form of analysis would have been addressed in the past. However, data are not readily available and careful collection, collation and statistical testing has now been completed on a sample of real estate assets.

In drawing the conclusion that CAPM does not appear appropriate as a relative pricing model for the majority of real estate assets, one important consideration must be borne in mind. This inference is based on analysis of a specific sample of data. Further research may be meaningfully conducted into transaction prices of real estate trades. The extent to which current data series accurately reflect actual trades does appear to warrant further consideration. The introduction of new computer technology into the Land Title Offices in Australia, may afford the opportunity for extracting alternative sources of transaction data.

Why the yield on real estate is so low vis-a-vis the risk-free rate of interest remains unresolved. It does not appear to reflect the relative riskiness of physical real estate but rather represents the characteristics of a particular inefficient market.

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