ACTIVE PORTFOLIO MANAGEMENT AND THE GAINS FROM INTERNATIONAL PORTFOLIO DIVERSIFICATION

by

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ABSTRACT

The thesis estimates the benefits of international portfolio diversification using an 'active' portfolio management policy. Such a policy was desirable on two counts. First, the expected returns and/or the variance-covariances of international asset returns were found to be non-stationary. In active portfolio management, it is possible to 'internalize' the non-stationarity of the stochastic process generating the data. Second, the international capital market was found to be inefficient by some earlier studies. In such a market, there exists super risk-premium which may be obtained through active management strategy.

Using ex ante data, the additional benefits of 'international' over 'domestic' diversification was demonstrated by comparing the risk-return characteristics of some 'international' portfolios with those of a domestic benchmark portfolio. The portfolio selection model used throughout was the single-period Markowitz Mean-Variance model. Several portfolio strategies were investigated and it was seen that for a representative U.S. investor there were significant additional gains to be enjoyed from holding internationally diversified portfolio rather than the domestic portfolio.

The average returns of the actively managed portfolios over the period were then compared to those of some 'passive' buy-and-hold portfolios after allowing for some arbitrarily

selected transaction costs. It was seen that the actively managed portfolios outperformed the buy-and-hold portfolio for almost all the holding period cases. This result supports the 'partial' segmentation view of the international capital market and its consequent inefficiency.

Incorporating Pratt-Arrow measure of relative risk-aversion in the expected utility function, the effect of investor's risk tolerance on portfolio risk and return was explored. It was seen that between two classes of risk-averse investors, the more risk-averse class earned less risk-adjusted return on average than their less risk-averse counterparts.

Finally, the effect of the exchange factor on portfolio risk and return was analysed by decomposing portfolio return and variance into constituent parts. It was seen that under the fixed exchange rates system, the exchange rate changes led to a reduction of portfolio variance for some periods while under the flexible rates system they raised it. Their effects on portfolio return were mixed; however, on average, over a large number of periods, they contributed positively. Also, the exchange factor was found to affect portfolio choice -- a result at variance with the view held by the proponents of the PPP theory of exchange rate determination.

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DEDICATION

To the Loving Memory of My Father, Sirajul Haque Khan,

Who Would Have Been Happier Than Anybody Else

and also to my

Mother, Firoza Khanam

Brother, Mahbubal Haque Khan

Sister, Lutfun Nesa Khanam and

Wife, Munira Begum Ruby

Whose Debts Are Irrepayable

TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

INTRODUCTION AND THE PERSPECTIVE

With the advancements of communication technology, the world capital market is becoming more and more integrated. Whether it is 'one' integrated market or a combination of segmented parts is debatable. But there is no denying the fact that this market is far more integrated today than it was two decades ago. Today, sitting in New York or London, one can communicate with major financial centres around the world instantly and carry out business. What people could not think of two decades ago is now a reality. It is with this far-sightedness that the theory of International Portfolio Diversification was developed almost two decades ago (Grubel, 1968).

Basically an extension of the theory of portfolio diversification developed by Markowitz (1952,1959) and Tobin (1958), this theory states that it is possible to reduce portfolio risk even further from the level attained under domestic diversification by including foreign assets in the portfolio. This extra gain emerges mainly from the low and sometimes negative correlation between asset returns of the domestic and the foreign countries.

The theory has the interesting implication that the domestic market portfolio which is well-diversified so as to include all securities listed on the stock exchange is no longer efficient! Some of the systematic risk which is not diversifiable at the domestic level can be diversified away by including foreign assets in the portfolio. This theory also sheds some light on why the domestic Capital Asset Pricing Model (CAPM) could not explain security price behavior satisfactorily. Domestic security prices are influenced significantly by factors developed in the foreign financial markets (Lessard, 1973; Solnik, 1974) and these factors are not covered by the domestic CAPM.

The potential benefits of international diversification and their implications for the domestic CAPM, however, depends on the degree of integration of the world capital market. Under the hypothesis of perfect integration with no market imperfections (e.g., restriction of goods and capital flow, transaction costs etc.) and with no exchange risk, all securities, domestic as well as foreign, would be priced according to the 'international' or 'world' systematic risk. Due to the arbitrage process, no security would be over-valued or under-valued and would be plotted on the international security market line if it can be defined in a meaningful sense. Under such circumstances, there would be only 'normal' benefits of 'pure diversification' (McDonald, 1973).

Under the perfectly segmented market hypothesis, domestic securities would be priced according to their 'domestic' systematic risk without any consideration of what is happening in the foreign markets and the domestic CAPM would be the relevant model determining security price behavior.

Since financial investment across countries takes place in the real world, national capital markets are not 'perfectly' segmented. On the other hand, given the existence of different types of barriers to the international flow of goods and capital, they are not perfectly integrated either. The real world, thus, falls in-between the perfectly integrated and the segmented market (Levy and Sarnat, 1975). In this 'partially' segmented world capital market, there could be 'supernormal' benefits from international portfolio diversification (Errunza and Losq, 1985) which are due to the incomplete arbitrage process.

If the international capital market were perfect and efficient, there would be no room for profitable asset choice. Picking securities would only reduce the benefits of diversification since the portfolio managers cannot have superior information than the market and the best bet would be to hold the market. In view of the presence of different types of barriers to international flow of capital and goods, multiple currencies etc. and also of the evidence of 'super risk-premium' found by some authors (mentioned above) in the international security market investment, there is considerable amount of doubt if this market is efficient.[1] Consequently there could be

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[1]Bertoneche (1979) applied the Foster-Stuart records test and another test due to Kolmogoroff and Smirnov to test for randomness of stock price behaviour to seven national stock markets and found that the null hypothesis of randomness could not be rejected at 95 p.c. level of confidence. However, the spectral analysis (on which these tests were based) should not be considered as a powerful test of market efficiency since it tests for randomness against the alternative hypothesis that

additional benefits from picking securities as opposed to holding the market since not all securities are plotted on the international security market line.

One added feature of international investment is the presence of nominal exchange risk. Whether this is relevent in determining asset choice is debatable and depends on the particular model and its assumptions (Solnik, 1977; Roll and Solnik, 1977; Grauer, Litzenberger and Stehle, 1976). According to the Law of One Price, goods with similar characteristics should be priced similarly, irrespective of the markets in which they are traded. One application of this Law to a basket of commodities is the Purchasing Power Parity (PPP) theory which states that a basket of identical goods would have the same value in different countries. However, due to the existence of multiple currencies, local currency price may be different across countries but in terms of a numeraire currency price would be the same everywhere. If the PPP theory holds, then, of course, exchange risk has no real identity and the same asset would have same risk and return characteristics in all countries.

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[1](cont'd) non-randomness is of a time-dependent source. There could be other types of non-random behaviour and spectral analysis may not detect those (Logue and Sweeney, 1977, p.762). Bertoneche also used a simple filter test and found that substantial profit could be made in six European markets even after accounting for transaction costs. This implies that over the period studied (1969-1976), these markets were quite inefficient (Bertoneche, 1979, p203).

Whether the PPP theory holds in reality has been a much debated issue and occupied much attention in the literature. Short-run deviations of exchange rates from the PPP rate have been observed by many studies, specially after the break down of the fixed exchange rate system in 1971 (Aliber and Stickney, 1975; Giddy, 1977; Richardson, 1978; Kravis and Lipsey, 1978; Genberg, 1978; Levich, 1979). With the well-known causes of this violation (e.g., the existence of non-traded goods, trade barriers etc.) are added another important factor --- the portfolio demand for foreign currencies which influences short-run spot exchange rates independent of the influences of the demand for goods and services. Therefore, at least in the short-run, the exchange rate becomes a relevant variable affecting consumption-asset choice across countries. The growth and development of the forward market in currencies is a case at point. If exchange risk did not matter, such a market would not have developed in the first place.

The exchange risk arising from fluctuations in nominal exchange rates is likely to make international investment more risky specially under the flexible exchange rates system.[2] This additional risk can be covered by entering into a forward contract in the forward exchange market the cost of which, among other things, is the difference between the forward rate and the

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[2]Theoretically, of course, we cannot say anything conclusive about the effects of exchange rate changes on the risk of international investment. Because of the covariance terms involved, the net effect of exchange rate changes may be positive or negative. The issue is investigated in greater detail in chapter seven.

spot rate at the time contract becomes effective. Since forward coverage may not be available for longer term contracts, this method of hedging is not suitable for portfolio investment.[3] Moreover, as Makin (1978) argued, the protection offered by the forward market is considerably less than supposed. An alternative way of hedging exchange risk is to borrow an amount of money in the foreign market and sell it immediately for domestic currency and invest the proceeds in the domestic risk-free asset.[4] Unlike hedging through the forward market, this method does not involve any 'contract' and can be hedged as long as one wishes.

If uncovered by any of the two means mentioned above, part of the exchange risk in international stock market investment can be diversified away by investing in more than one foreign country. This holds true as long as returns from exchange rate fluctuations between countries are less than perfectly positively correlated. This is in line with the spirit of the benefits of the diversification shown by Markowitz and Tobin. Though exchange rates are not treated as independent assets in international equity investment, as foreign stocks are treated, some reduction of exchange risk occurs if the portfolio contains stocks of two or more countries. Because of the speculative position in foreign currencies, there could be speculative

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[3]Forward contracts may be available for longer than one year terms but these are unusual, and, for the nature of their rigidity, not suitable for portfolio investment.

[4]See Solnik (1974a).

gains (and losses, of course) from holding assets in foreign currencies.

Besides the risks arising out of the uncertainty about future spot exchange rates, there could be risks due to unforeseen exchange control e.g. restriction on repatriation of the full amount of profits, compulsory sale of foreign currency at a premium to the foreign central banks etc.

Another potential source of risk of international investment which is particularly relevant for investment in some developing countries is the political risk. Governments of these countries are relatively more unstable than those of the developed countries. A liberal government that encouraged foreign capital may be toppled by one which is very much nationalistic and is likely to confiscate all foreign assets.

Given the complexities of the real world characterized by exchange risk, restrictions on capital flows, political risks, lack of readily available information about foreign firms etc. some people, while recognizing the benefits of international diversification, suggested that these benefits could be reaped by buying shares of the multi-national companies (MLCs) whose activities are dispersed over many countries. The argument is that these firms are in a better position than individual investors to cope with exchange controls and other forms of government intervention in the free flow of capital (Logue and Rogalski, 1979, P.9). While such an argument contains some grain of truth, it is not at all clear if shares of the MLCs would be good and certainly not perfect substitutes for foreign securities. In fact, as evidenced by Jacquillat and Solnik (1978), a portfolio of MLCs' shares performed very poorly as a means of reducing portfolio risk as compared to an internationally diversified portfolio.

It is true that the domestic MLCs may operate in many foreign markets and their earnings may reflect the ups and downs of foreign economies, but it is equally true that the total earnings of these companies are determined largely by the domestic market.[5] As such, buying shares of the MLCs does not fully capture the potential gains of international diversification. Besides, shares of these companies are included in the domestic investment opportunity set and are available to the domestic investors. A well-diversified domestic portfolio may include these shares anyway. Benefits of international diversification are in excess to the benefits of such domestic diversification. International diversification is unique in itself and has no close substitutes.

Previous studies on the benefits of international portfolio diversification took several different approaches the most popular one among them being the Markowitz mean-variance approach. Most of the studies following this approach used ex post or realized data to solve for the efficient portfolios. The

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[5]Some Dutch and Swiss MLCs may be an exception to this statement.

use of ex post data is appropriate only if the stochastic process that generate the data is stationary over time. The evidence found by Maldonado and Saunders (1981) suggests that this process is not stationary.

The evidence of inefficiency of the international stock market (Levy and Sarnat, 1975; Bertoneche, 1979; Errunza and Losq, 1985) accompanied by the intertemporal instability of the return generating process suggests a portfolio management policy where the portfolio is revised every period in the light of the most recent past data available. Under this 'active' portfolio management policy, the most recent past information is made use of in estimating the ex ante return distribution for the current period. Since the portfolio is revised in every period the instability of the return generating process is also taken care of.

The primary objective of this thesis is to estimate the benefits of international portfolio diversification within mean-variance framework using an active management policy. For simplicity, I use exchange rate fluctuations as the measure of exchange risk. Since international Fisher effect and the PPP theory were not found to hold, specially in the short run, exchange gains/losses due to exchange rate fluctuations cannot be offset through changes in interest rates and price levels (Giddy, 1977). Therefore, at least in the short run, exchange risk is expected to influence asset choice. In this thesis I investigate how this exchange risk affects portfolio choice and consequently the benefits of international portfolio diversification.

The thesis is organized as follows. Chapter one reviews the existing literature on international portfolio diversification while chapter two describes the objectives and methodology and also the portfolio selection models used in this study.

Chapter three reviews decision-making under uncertainty using the mean-variance approach which is the chosen approach of this thesis. It also discusses security price behaviour when all investors act like mean-variance decision makers. The international counterpart of the domestic CAPM is then discussed and the associated problems analysed.

Chapter four describes the source(s) of data and some of the definitions used.

Chapter five provides the rationale for active portfolio management in the international context and demonstrates the potential as well as realized benefits of international over domestic diversification using the portfolios described in chapter two. It also compares the benefits under active and passive portfolio management.

Chapter six classifies the risk-averse investors of the previous chapter into different groups according to their risk-tolerances as measured by the Pratt-Arrow definition of relative risk-aversion. It then examines the benefits of international diversification for each group of risk-averse investors using portfolios that maximize expected utility which is approximated by its mean and variance.

Chapter seven decomposes portfolio risk and return into parts attributable to exchange rate changes and into those specific to the security characteristics only. It also compares the benefits of international portfolio diversification under the fixed and flexible exchange rates systems.

The last chapter summarizes the main findings and mentions some of the limitations of this study.

CHAPTER I

A BRIEF REVIEW OF THE LITERATURE ON INTERNATIONAL PORTFOLIO DIVERSIFICATION

Following the pioneering work of Grubel (1968), substantial volume of research has been done on the benefits of international portfolio diversification, all confirming its potential benefits. These studies which followed different approaches and perspectives may be classified, for expository purposes, under the following categories.

1. Mean-Variance Efficient Frontier Approach : Grubel (1968), Levy and Sarnat (1970, 1975, 1978, 1981), Saunders and Woodward (1977), Solnik and Noetzlin (1982), Logue (1982), Jorion (1983)
2. International Market Model and International Capital Asset Pricing Model Approach : Agmon (1972), Solnik (1974a, 1974b, 1974c), Black (1974), Grauer, Litzenberger and Stehle (1976), Stehle (1977), Solnik (1977), Stulz (1981), Errunza and Losq (1985)
3. Investment Trust Fund Approach: McDonald (1973), Guy (1978a, 1978b), Gandhi, Saunders, Woodward and Ward (1981), Woodward (1983)

These groups may not be mutually exclusive and, are by no means, exhaustive. The purpose of this classification is only to show the direction of research on the subject and also to locate where the present research fits into. We discuss briefly each of these approaches below.

1. The Mean-Variance Efficient Frontier Approach

a. The Ex Post Analysis

The earliest work done on international portfolio diversification is that of Grubel (1968) and it falls in this category. Grubel pushed the idea of portfolio diversification developed by Markowitz (1952, 1959) and Tobin (1958) beyond national boundary and showed that greater risk reduction was possible for any given expected return by including foreign securities in the portfolio. Using ex post data on 11 major stock market indices over the period 1959-1966 to estimate the expected returns and the variance-covariance matrix, he showed that for the same risk as that of Moody's Industrial Average, a representative American investor could have earned 68 p.c. higher annual return by investing in foreign stock markets than by holding Moody's index only.

Grubel's study has important implications for the movement of capital between countries. Traditionally, capital flows were dictated by interest rate differential between two countries. Grubel asserted that capital might flow between them even if the interest rate differential is zero if 'an increase in the rate of economic growth of one country causes the rise of that country's gross purchases of foreign assets'. However, even in the absence of economic growth, it is possible for portfolio capital to move if substitution by domestic investors in favour of foreign assets and away from domestic ones takes place.

Aside from the limitation of using indices instead of individual securities, as noted by Agmon (1972), one important limitation of Grubel's study (which is also common in many other empirical studies) is that it used ex post data to estimate the expected returns and variance-covariance matrix which were used as inputs in the calculation of the efficient set. The implication of the failure to use ex ante return distribution is well-known: it underestimates portfolio risk and overestimates the benefits of diversification. Nevertheless, the basic idea of 'international' diversification is powerful enough to survive such limitations of empirical studies.

The essential ingredient of international diversification is the 'low and sometimes negative' correlation between security returns of different countries. Grubel and Fadner (1971) provided evidence on the lower correlation coefficients for inter-country pairs than for the intra-country pairs of assets. They also argued and found evidence that these correlations were an increasing function of the length of holding periods. In the short run, share prices are influenced strongly by random factors which affect different shares differently. As time passes, the influence of these random factors becomes dominated by real factors which affect all share prices similarly. Since benefits of diversification are a decreasing function of the degree of correlation between pairs of assets, they argued that these benefits would be smaller for longer than for shorter holding periods.

Following Grubel, Levy and Sarnat (1970) demonstrated the potential benefits of international diversification by using a larger sample of countries (28, developed as well as underdeveloped) and covering a wider interval of time (1951-1967). They constructed mean-variance efficient frontiers taking into account all countries as well as using different subsets of countries. It appeared that the mixed sample of developed and developing countries showed greater potential benefits than either sample of developed or developing countries alone.

Lévy and Sarnat (1975) used the mean-variance portfolio selection model to explain the possibility of portfolio capital movement between the U.S. and Israel. Doing the analysis separately from the point of view of U.S. as well as Israeli investors, they found that neither country's international portfolio contained securities from the other country. Attributing the failure of Israeli securities to attract U.S. investors to Israel's sporadic devaluations, they repeated the analysis under the hypothetical cases of no devaluation and uniform devaluation at rates of 1, 4, 5, 6 and 8 p.c. In the absence of Israeli devaluation, Israeli assets marginally entered U.S. investor's optimal portfolio at (domestic) interest rates below 7 p.c. On the other hand, 24 p.c. of Israeli investor's portfolio was committed to the U.S. securities. Thus with no devaluation or uniform annual devaluations of rates below 9 p.c., there was significant net capital outflow from Israel into the U.S.

Their analysis also shed some light on the importance of exchange risk and also on the structure of the international capital market. If this capital market were integrated and there were only one currency (or multiple currencies with perfect positive correlation among exchange rates), all assets would have had the same nominal risk-return characteristics as seen by the U.S. and Israeli investors and there would have been no exchange risk. Under the circumstances, both the U.S. and Israeli investors would have the same nominal efficient frontier. If multiple exchange rates always followed the 'parity' rate, then the efficient frontier with 'real' returns would also be the same for investors of the two countries. Higher nominal rate in one country in such a case would be solely due to higher rate of inflation. Levy and Sarnat found both nominal and real efficient frontiers to be different for the U.S. and Israeli investors and hence concluded the existence of exchange risk and segmentation of the international capital market.

Levy and Sarnat (1978) and Levy (1981) applied the mean-variance portfolio selection model to explain diversification of foreign currency holdings, as seen in the portfolios of many central banks, international banks and multinational corporations. Since the essence of portfolio theory is that risk can be reduced by combining various options, diversification of foreign currency holdings would reduce risk as well. Such a practice got special attention since the inception of the flexible exchange rates system in the early seventies. Since exchange rates are flexible and uncertain, substantial speculative gains/losses are possible from holding a portfolio of foreign currencies.

Levy (1981) analysed portfolio demand for foreign currencies from the point of view of U.S. investors as well as investors of 16 other countries. Surprisingly, the Danish Krone was the only currency which occupied more than 70 p.c. weight in the portfolios of investors of 15 out of 17 countries and for investors of 8 countries, it occupied almost 100 p.c. weight. Levy explained this by the high return and relatively low risk of the Krone as compared to other currencies.[1]

What is more important is the implication of foreign currency holdings by domestic investors on the demand for domestic currency and the monetary authority's ability to pursue effective monetary policy. As shown by Levy and Sarnat (1978), given the existence of a risk-free asset, internal demand for domestic currency for 'portfolio' purposes could be zero, thereby contradicting Tobin's portfolio demand for money. All

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[1]One important limitation of this kind of finding is that such benefits cannot persist. In this particular case, for example, the market for Krone is not big enough to satisfy foreigners' demand for it. Competition among the foreigners would raise its price in terms of domestic currency thereby reducing its expected return.

investors in that case would hold the domestic risk-free asset and foreign currencies. On the other hand, there could be foreigners' portfolio demand for domestic currency.

Most of the studies done so far were from the point of view of U.S. investors with a few exceptions, like, Saunders and Woodward (1977) who took the British point of view. They also incorporated some barriers to foreign investment and investigated their impacts on the risk and return of foreign investment. The U.K. investors, in order to buy foreign securities, had to buy dollars at a premium rate and also had to surrender 25 p.c. of the proceeds from foreign investment to the government at the spot exchange rate. Saunders and Woodward adjusted the rates of return from foreign investment to reflect these restrictions. Using relative stock market capitalization for 7 countries as portfolio weights they calculated the mean and standard deviation of portfolio returns adjusted as well as unadjusted for the restrictions. In both cases, the internationally diversified portfolio dominated the domestic U.K. portfolio. In fact, restrictions on foreign investment did not appear to have any significant impact on the gains from international diversification for U.K. investors during the period studied.

Saunders and Woodward also estimated an efficient portfolio a‡ la Markowitz using the full covariance matrix and under the assumption of no short selling of assets. They found that the efficient portfolio contained asset of only one country - Japan.

They claimed that this contradicted the essence of the international diversification of portfolios.

Fung (1979), in a comment on Saunders and Woodward (S-W), noted the problem of estimated negative expected returns of assets, specially when short selling of assets was not allowed. These negative expected returns could cause serious distortions in the construction of the efficient portfolios and, as Fung maintained, S-W's results might have been a reflection of this phenomenon.

Fung argued for and studied the minimum variance portfolio which is independent of the expected returns of the assets. Allowing for short selling of assets, he estimated the minimum variance portfolio (MVP) with S-W data and found that it involved short selling of two countries' assets. With these two countries removed from the sample, he re-estimated the MVP and found that it dominated all countries except Japan which had both higher expected return and higher variance. Thus, the Japanese asset cannot be said to have dominated the MVP. According to Fung, a necessary and sufficient condition for gains from international portfolio diversification to exist is that the MVP have non-zero investment in more than one asset. At least two assets in the MVP would (be combined to) reduce portfolio risk.

Solnik and Noetzlin (1982)'s study demonstrated several important points. Using the passive management approach, they showed the gains from international diversification simply by comparing the risk-return characteristics of a U.S. market index (S & P's 500 Index) with those of a world market index (Capital International World Stock Index). With bonds included in the indices, they showed that risk could be reduced drastically.

Using ex post data, they estimated the mean-variance efficient frontier with stocks only as well as with stocks and bonds as assets. The world market portfolio (measured by the world index) was seen to lie far below the efficient frontier which demonstrated the desirability of 'asset choice' over the 'index-fund' approach. The evidence that the world market proxy was dominated by the portfolios on the efficient forntier casts serious doubt on the suitability of these world indices as real world surrogates of the 'true' market portfolio, which, according to modern capital market theory, must be efficient (i.e., must lie on the efficient frontier).

Solnik and Noetzlin also found that the optimal asset allocation was unstable and hence concentrated on the performance of the minimum variance portfolio (MVP) which is independent of return measures.[2] Using the risk of the MVP under the ex post or the 'perfect foresight' approach as a benchmark, they calculated the average 'efficiency loss ratio'[3] for some

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[2]They found (elsewhere) that the risk structure "showed up a 'relative' but meaningful degree of stability" (p.20).

[3]The 'efficiency loss ratio' was defined as EL = $(\sigma - \sigma(A))/\sigma(A)$ where $\sigma(A)$ is the SD of the benchmark portfolio and σ, the SD of any other portfolio.

passive portfolios as well as for the MVP under the 'extrapolative' approach.[4] They found that the 'extrapolative' approach where the covariance matrix was revised frequently performed consistently better than the simple passive portfolios.

b. The Active Management Approach

If the stock market works efficiently in the sense of making efficient use of all relevant information, there remains no unexploited profit opportunities and the best bet is to hold the average market portfolio. Picking securities or country indices cannot be more profitable since the portfolio manager cannot have more information than the market. The controversy over active vs passive management, therefore, boils down to a controversy about market efficiency. Unfortunately, most of the studies done so far deal with tests of the implications of market efficiency rather than with market efficiency itself.

Logue (1982) compared the performance of an actively managed international portfolio with that of a passive U.S. market index and found that the two performances were equal.[5] He, therefore, concluded that active international diversification might not be

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[4]In the extrapolative approach, the portfolio was based on the covariance matrix of the preceding period.

[5]Logue used a simple mechanistic rule to estimate the ex ante return distribution: to estimate the distribution for 1960, he used data from 1955 to 1959; for 1961, data from 1956 to 1960 and so on. He calculated monthly expected and actual returns without monthly updating of data but it is not clear how (see his table 1 and footnote 4).

better than passive domestic investment for an U.S. investor.[6] He also found significantly superior performance of the ex post optimal portfolio over the ex ante optimal one.[7] This is not surprising and is as expected in view of the fact that the ex post or the 'perfect foresight' model overestimates the benefits of diversification.

In view of the transaction costs and other problems associated with international investment, Logue suggested that the benefits of international diversification might be enjoyed by holding shares of U.S. multinational firms who diversify their activities across countries. He substantiated his arguments by comparing the mean/SD ratio of an optimal portfolio of international shares and that of U.S. multinational firms' shares. With both ex ante and ex post data, he found that the portfolio consisting of multinational firms' shares did better than the other portfolio. Logue, however, did not do any test of hypothesis concerning the difference in performance between the two portfolios to see whether it was statistically significant.

Jorion (1983), in connection with explaining 'estimation risk' in optimal portfolio choice, emphasized the problem of estimating expected returns. He asserted that expected returns estimated from historical data alone could be very misleading

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[6]It may be mentioned here that Solnik and Noetzlin (mentioned earlier) found quite opposite results - their 'extrapolative' portfolio (which was actively managed) outperformed the passive domestic portfolio.

[7]The optimal portfolio Logue used was the one given by the tangency of a ray from the origin to the efficient frontier.

with the consequent impact on the construction of the efficient portfolios.[8] Assets which performed well in the past may not do so in the future. Moreover, the historical averages have the disadvantage of being affected by the extreme values. Expected returns, therefore, could be very unstable.

Jorion, therefore, proposed an alternative estimator of expected returns where each asset mean (calculated as historical average) should be 'shrunk' toward a common value. This estimator effectively combines the Bayesian approach and the Stein estimator and as such recognizes the multivariate nature of the problem. As mentioned by Jorion, this 'shrinkage' or the Bayes-Stein (B-S) estimator has the remarkable property to uniformly dominate the sample mean by means of minimizing a quadratic loss function which is an aggregate of estimation errors for all assets. Losses are minimized by minimizing the aggregate function rather than each element separately.

The common value toward which each asset mean would be shrunk could be, according to Jorion, the mean of the world market portfolio or the return on the minimum variance portfolio. The proposed B-S estimator is

$$ER_j(w) = (1-w)\bar{R}_j + wR_0, \qquad \text{for all } j \tag{1.1}$$

where w is the weight assigned to the common value (R_0) and $\bar{R}_j$

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[8]Fung (1979) also recognized this problem and to get around with it, advocated for the minimum variance portfolio which is independent of the sample expected returns. See Fung, op. cit.

is the sample mean. As can be seen from the above expression, when w=0, the estimator is the usual sample mean and when w=1, it is independent of the sample mean. Using three different values of w (0.0, 0.65 and 1.0), Jorion showed that as the value of w increased, the mean-variance efficient frontier flattened out and in the extreme case of w=1, it was a straight line. The ex ante gain in expected return, therefore, dissipated as w increased, and with w=1.0, gains from international diversification accrued from risk reduction only.

Jorion compared the ex post performances of some international portfolios under each of the Bayes-Stein estimator approach, the classical approach and the passive approach. With the shrinkage factor w=0.65, he showed that the B-S portfolios outperformed all other portfolios - the classical and the passive U.S. and world market portfolios. However, the performance of the minimum variance portfolio (w=1.0) was even better than those of the B-S portfolios with w=0.65. The tangent portfolio under the classical approach performed the worst and was outperformed even by the passive U.S. or the world market portfolio.

Since the Bayes-Stein portfolios were much closer to the minimum variance portfolio, Jorion argued that the potential benefits from international diversification would emerge from risk reduction only.

One oft-quoted disadvantage of the Markowitz Full Covariance model approach lies in its input requirements and consequently, on the computer cost. With n=100 securities, one has to estimate n(n-1)/2 = 4950 distinct covariances before one can proceed on to solve the portfolio selection problem. However, in this age of highly developed computer technology where CPU time is calculated in nanoseconds (one-billionth of a second) or microseconds (one-millionth of a second), the dimension of the cost aspect of the problem is really a tiny fraction of what it was two decades ago.

2. The International Market Model and the International Capital Asset Pricing Model Approach

The International Market Model is a straightforward application of the domestic market model developed by Sharpe (1963) in response to the vast input requirements of the Full Covariance model discussed in the last section. Sharpe's market model, also known as the Diagonal model, drastically reduces the input requirements for the portfolio selection problem. In this model, each asset return is assumed to be influenced by a common factor that affects all securities similarly and simultaneously. Two asset returns are correlated only through their common relationship with the common factor.

Proponents of the international market model argued that the national capital markets of different countries were interrelated and this interrelationship was due to factors like international trade and capital flows, foreign direct investment etc.[9] As a result, asset prices in one country were determined not only by domestic economic activities but also by those abroad. Potential benefits of international diversification in this model emerge from the fact that some of the risk of domestic securities which is not diversifiable domestically becomes diversifiable internationally.

The international capital market is characterized, among other things, by the presence of barriers to trade and capital flows, multiple currencies, different consumption patterns, heterogenous expectations on the part of the investors, transaction and transportation costs etc. Yet, there have been attempts in the past to show that the world capital market is 'one integrated market'. More particularly, some authors tried to show that share price behavior in different national markets is consistent with 'one integrated market' even though there exist different types of market imperfections. To this end, Agmon (1972) estimated an international market model with share price data from the U.S., U.K., Germany and Japan, with the U.S. market index as a proxy for the international or the world market portfolio. Among the three non-U.S. markets, he found only German share prices to move closely with the U.S. market.

In the next step, Agmon proceeded on to estimate an international CAPM with the 'beta' estimates found earlier.

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[9] See Lessard (1974), Solnik (1974c) etc.

Unfortunately, none of the estimated slope coefficients was significantly different from zero and also, they were significantly different among themselves.

In a comment on Agmon (1972), Adler and Horesh (1974) pointed out some important methodological errors that made Agmon's findings very very questionable. First of all, Agmon's choice of the U.S. index as a proxy of the world index was not appropriate. To be consistent with the 'one world market' hypothesis, the weighted average of the country 'betas' should, by definition, be equal to unity. With Agmon's data, they found this to be equal to 0.81 and hence concluded that Agmon's betas were deficient as measures of risk and the use of U.S. index was inconsistent with the single market hypothesis.

Second, Agmon did not specify which risk-free rate he was using. Since he converted all non-U.S. returns into U.S. dollars, it implies that he assumed the U.S. risk-free rate to be equivalent to the international risk-free rate. Given the presence of exchange risk and market imperfections, such an assumption was very inappropriate. Under certain conditions, exchange risk would be irrelevant and an international risk-free rate could be defined (theoretically) but Agmon did not assume those in his model.

Agmon's specification of the relationships among security markets and international pricing of risk was not based on any theoretical model. This void was filled up by a thorough and detailed investigation of the issues by Solnik (1973, 1974b) where the author developed an intertemporal equilibrium model of the international capital market and provided various tests for it. The asset pricing model Solnik derived was

$$E(R_{ki}) - R_{fk} = \gamma_{ki}\{E(R_w) - R_{fw}\} \qquad (1.2)$$

where $E(R_{ki})$ is the expected return on security i of country k, R_{fk} is the risk-free rate of country k, $E(R_w)$ is expected return on the world market portfolio, R_{fw} is a measure of international risk-free rate and γ_{ki} is the 'international systematic risk' of security i. The validity of such a model has important implications for the pricing of domestic securities: they are priced according to their international systematic risks rather than their domestic systematic risks. This may explain why empirical tests did not find strong support for the domestic CAPM.

Solnik suggested different tests of the International Asset Pricing Model (IAPM) depending on the way international factors affected security prices in different countries. In other words, these tests were based upon different assumed stochastic processes involving national and international factors that generated security returns.

The simplest specification was to assume that all securities' returns were affected by one common factor - the 'market' factor of a single world market. One important criticism of this 'Single Index World Market model' is that it assumes all security prices (irrespective of the countries in which they are listed) to be similarly affected by a single world factor. This may not be a realistic assumption. Every national market exerts its own influence on prices of securities listed there apart from the influence of the world factor and this 'national' factor is expected to be quite dominant. Recognizing this, Solnik proposed his 'Nationalistic Multi-index model' where security prices have in common a national factor which in turn is dependent on the world factor. Specifically this model is

$$R_{ki} = E(R_{ki}) + \beta_{ki}\{R_{Ik} - E(R_{Ik})\} + \eta_{ki} \qquad (1.3)$$

and R_{Ik} is given by

$$R_{Ik} = E(R_{Ik}) + \gamma_k\{R_w - E(R_w)\} + \epsilon_k \qquad (1.4)$$

where R_{Ik} and $E(R_{Ik})$ are observed and expected return on the national index of country k, R_w and $E(R_w)$ are observed and expected return on the world market portfolio, γ_k is international systematic risk for country k, R_{ki} and $E(R_{ki})$ are observed and expected return on security i of country k, β_{ki} is national systematic risk of security i of country k. Combining equations (1.3) and (1.4), Solnik got

$$R_{ki} = E(R_{ki}) + \beta_{ki}\gamma_k\{R_w - E(R_w)\} + \eta_{ki} + \epsilon_k$$

$$= E(R_{ki}) + \gamma_{ki}\{R_w - E(R_w\} + \epsilon_k \qquad (1.5)$$

where γ_{ki} is international systematic risk of security i in country k. This model assumes that the world factor influences security prices of different countries through its relationship with the national factor. Specifically,

$$\gamma_{ki} = \beta_{ki}\gamma_k \qquad (1.6)$$

Combining (1.2), (1.5) and (1.6) Solnik derived the following testable relationship

$$E(R_{ki}) - R_{fk} = \beta_{ki}\{E(R_{Ik}) - R_{fk}\} + \eta_{ki} \qquad (1.7)$$

The Nationalistic Multi-index model discussed above has its own limitations. It assumes that 'all securities are only and identically affected by international variations through the national index' (Solnik, op. cit., p.81). This is a very strong assumption which is unlikely to be met in practice, for, two securities of any country with same domestic risk (β_{ki}) may be affected differently by international events such as international competition, export-import pattern, international link of the firms etc.

In an attempt to correct for this limitation, Solnik proposed a 'Multinational Index Model' where all security prices were assumed to be affected by a common world factor and a purely national factor orthogonal to the world factor. This national factor is taken to be the residual of the regression of the national index on the world index. Specifically,

$$R_{ki} = E(R_{ki}) + \gamma_{ki}\{R_w - E(R_w)\} + \beta_{ki}\epsilon_k + \eta_{ki} \qquad (1.8)$$

where ϵ_k is given by

$$R_{Ik} = E(R_{Ik}) + \gamma_k\{R_w - E(R_w)\} + \epsilon_k \qquad (1.9)$$

ϵ_k is a measure of the purely national factor orthogonal to the world factor. Combining equations (1.2), (1.8) and (1.9) Solnik got the following testable relationship

$$R_{ki} - R_{fk} = (\gamma_{ki} - \beta_{ki}\gamma_k)(R_w - R_{fw}) + \beta_{ki}(R_{Ik} - R_{fk}) + \eta_{ki} \qquad (1.10)$$

In this model it is no longer true that $\gamma_{ki} = \beta_{ki}\gamma_k$. If $(\gamma_{ki} - \beta_{ki}\gamma_k) > 0$, security i is more sensitive to international variations than a typical security of that country. Empirical tests of this improved model showed that, on average, the national factor was quite dominant which implied that the stock prices followed the national factor quite closely. This, however, did not reject the international structure of the market because, for some securities (or portfolios), the international factor appeared to be quite strong.

Wallingford, in his discussion of Solnik (1974c), demonstrated that Solnik's empirical evidence was consistent with a variety of alternative specifications of the IAPM, including the market segmentation version at one extreme. Thus, Solnik's tests failed to discriminate among the alternative specifications of the IAPM and hence was inconclusive.

Moreover, Solnik's model contained only one consumption good which differed by the country of residence. In such a model, there is no price competition for goods, as noted by Grauer, Litzenburger and Stehle (1976), since a given country's consumption good has zero marginal utility to residents of other countries. There is no international transfer of goods and financial claims on real wealth and no exchange ratio exists.

Grauer, Litzenburger and Stehle (henceforth G-L-S) developed an international asset pricing relation for a world composed of many commodities which were not separated nationally. All individuals were assumed to have identical homothetic taste and they faced the same consumption opportunity set. This model permitted international transfer of goods and of financial claims on real wealth.

Decomposing the nominal rate of return on an asset into a component correlated with the return on the international market portfolio and a component uncorrelated with it, these authors derived an international asset pricing relation. In this model, the security's risk contained its beta and a term involving covariance between the world consumer price index and that component of security's return which was uncorrelated with the international market portfolio. They asserted that this covariance would, in general, be different from zero and hence risky assets would provide some protection against changes in commodity prices.

Using real rates of return, they also derived a similar risk-return relation which, on the assumption of independence between the error term and the real return on the market portfolio, reduces to a Sharpe-Lintner type CAPM. In this model, uncertainty about inflation does not have any influence on international pricing of securities. About exchange risk, they asserted that nominal asset returns would fluctuate with changes in exchange rates but since consumption and asset choices were governed by real returns exchange risk was irrelevant.[10]

Stehle (1977) criticized prior studies on international asset pricing for misspecifying the true relationship between risk and return. According to him, a security's domestic 'beta' measures its systematic risk not only when markets are segmented

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[10]It may be mentioned here that the validity of G-L-S's assertation hinges critically on whether the Purchasing Power Parity (PPP) theorem holds or not. The short run deviation of exchange rates from the PPP rates is, by now, an almost established fact though in the long run they may track the PPP rates. Therefore, in the short run, exchange risk is expected to influence consumption-asset choices.

but also in an international market when returns on the domestic and international market portfolios are positively correlated. In addition, a security's rate of return may be correlated with those components of the return of the international market portfolio which are uncorrelated with the domestic market portfolio. Stehle called this second source of a security's risk 'non-domestic international risk' and asserted that omission of this component of risk would misspecify the true relationship between risk and return.

The pricing relations Stehle estimated were

$$E(R_i) - R_f = \beta_{iD} b_1 \quad : \text{domestic CAPM}$$

$$E(R_i) - R_f = \beta_{iD} b_1 + \gamma_i b_2 \quad : \text{International CAPM}$$

where β_{iD} is domestic systematic risk of security i and

$$b_1 = E(R_d) - R_f$$

and

$$b_2 = \frac{cov(v_w, R'_w)}{cov(R_d, R'_w)} \{E(R_d) - R_f\}$$

where R_d is unity plus the rate of return on the domestic market portfolio, v_w is the component of the international market portfolio's return (R_w) which is uncorrelated with R_d, $R_w' = (R_w - R_f)/R_w$ and γ_i is non-domestic international risk.

Tests of the above two relationships produced rather surprising results: 20 years of monthly data did not support either the domestic or the international model, as far as statistical significance was concerned. However, the estimated slope coefficients had the signs predicted by the international model: both β_{iD} and γ_i had positive sign.

Solnik (1977) presented some pessimistic views about empirical tests of different international asset pricing relations. Following Roll (1976), he argued that the only economic test of any CAPM would be to see if the ex post optimal portfolio was the market portfolio and the only economic implication of the model would lie with the composition of the ex post optimal portfolio and not with the pricing relation which was a 'direct by-product'.

Accordingly, he compared the composition of ex post optimal portfolios for three different models of asset pricing and found them to be markedly similar. Empirically, it was not possible to distinguish among the models. Since the three models he studied were based upon alternative assumptions about exchange risk, viz, no exchange risk, monetary exchange risk and real exchange risk, his results indicated that exchange risk - real or nominal did not matter in international asset pricing. Since the tests failed to discriminate among the models, their implications about exchange risk were also suspect.

Since Solnik claimed to have used the 'only economic test' of the international asset pricing models which did not succeed in differentiating among models, he concluded that 'international asset pricing seems to be a very fruitful area for theoretical research, not empirical'(Solnik, 1977, p.511).

As regards tests of the segmented vs. integrated market structure, he suggested that some type of imperfection would have to be identified first and its impact on portfolio optimality and asset pricing be ascertained later.

Following the recommendation of Solnik (1977), Errunza and Losq (1985) studied the segmented vs. integrated issue of the international capital market structure by introducing specific imperfection in their model. The particular imperfection they studied was based on unequal access assumption - a subset of investors was assumed to trade in all the securities available while others were assumed to trade only in a subset of the securities. The securities accessible by all were termed as 'eligible' while those accessible to a subset of the population were called 'ineligible'.

Under the assumed market structure, the authors asserted that the eligible securities would be priced as if the markets were completely integrated while the ineligible securities would command a super risk-premium which, on average, would be positive. The authors also derived risk-return relations for the two groups of securities and tested them with monthly data from 9 less developed countries and the U.S. The empirical test lent support to the 'mild' segmentation view of the international capital market.[11]

The international capital market has some unique characteristics which are not present in any domestic market. These are due to the involvement of more than one country with independent monetary and fiscal policies. These characteristics are: multiple currencies, exchange controls, different tax systems, absence of an international risk-free asset, different tastes and preferences across countries and the like. Because of these factors, a straightforward extension of the domestic CAPM to the international market would appear not to be possible. To develop an appropriate international CAPM, one needs to incorporate these diverse characteristics into the model. In view of the complexities involved, many authors like Solnik and Noetzlin (1982), Adler and Dumas (1983) were doubtful if any appropriate IAPM would ever be built.

3. The Investment Trust Fund Approach

Under this approach, several authors (McDonald (1973), Guy (1978a,b), Woodward (1983) etc.) evaluated the performances of some real world international portfolios - those held by international mutual fund companies. These companies, though they hold foreign securities in their portfolios, are not allowed to choose their holdings of these securities at will.

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[11]This supports the evidence found by Levy and Sarnat (1975) on segmentation of the international capital market.

Very often, their exposure to foreign securities is constrained by law. As such, portfolios of these funds are not representative of true international portfolios and, therefore, their performances should be viewed as those of 'partially' internationally diversified portfolios.

McDonald (1973) investigated 8 French mutual fund companies which had varying degrees of international diversification over 1967-69. The performances of these funds over the period were compared among themselves as well as with the performance of a market-value weighted French market portfolio. It was seen that the firm having the highest degree of international diversification (Soginter) performed the best while the one with no international exposure (Sliva France) performed the worst. However, it is not clear from his analysis whether the best performance of Soginter was due to its more international orientation or due to its ability to select undervalued domestic securities. All internationally diversified funds performed better than the French market portfolio. McDonald explained the superior performances of these funds by the relatively advantageous position of French banks, as mutual fund managers, in their access to as well as analysis of information.

Guy (1978a) examined the performances of 47 British closed-end investment trusts over 1960-70. Using the traditional performance measures of Sharpe, Treynor and Jensen, he found that no trust had a performance measure significantly different from zero! Guy also proposed and investigated two other performance measures - one based on the estimated Sharpe-Lintner form of the CAPM and the other, on zero-beta form of the CAPM. In both cases, significant performance measures were obtained for some trusts.

Guy (1978b) investigated the performance of a hypothetical equally-weighted portfolio of 99 U.S. securities (50 having largest market capitalization and 49 chosen randomly from the remaining population), 99 U.K. companies and 198 combined U.S. and U.K. securities under various assumptions of portfolio management. He emphasized the institutional costs for the British investors from a trading policy of buying and selling securities every period as opposed to a buy-and-hold policy. He estimated the cost imposed by the quarter-p.c. surrender rule (introduced in 1965) for a British investor who bought U.S. securities at the start of each month and sold them at the end and found this to be 1.76 p.c. per month, on average. He, therefore, concluded that the institutional constraints in the U.K. worked against an active management policy when it came to international portfolio diversification and favoured a passive management policy.

In order to investigate determinants of trust performance, Guy ran a multiple regression with each of the traditional performance measures as the dependent variable and the fund's beta, size, p.c. invested in fixed-income securities and p.c. invested in the U.K. securities as four explanatory variables. If international diversification affected portfolio performance, he expected this to be reflected in the estimated coefficient of the 'p.c. invested in U.K. securities' variable. With all cases of performance measures, this estimated coefficient had the correct sign (negative) but was statistically insignificant. It may be mentioned that his sample consisted of securities from two countries only. This limited foreign exposure of the funds under investigation did not capture all the potential benefits of international diversification.

The mean-variance approach (described in the first section) is often criticised on grounds that it uses only two moments of the return distribution, ignoring others and that it is consistent with the expected utility maximization principle only under the assumption of quadratic utility functions or normality of return distributions. A more general decision rule is provided by the Stochastic Dominance (SD) approach which takes into account the entire return distribution for each asset and compares this with the distributions of other assets. This criterion, as such, is independent of the concavity/convexity of the utility functions.

An application of this SD rule to international portfolio diversification was made by several authors (Gandhi, Saunders, Woodward and Ward, 1981; Woodward, 1983). The second degree SD rule (used by these authors) may be stated as: an option A is said to dominate another option B if

$$\{F(x) - G(x)\} \leq 0 \qquad \text{for all } x$$

$$\text{and} \quad F(x) \neq G(x) \qquad \text{for at least one } x$$

where F(x) and G(x) refer to the cumulative return distribution for option A and B respectively.[12]

Using the SD criterion, Woodward (1983) estimated the performances of 35 U.K. investment trusts (grouped in 3) which had most of their equity holdings in the U.K. and North America and compared them to three artificially constructed buy-and-hold portfolios with varying degrees of international diversification. He found that over the 10 year period studied (1968-77), most of the investment trusts performed poorly relative to their assigned international benchmark portfolio. This implied that the U.K. investors could have done better by holding the international portfolios rather than investing in the internationally oriented investment trusts. This might be due to the limited foreign exposure of the trust funds permitted by law.

One practical limitation of the SD criterion is that if one is confronted with a large number of securities, comparing each asset and each possible combination of assets with another asset/combination (which this rule requires) would be very costly in terms of computer time and money and this should be weighed against the additional gain in efficiency.

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[12]See Levy and Sarnat (1972) under the 'General Criterion' for explanation.

Summary

This chapter reviews the existing literature on international portfolio diversification. For expository purpose, these studies are grouped in three major categories: the Mean-Variance Efficient Frontier approach, the International Market Model and the IAPM approach and the Investment Trust Fund approach.

The International Market Model has the great virtue that it reduces the input requirements for a portfolio selection problem drastically as compared to the Full Covariance Model of Markowitz. But international financial investment is too complicated to be explained by this simple model. While this Single-index model has been extended by several authors to account for the significant national factor, the testability of these models posed problems. Because of the complexities of international financial investment, many authors belive that the International Market Model approach is not appropriate. Also, even though asset prices across countries are influenced by some 'world factor', a straightforward extension of the domestic CAPM to the international market may not be warranted.

Like the International Market Model approach, the Investment Trust Fund approach does not tell us how the internationally diversified portfolios are chosen. Given the composition of some internationally oriented funds, this approach estimates the additional benefits from including foreign assets in the portfolio relative to the domestic portfolio. This approach, therefore, overlooks an important element of portfolio selection --- the correlation among security returns. Moreover, these funds are very often constrained by law regarding their foreign exposure.

Markowitz's Full Covariance Model approach is the only approach that takes into account the essential elements of portfolio selection. One of the major limitations of this approach was its large input requirements but due to the rapid development of the computer technology over time, the dimension of the problem has been reduced greatly. Computer time and cost today are only a minor consideration even for a large portfolio selection problem.

In the Markowitz model there are two approaches, the ex post and ex ante -- depending on the way the expected returns and the variance-covariance matrix are estimated. In the ex post analysis, the ex post or realized asset returns are used to calculate the expected return and variance-covariance matrix. The ex post analysis which is also a perfect foresight analysis, overestimates the gains from diversification. Most of the studies on international portfolio diversification using Markowitz Full Covariance Model used ex post analysis while the appropriate analysis should be ex ante.

CHAPTER II

OBJECTIVE, METHODOLOGY AND MODEL

The primary objective of this thesis is to demonstrate the benefits of international portfolio diversification from a policy of active portfolio management. Such a policy is desirable in view of the inefficiency of the international stock market evidenced by some earlier studies and also of the non-stationarity of the expected returns and the variance-covariance matrix of national stock market returns. Previous studies used ex post data over a number of periods to calculate an expected return vector and a variance-covariance matrix which were then used as inputs in the portfolio selection problem. Such a practice is appropriate only when the expected returns and the variance-covariance matrix are stable over time. As mentioned earlier, these were found to unstable by some authors, and this casts doubt about the validity of the ex post analysis.

Moreover, use of ex post data ignores 'estimation risk' which arises out of the fact that the future return distributions are unknown and have to be estimated. Use of ex post data basically assumes that the estimated values of the parameters are equal to their respective 'true' values. This 'perfect foresight' model ignores the standard errors of the estimates and as such underestimates portfolio risk and hence overestimates the gains from diversification.

These limitations of the previous studies are taken care of in this thesis by using ex ante distribution of asset returns in every period. This distribution is estimated as follows:

Using the most recent past T periods observations on asset returns, the joint probability distribution for the current period is estimated by assigning an equal probability (1/T) to each of the T past joint realizations to occur in the current period. In the next period, one more set of observations becomes available and is added to the information set and one set of observations is dropped from the other end so that joint realizations over the most recent past T periods are used to estimate the joint distribution for this period. In this moving fashion, joint return distribution for each period is estimated.[1]

The procedure updates the information set in each period on the basis of the most recent past information available and is, therefore, efficient. Having estimated the joint return distribution for a given period, the expected returns and the variance-covariance matrix are calculated using the marginal distributions which are then used as inputs in the portfolio selection problem. The procedure is then repeated for every other period in the sample.

The portfolio selection model used throughout is the single-period, Markowitz Mean-Variance model. Because of the

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[1]See Bawa (1979) for a rationale and Grauer and Hakanson (1982) and Grauer (1985) for application of this methodology.

non-existence of an 'international risk-free rate' and because of the practical difficulties involved in constructing a 'world market portfolio', no attempt will be made to estimate an international counterpart of the domestic CAPM or an 'international market model'.[2] Solnik, after experimenting with 'international capital asset pricing model' finally concluded

> Given the complexity of the international context, with different taxes, exchange controls, exchange risk, and monetary interrelationships, no satisfactory asset pricing theory has been (and probably will ever be) developed. ... ... The only alternative appears to be the well known risk-reward (mean-variance) optimization introduced by Markowitz. (Solnik and Noetzlin, 1982, p.12)

Throughout this thesis, I want to look at the financial world through the eyes of a representative U.S. investor. In other words, I want to analyse portfolio behaviour of a typical U.S. investor who is confronted with an enlarged investment opportunity set beyond his national boundary. As such, returns from foreign assets will be converted into U.S. dollar using the end-of-period spot exchange rates and no coverage for the exchange risk will be assumed.

The domestic market portfolio which is the benchmark portfolio in this analysis is taken to be the index of Standard and Poor's 400 industrial shares listed on the New York Stock Exchange.

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[2]The difficulties involved in using them in an international context are mentioned in the previous chapter and explained in greater detail in the next chapter.

For the purpose of comparison with the domestic market portfolio, some arbitrarily selected but intuitively appealing international portfolios are investigated. These are

1. the portfolio that maximizes expected return for a given variance equal to the variance of the domestic benchmark portfolio (portfolio E in figure 2.1)
2. the portfolio that minimizes portfolio variance for the same expected return as that of the domestic portfolio (portfolio F in the diagram)

Given the existence of a domestic risk-free asset, portfolio return could be further increased for the same risk, or portfolio risk could be further reduced for given return from those given by the efficient frontier (M-N) in figure 2.1. This suggests two other portfolios (E' and F' in the diagram) located on the Capital Market Line (R_f-Q).

For comparison with some existing studies, two additional portfolios will also be investigated. These are (1) the tangent portfolio (portfolio T) and the minimum variance portfolio (portfolio M). The tangent portfolio is obtained by the point of tangency of a ray from the domestic risk-free rate (R_f) to the efficient frontier in the mean-standard deviation space. By construction, T is a portfolio of all risky assets. Depending on the risk-preferences, investors may invest (or lend) part of their funds in the risk-free asset and the rest in the portfolio of risky assets or they may borrow money at the risk-free rate of interest and invest the total fund in the risky assets. The

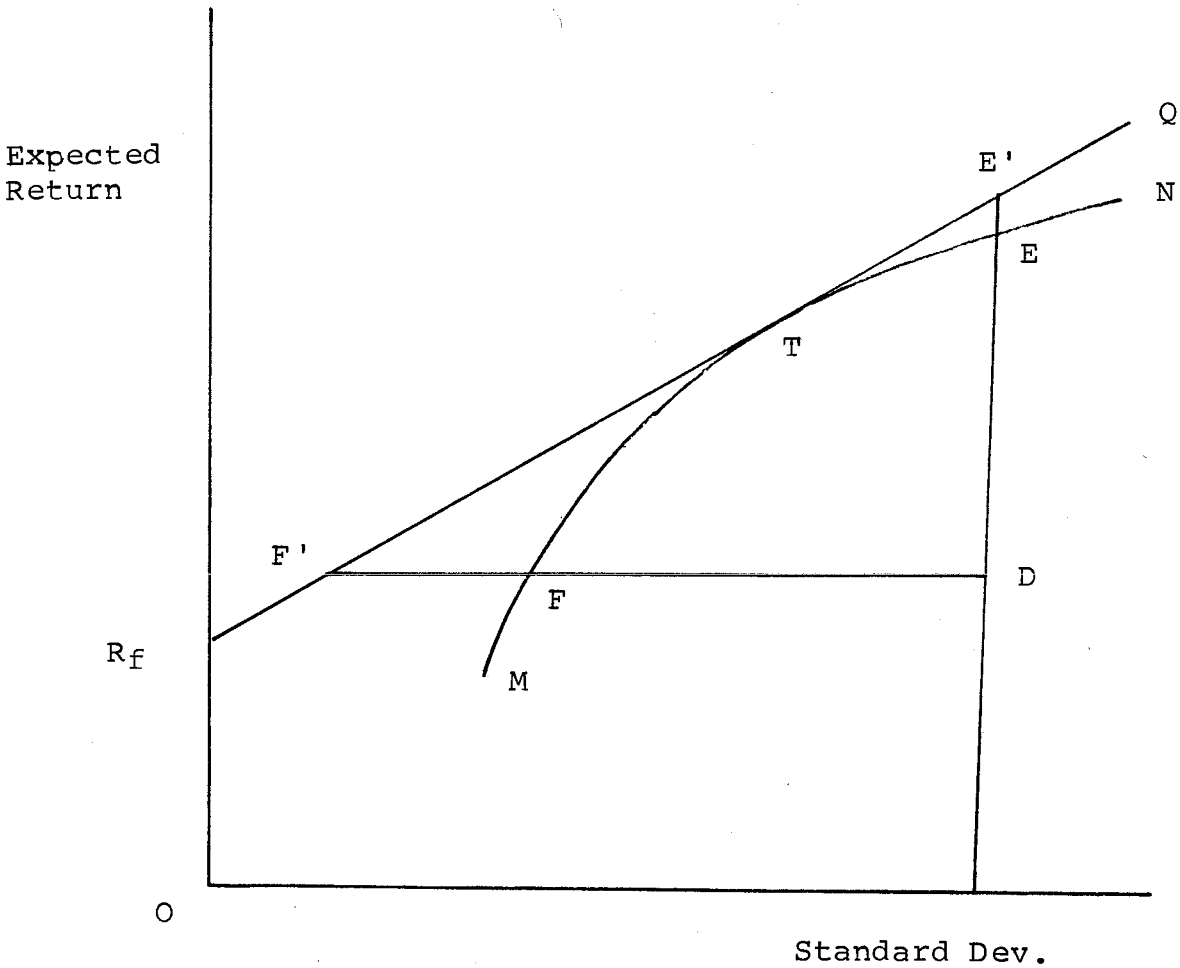

FIGURE 2.1 The Portfolios Investigated

minimum variance portfolio (M) minimizes portfolio variance without any regard to portfolio expected return.

The portfolios mentioned above are estimated from the portfolio selection models described below.

1. Portfolio E is obtained from

$$\begin{aligned} &\text{Maximize} && X'E \\ &\quad\text{subject to} && X'\Omega X = V\,(\text{U.S.}) \\ & && X'1 = 1 \\ & && X \geq 0 \end{aligned}$$

where X is a nx1 column vector of portfolio weights, E is a nx1 column vector of expected returns, V (U.S.) is the variance of the U.S. return, 1 is a nx1 column vector of 1's, and Ω is a nxn matrix of variances and covariances.

2. Portfolio F is obtained from

$$\begin{aligned} &\text{Minimise} && X'\Omega X \\ &\quad\text{subject to} && X'E = E\,(\text{U.S.}) \\ & && X'1 = 1 \\ & && X \geq 0 \end{aligned}$$

where E (U.S.) is the expected return of the U.S. asset

3. Portfolio T is estimated from

$$\begin{aligned} &\text{Minimise} && -X'(E - 1R_f) + X'\Omega X \\ &\quad\text{subject to} && X \geq 0 \end{aligned}$$

where R_f is the domestic risk-free rate of interest. Note that the sum of the weights is not constrained to be 1 because X denotes investment in risky assets only and does not include the risk-free asset. The tangent portfolio weights are calculated as

$$X(T) = \frac{X}{1'X}$$

where X(T) is the vector of tangent portfolio weights. The portfolio T depends on both the expected returns and the variance-covariance matrix. The proportion invested in the risk-free asset is calculated as

$$X(RF) = 1 - 1'X$$

4. Portfolio M is estimated from

Minimise $X'\Omega X$

subject to

$$X'1 = 1$$
$$X \geq 0$$

Note that this portfolio does not have any pre-assigned expected return. M, by construction, depends only on the variance-covariance matrix and is independent of expected returns as can be seen from the following:

$$X(M) = \frac{\Omega^{-1}1}{1'\Omega^{-1}1}$$

where X(M) is the vector of minimum variance portfolio weights. This portfolio is specially appealing to those who argue that the expected returns cannot be estimated precisely.

5. Finally, Portfolio E' and F' are obtained from the Capital line (CML)

$$E(R_p) = R_f + m\ SD(R_p)$$

where m is the slope of the CML, defined as,

$$m = \frac{E(T) - R_f}{SD(T)}$$

and E(T) and SD(T) are expected return and standard deviation respectively of the tangent portfolio (T). Note that E' is a borrowing portfolio while F' is a lending one.

Using the methodology described earlier to estimate the ex ante return distribution, the optimal weights for portfolios E, F, T and M are calculated for the current period. At the end of this period when 'realized' or actual returns on assets become available, realized portfolio return for each of E, T and M is calculated using the begining-of-period portfolio weights. At the begining of the next period, optimal weights are solved for in a similar manner and at the end of the period, realized returns for the three portfolios are calculated. The process is repeated for every other periods in the sample.

For portfolio E which has the same risk as the domestic portfolio, the average expected and realized returns over the period are calculated and compared to those of the benchmark portfolio. The additional returns due to international diversification are then calculated and their summary statistics computed.

For portfolio F which has the same expected return as the domestic portfolio, variance in each period is compared to that of the domestic portfolio. The additional reductions of portfolio variance made possible through international diversification are then calculated and their summary statistics computed.

Realized performances of T and M over the period are calculated using Sharpe's (1970) measure and compared to that of the domestic portfolio. Tests of hypotheses are then carried out using the statistic developed by Jobson and Korkie (1981) to see the statistical significance of the difference in performance of the domestic and international portfolio.

The portfolio selection process described above is basically one of revising the portfolio every period in the light of the most recent past data available. In view of the presence of transaction costs in stock trading, attempts are made to incorporate them in the active portfolio management analysis. Also, the performance of this 'active' portfolio management is compared to that of a naive 'buy-and-hold' portfolio allowing for some measures of transaction costs to see if information generated in the international stock and foreign exchange markets can be used to have superior portfolio performance. For the 'buy-and-hold' strategy, two different portfolios are tried, namely, the equally weighted portfolio and a portfolio formed by using the proportion of GNP of a country in the world GNP as its weight.

Several different holding periods are considered and the ex post performance of each of these 'buy-and-hold' portfolios over the holding period is compared to those of the 'actively' managed portfolios. If the international capital market is not efficient, as claimed by some earlier studies, I would expect this to be reflected in the superior performances of the actively managed portfolios over the passive portfolios.

Next, I would like to investigate the following interesting question --- does international portfolio diversification benefit risk-averse investors of all classes? Or, does it benefit one class more than the other just because one class is more or less risk-averse than the other? To investigate this, I incorporate the Pratt-Arrow measure of relative risk-aversion in the expected utility function which is maximised for different arbitrarily chosen values of the relative risk-aversion parameter to solve for the optimal portfolio weights. The performances of these expected utility maximizing portfolios are then compared among themselves.

One added feature of international investment over domestic investment is the presence of 'exchange risk', arising primarily because of the uncertain future values of exchange rates. In a regime of fixed exchange rates where monetary authorities are commited to maintain exchange rates at par value, this additional risk may be minimal. However, in the flexible rates system which came into practice in the early seventies, future exchange rates are uncertain and the magnitude of exchange risk has increased substantially. In this system, domestic investors, contemplating foreign investments, are required to estimate two return distributions -- one for the foreign stocks and the other for the exchange rates. Total risk, as such, is expected to be higher in international investment than in a comparable domestic investment, simply because we have more random variables in the former. One other objective of this research is to investigate the effects of the exchange factor on portfolio risk and return and see if international portfolio diversification is desirable in the presence of exchange risk.[3] The contribution of the exchange factor is separated out by decomposing expected return and variance of some internationally diversified portfolios into

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[3]As mentioned in the introduction, some people argue that the exchange risk has no influence on portfolio choice since fluctuations in the exchange rates would be reflected in the security price changes. This is true only if the exchange rates follow the parity exactly in each period -- a condition rejected by many earlier studies.

constituent parts.

To measure the impact of the exchange factor on optimal portfolio weights, a hypothetical world devoid of any exchange rate fluctuations is envisaged. In other words, a world with 'perfectly' stable exchange rates is assumed. The optimal portfolio under this system is compared to that under the real-world, flexible exchange rates system. Since the only difference between the two situations is the exchange rate variations, the difference in the optimal weights is attributed to the exchange factor.

CHAPTER III

INVESTMENT DECISION UNDER UNCERTAINTY: THE MEAN-VARIANCE APPROACH

Mean-Variance Model of Portfolio Choice

In a world of uncertainty rational decision making can be accomplished, under certain assumptions, by invoking the principle of expected utility, as shown by Von Neumann and Morgenstern (1953). In order to maximize expected utility, precise knowledge about the investor's utility function and/or the nature of distribution of the relevant random variables is necessary. Expected utility, in general, depends on all the statistical moments of the probability distribution. Assuming a specific utility function allows us to concentrate on a subset of these moments. For instance, if the investor's utility function is quadratic, investment decision becomes a function of only the first two moments, namely, the mean and the variance. In this thesis we will not assume utility function of any specific shape except that

1. the marginal utility is positive, $u'(.) > 0$, i.e., investors prefer more wealth to less
2. the utility function is concave downwards, $u''(.) \leq 0$, implying that investors are risk-averse

We assume that utility is a function of the end of the period wealth, $\tilde{w}$, which is a random variable, i.e., $u = u(\tilde{w})$.

Expanding this function by Taylor series approximation around mean wealth, $E(\tilde{w}) = m$ and taking expectation we get

$$E\{u(\tilde{w})\} = u(m) + 1/2\ u''(m)E(\tilde{w} - m)^2 + 1/3!\ u'''(m)E(\tilde{w} - m)^3 + 1/4!\ u''''(m)E(\tilde{w} - m)^4 + \ldots\ \ldots \qquad (3.1)$$

where $u(m)$ is the value of the utility function at m, $u'(m)$ is the first derivative of the function evaluated at m, $u''(m)$ is the second derivative evaluated at m and so on. Expected utility, thus, is a function of all the statistical moments of the probability distribution of $\tilde{w}$.

Empirically, such a relationship has been tested by some authors.[1] In all of these cases, the first two moments were found to be highly significant statistically. In some cases, the third moment and in even smaller number cases, the fourth moment was significant.

Following these empirical studies, I would consider only the first two moments and ignore the higher order ones. While making investment decisions investors are mostly concerned about the expected return and the dispersion of the returns from this expected value. Expected utility, therefore, is primarily a function of the expected return and variance. Symbolically,

$$E\{u(\tilde{w})\} = f\{E(\tilde{w}), V(\tilde{w})\} \qquad (3.2)$$

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[1]See Levy, H. and M. Sarnat (1972), Fama (1965), Blume (1970), Tsiang (1972) and Ohlson (1975).

Since investors prefer more wealth to less (assumption 1), expected utility would increase as expected return increases and since they dislike variance (a measure of risk), expected utility would decrease as variance increases and vice versa (assumption 2).

The indifference curves in the expected return-variance space are upward-sloping because an increase in variance needs to be accompanied by an increase in expected return in order for the investor to have the same level of expected utility as before. The rate at which the risk-return trade-off takes place is given by the slope of the indifference curve. The indifference curves are convex downwards indicating that as variance increases the risk-averse investors require increasingly higher amount of expected return at the margin to maintain the same level of expected utility. A relatively more risk-averse investor will have an indifference curve which is everywhere steeper than that of another investor who is less risk-averse.

With the help of mean and variance, the investor is able to choose between alternative options (or portfolios). The mean-variance criterion, used for this purpose may be stated as follows:

An option, x, dominates another option, y, if and only if

$$E(x) \geq E(y) \quad \text{and} \quad V(x) \leq V(y) \qquad (3.3)$$

on the condition that at least one of the inequalities holds strongly.

Graphically, the mean-variance criterion may be shown as in figure 3.1 below. Given its expected return and variance, any portfolio can be represented by a point on such a space and the set of all possible portfolios can be enclosed by an envelope such as the one shown in the figure. Using the mean-variance criterion, it can be shown that the options represented by the arc segment AFEB are dominated by those on segment ADB. For example, option F is dominated by option D since for given variance, D offers more expected return and hence is more preferable. Option E is dominated by option A since for given expected return, A offers less variance and hence is more preferable. In this way it can be shown that options on the arc segment ADB dominates options on the arc segment AFEB. The arc segment ADB is called the 'efficient' set or frontier --- the options on this frontier are efficient in the sense that for a given variance, it gives the maximum possible expected return or, equivalently, for given expected return, it shows the minimum possible variance.

The efficient frontier is obtained by solving a quadratic programming problem of the following form:

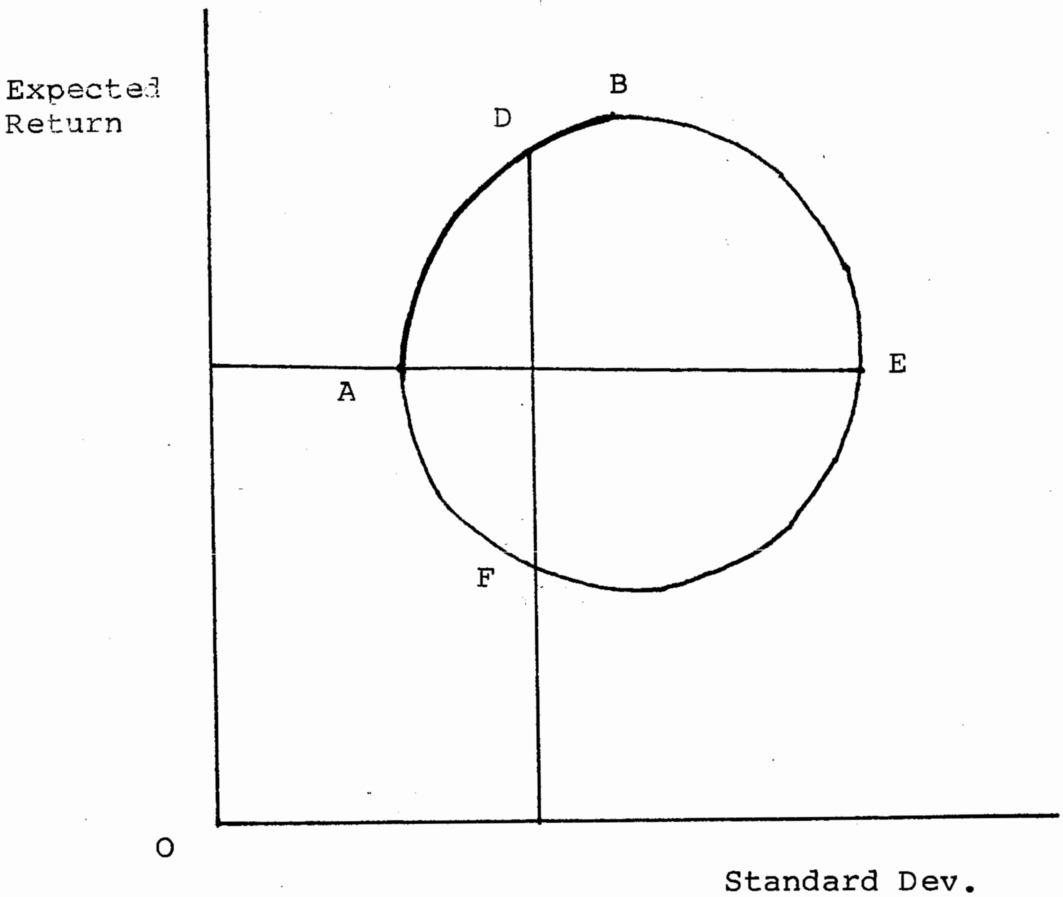

FIGURE 3.1 The Efficient Set

$$\text{Minimize} \quad X'\Omega X$$

subject to

$$X'E = E^*$$
$$X'1 = 1$$
$$X \geq 0 \qquad (3.4)$$

where X is a nx1 column vector of portfolio weights, Ω is a nxn matrix of variance-covariances, E is a nx1 column of expected returns and 1 is a nx1 column vector of 1's.[2] The first constraint implies that the expected portfolio return is equal to some pre-assigned value (E*) while the second constraint requires that the weights should sum up to unity. Finally, the third constraint requires that the weights are non-negative, i.e., short-selling of assets is not permitted.

Solution of this portfolio selection problem for different pre-assigned values (E*) of portfolio return gives the minimum portfolio variance for each E*, which, when plotted on the mean-variance space, generate the efficient frontier. A rational investor selects one point from this frontier. Such a choice is governed by the investor's attitude towards risk -- more specifically, by his indifference curves. If we superimpose the investor's indifference map on the efficient set, the optimum portfolio expected return and variance will be given by the

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[2]This is Markowitz's full-covariance model of portfolio selection where n(n-1)/2 distinct elements of the variance-covariance matrix must be estimated before solving for the optimal portfolio weights. As mentioned in chapter 1, a simplified portfolio selection model has been developed by Sharpe (1963) which does not require the full covariance matrix to be estimated. This model is discussed later.

point of tangency of the highest possible indifference curve with the efficient set. One such point is shown (point E) in figure (3.2) below.[3] The choice of an optimal portfolio may be viewed as a two-stage process. In the first stage, one obtains the admissible set of portfolios. The optimal portfolio is then chosen from this admissible set in the second stage.

In the presence of a risk-free rate of interest (R_f) at which any amount of money could be borrowed or lent, the efficient frontier takes on a very simple form. It is given by the straight line tangent to the efficient frontier from the risk-free rate on the expected return axis (figure 3.3 below).

Except for the point E, portfolios on the mean-variance efficient frontier are no longer efficient. This is because by including the risk-free asset in the portfolio it is possible to have more expected return than that given by the efficient frontier for any SD.

R_f represents the rate at which the money market is in equilibrium i.e., supply of loanable funds equals demand for it. At point R_f on the expected return axis, all money is invested in the risk-free asset and X, the proportion invested in the risky assets, equals zero. At point E, which is the only point on the curve that lies on the efficient set straight line, all money goes to the risky assets and X = 1. Points between R_f and E represents portfolios obtained by combining the risk-free

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[3]This is true if there does not exist any risk-free asset and there is no short-selling of assets.

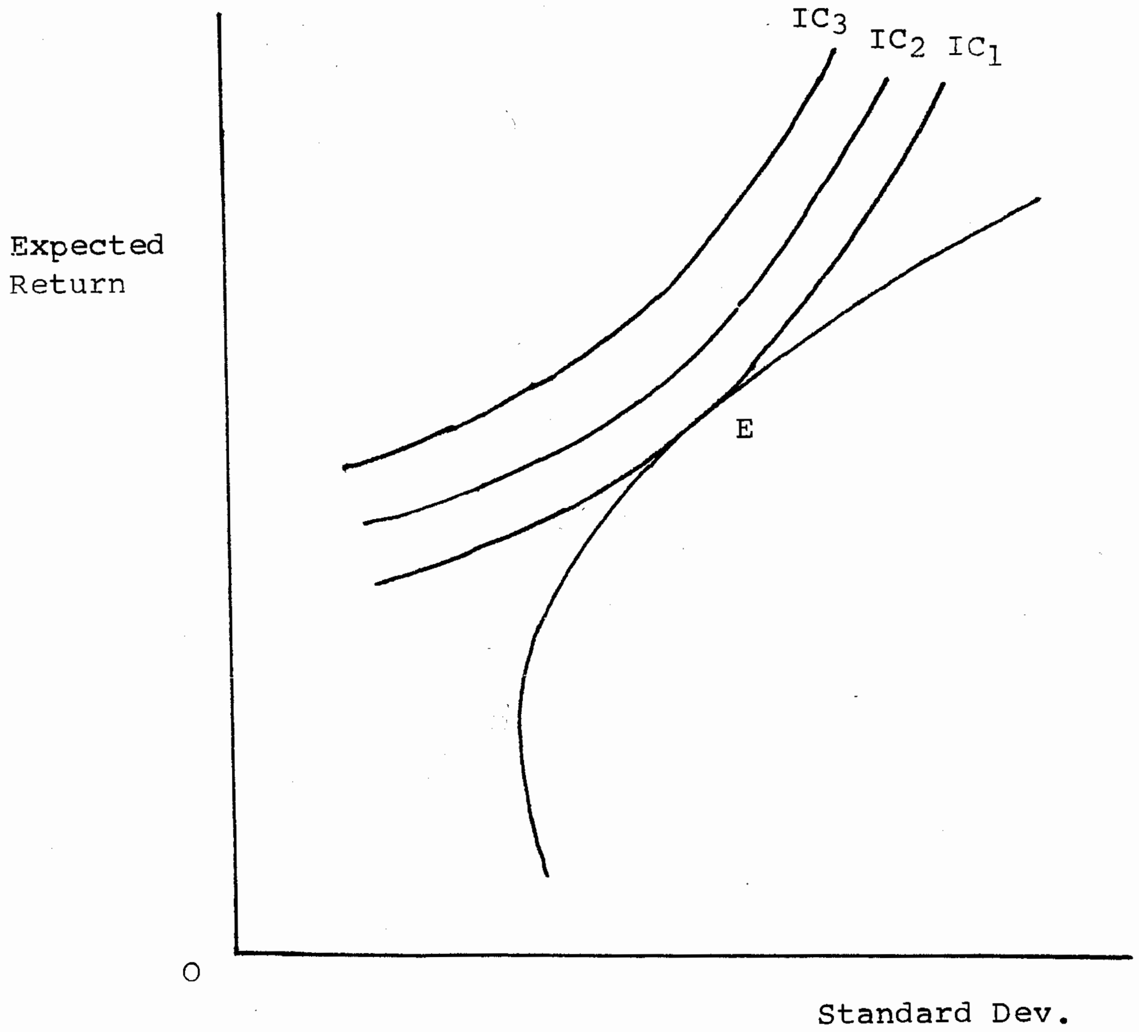

FIGURE 3.2 Optimal Portfolio Choice in the Absence of a Risk-free Asset

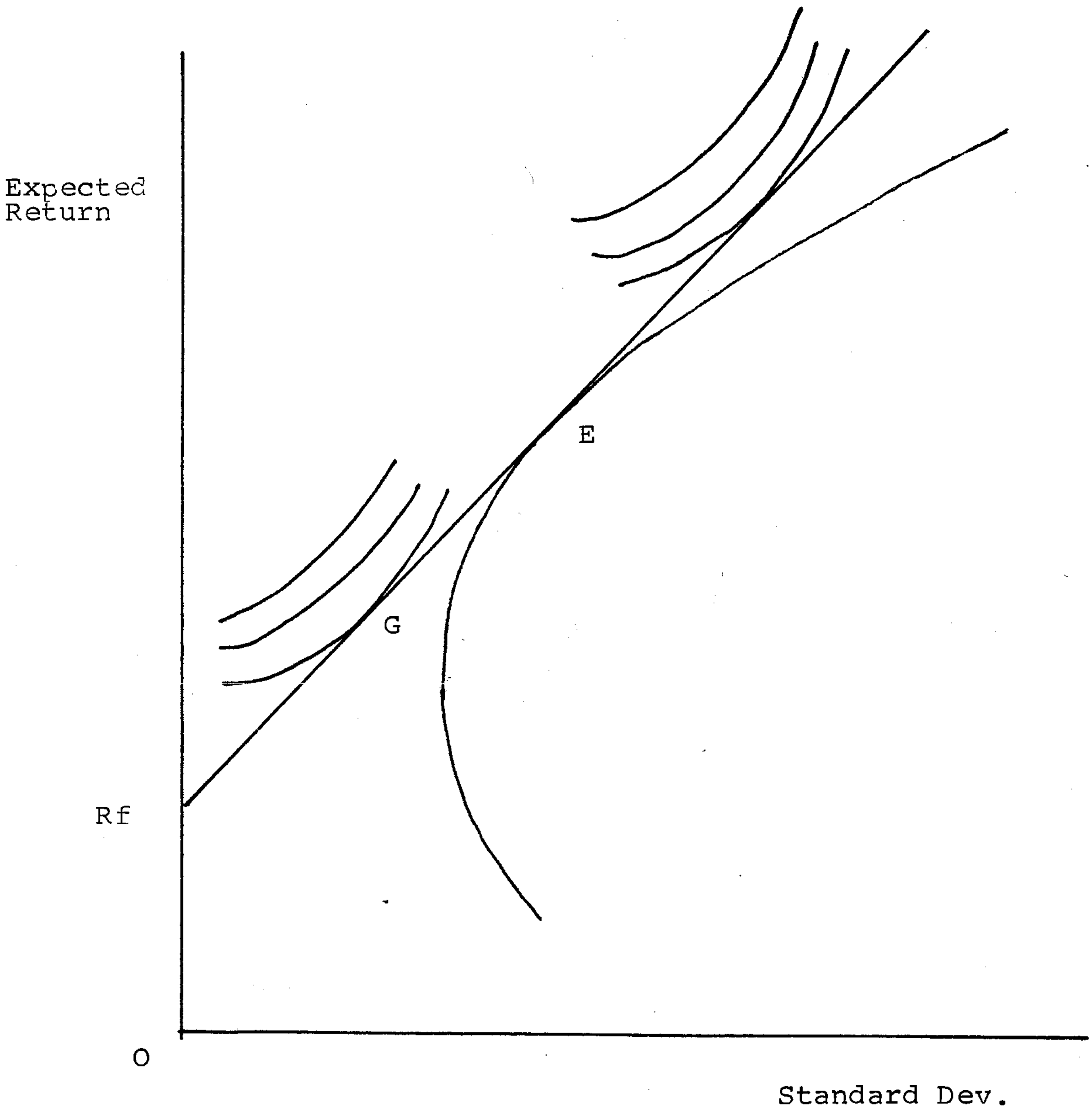

FIGURE 3.3 Optimal Portfolio Choice for Two Risk-averse Investors in the Presence of a Risk-free Asset

asset with the portfolio of all risky assets (E). For example, portfolio represented by point G has some fund in the risky assets and the rest in the risk-free asset. Points on the line beyond E represent borrowing portfolios where money is borrowed at the risk-free rate and invested in the portfolio of risky assets (E). For these portfolios, proportion invested in the risk-free asset, $(1-X) < 0$. In other words, there is negative investment or short-selling of the risk-free asset.

With a risk-free asset, thus, all efficient portfolios are combinations of risky assets (E) with the risk-free asset and are located on the tangent line. The exact combination for an investor depends on his risk-preference. If he is very risk-averse he selects a point on the straight line near R_f; if he is less risk-averse he chooses a point near E. If he is a risk-lover, he goes beyond E and selects a combination. These are illustrated in figure 3.3 above.

The Market Model as an Alternative

As mentioned in chapter one, an alternative, simple portfolio selection model has been developed by Sharpe (1963) which is popularly known as the 'market model' or the 'diagonal model'. This model greatly simplifies the task of portfolio selection in terms of input requirements. This saving of input data is made possible by the assumption that all pairwise covariances between security returns are zero.[4] Security

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[4]This makes the covariance matrix diagonal which is easy to estimate and invert for computational purpose.

returns, instead, are assumed to be related to one another only through their relations with some common index. This common index could be anything, like, the GNP, the stock exchange index, the market portfolio etc. which affects all security returns simultaneously. This model is described by the following equation

$$R_{it} = \alpha_i + \beta_{it} R_{mt} + \epsilon_{it} \tag{3.5}$$

where R_{it} and R_{mt} are return on ith security and the market portfolio respectively, ϵ_{it} is a random error term having expected value of zero, constant and finite variance and is independent of other ϵ_{it}'s and R_{mt}, α_{it} and β_{it} are constants. The common factor used here is the market portfolio.

The expected returns and the variance-covariances which are used as inputs in the portfolio selection problem are derived as follows

$$E(R_{it}) = \alpha_i + \beta_{it} E(R_{mt}) \tag{3.6}$$

$$Var(R_{it}) = \beta_{it}^2 Var(R_{mt}) + Var(\epsilon_{it}) \tag{3.7}$$

$$Cov(R_{it},R_{jt}) = E\{R_{it} - E(R_{it})\}\{R_{jt} - E(R_{jt})\}$$

$$= \beta_{it} \beta_{jt} Var(R_{mt}) \tag{3.8}$$

To generate the variance-covariance matrix from this model we need only n regression coefficients (β_{it}) and the variance of the common factor. In contrast, the full-covariance model would require n(n-1)/2 variance-covariances to be estimated. For n = 100, the market model requires only 101 elements as opposed to 4950 required in the full-covariance model.

Capital Market Equilibrium in a Mean-Variance World: the Capital Asset Pricing Model

So far, I have discussed portfolio selection of an individual investor in a mean-variance framework. We saw that in the presence of a risk-free asset, a rational investor would combine the risk-free asset with a portfolio of risky assets which is mean-variance efficient. Now, if all investors in the market behave in the same way and hold combinations of the efficient portfolio and the risk-free asset, what implication does this have for the equilibrium pricing of assets? In other words, if all investors hold efficient portfolios and the risk-free asset, what sort of relationship can we expect to observe between expected return and risk of securities in equilibrium.

For any individual investor, security prices are given. These are determined by the portfolio decisions of all investors in the market. To go from individual decision to the aggregate and to see its implication on security price determination we need some assumptions:

1. All investors are Markowitz-efficient diversifiers

2. A risk-free rate exists at which any amount of money can be borrowed or lent
3. All investors are assumed to have 'identical expectations' about the probability distribution of future rates of returns
4. No taxes or transaction costs for buying or selling securities exist
5. The capital market always clears

Since all investors in the market are assumed to have the same expectation about the future joint return distribution, everybody will have the same efficient frontier and given the presence of the risk-free asset, same optimal portfolio of risky assets. In other words, in terms of diagram (3.3) above, everybody will want to combine portfolio E with the risk-free asset. E is, therefore, a common portfolio demanded by everybody irrespective of the risk class.

However, due to the difference in the risk-preferences of various investors, they will differ in their way of financing the chosen portfolio. Some investors will lend part of their funds at the risk-free rate R_f and invest the rest in the risky assets; others might invest more than their initial funds in the risky assets by borrowing at the risk free rate. Still others may invest all of their funds in risky assets with no borrowing or lending. There is a clear dichotomy between the optimal investment decision of investors (point E in the diagram) and the decision to finance it (points of tangency between the indifference curve and the efficient line), depending on their attitudes towards risk. This is Tobin's famous Separation Theorem.

For market equilibrium, we need demand for each asset to equal its supply. In portfolio E which is the only portfolio of only risky assets demanded by everybody, aggregate demand for each asset should be such that the market for it clears. In other words, every asset must be demanded in exactly the same proportion in which it is outstanding in the market. This proportion is given by the ratio of the total market value of all outstanding units of *an* asset to the total market value of all outstanding units of *all* assets in the market. For equilibrium, therefore, E has to be a value-weighted portfolio. Since it represents market equilibrium, it is called the 'market portfolio' and represented by point M in figure 3.4 below.[5]

As is clear from the diagram, the market portfolio depends on the risk-free rate of return and the position of the efficient frontier which in turn depends on investors' expectations of the future return distribution. For a different risk-free rate and for different expectations on the part of the

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[5]In theory, the market portfolio includes far more assets than mere securities. It includes all tangible assets, like gold, real estate, collectible commodities, foreign currencies, bonds etc. It is not possible to include 'all' assets in any practical test involving the market portfolio. As such, market portfolio is only a theoretical abstract. Real world surrogates of this portfolio are, for example, the New York Stock Exchange index, the Standard and Poor's 500 index etc. Since these include only the securities, these are clearly sub-optimal and hence inefficient proxies for the 'true' market portfolio.

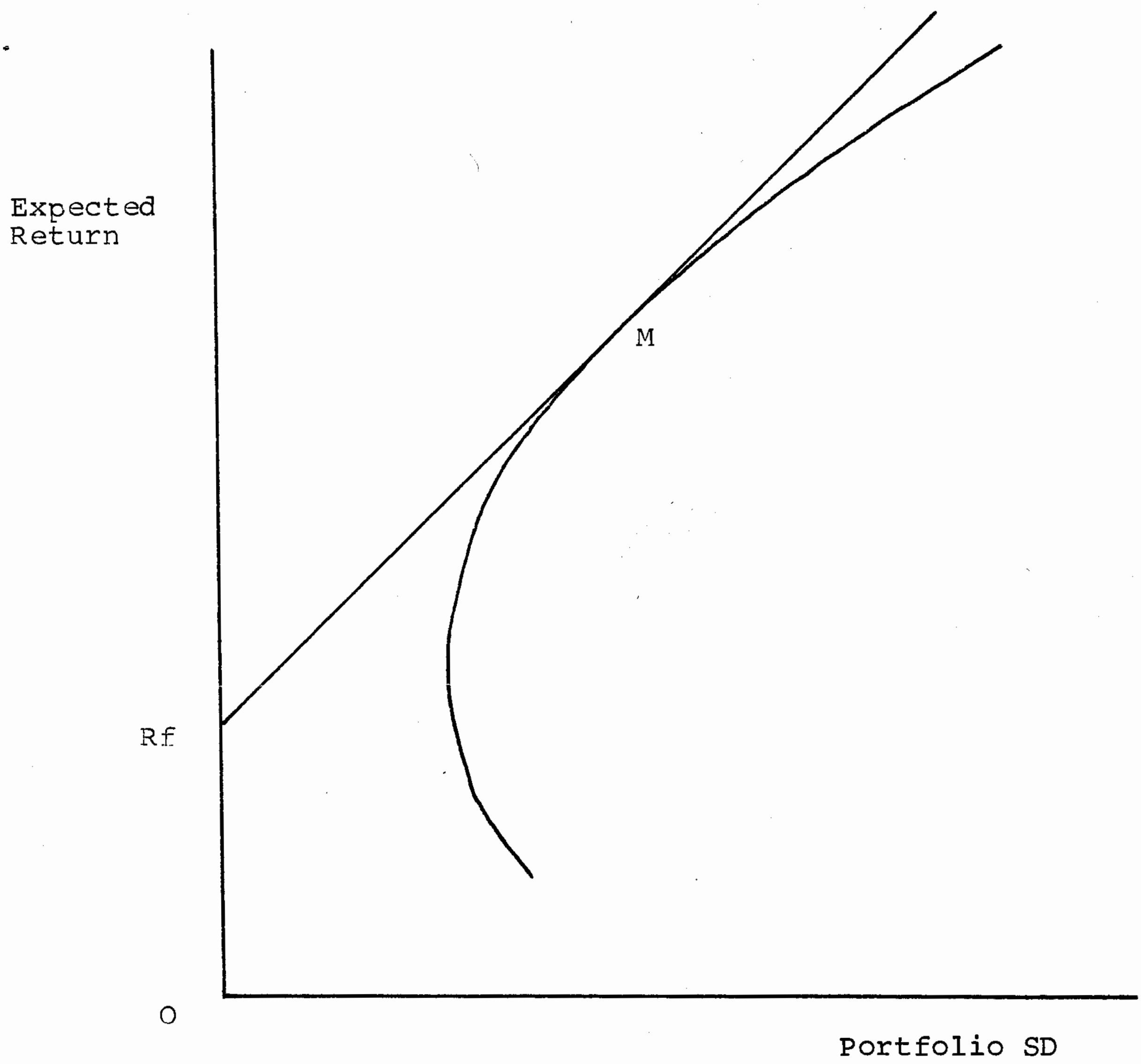

FIGURE 3.4 The Market Portfolio

investors regarding future return distribution, the market portfolio will be different. But in any case, it must be a value-weighted portfolio and since it lies on the mean-variance efficient frontier, it must be an efficient portfolio as well.

What does the market portfolio tell us about pricing of individual securities? For any mean-variance efficient portfolio, e, the relationship between expected return of a security included in that portfolio and its risk is given by the following equation

$$E(R_i) = R_f + \{E(R_e) - R_f\} \beta_{ie} \qquad (3.9)$$

$$i = 1, 2, 3, \ldots \ldots, n$$

where $E(R_e)$ is the expected return on the efficient portfolio (e) under consideration and β_{ie} is the risk of security i in portfolio e, measured relative to the risk of e. Such a relationship follows from the solution to the standard portfolio selection problem described earlier.[6] Since equation (3.9) is true for any mean-variance efficient portfolio and the market portfolio (m) is one such portfolio, we can write

$$E(R_i) = R_f + \{E(R_m) - R_f\} \beta_{im} \qquad (3.10)$$

where $E(R_m)$ is expected return on the market portfolio and β_{im} is the ith asset's risk in the market portfolio, defined as

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[6]See Fama (1976) for derivation of this relationship.

$$\beta_{im} = \frac{Cov(R_i, R_m)}{Var(R_m)} \qquad (3.11)$$

Equation (3.10) defines a linear relationship between expected return on a security and its risk in equilibrium and is called the Security Market Line (SML). Figure 3.5 shows this relationship. $\{E(R_m) - R_f\}$ is the risk-premium or the price of risk for the ith security. Expected return on a security is, therefore, equal to the risk-free rate (R_f) plus the risk-premium times its risk.

The SML has important implications for the equilibrium pricing of securities. In equilibrium, security prices would be such as to make all securities locate on the SML. Any security lying off the line would be in temporary disequilibrium. Consider a security lying above the line, say at L in figure 3.5. This security offers return which is excessively high in relation to its risk. People will buy more of it and its price will rise and consequently, its expected return will fall. They will continue buying it until expected return falls down onto the SML.

Similarly, any security lying below the line, such as N, would be overvalued and the arbitrage process in the market would raise its return up on the SML. Due to its implications for the equilibrium asset pricing, the SML is also called the Mean-Variance Capital Asset Pricing Model (M-V CAPM).

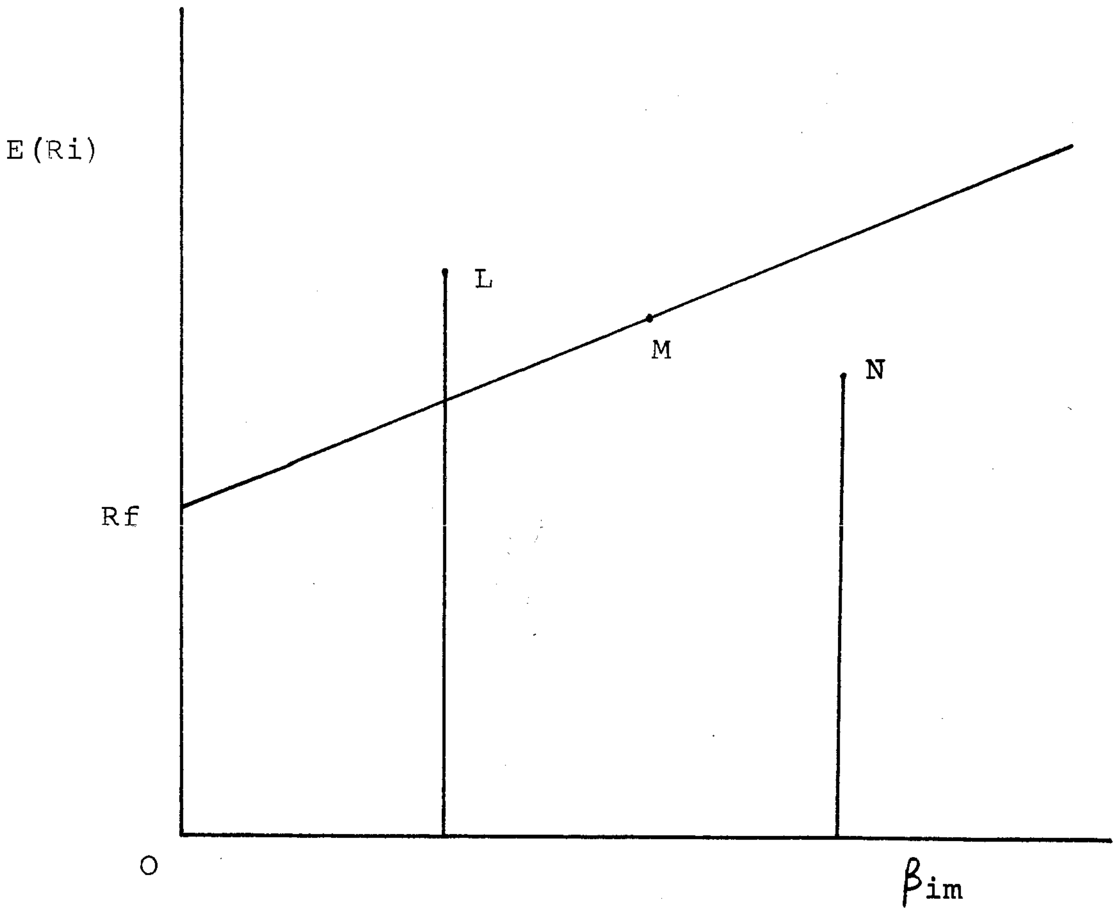

FIGURE 3.5 The Security Market Line (Sharpe-lintner Model)

Developement of this model is credited to Sharpe (1964) and Lintner (1965) and is also called the Sharpe-Lintner Asset Pricing Model.

One of the criticisms of the above model is that it is based on the existence of a risk-free asset. Many people argue that borrowing or lending is never completely risk-free due, for example, to default risk and the uncertain future inflation. An alternative to this model is the Black model which does not assume any risk-free asset in the sense of Sharpe and Lintner. Instead of the risk-free asset, this model, which is credited to Black (1972), uses a portfolio which has positive variance but whose return is uncorrelated with the return on the market portfolio. Such a portfolio contributes nothing to the variance of the market portfolio and hence is riskless in the market portfolio even though it is not risk-free in the sense of having no variability in its return. This portfolio is called the zero-β portfolio (Z). Using this portfolio the Black model is

$$E(R_i) = E(R_z) + \{E(R_m) - E(R_z)\} \beta_{im} , \quad i = 1, 2, 3, \ldots , n \tag{3.12}$$

where $E(R_z)$ is the expected return on the zero-β portfolio. It can be shown that the zero-β portfolio always exists but it is not efficient.

In figure (3.6) below Z is a zero-β portfolio. All minimum variance portfolios can be obtained by combining Z with M

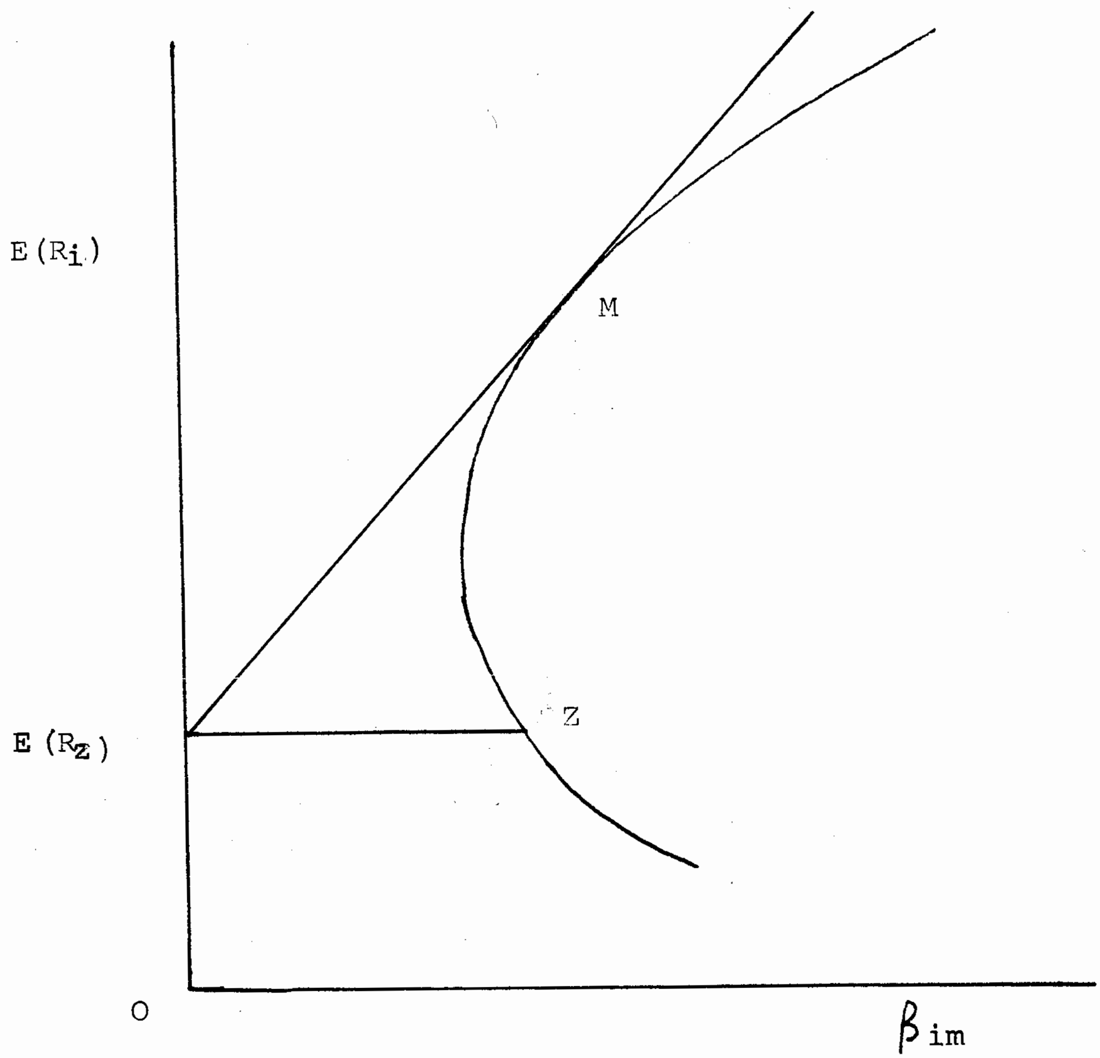

FIGURE 3.6 Zero-beta Portfolio and the Security Market Line (Black Model)

(market portfolio).[7] If X denotes the proportion invested in Z, then returns on different minimum variance portfolios can be obtained by

$$R_p = X\, R_z + (1-X)\, R_m \qquad (3.13)$$

If X = 1.0, we get portfolio Z while with X = 0, we have M. For 0 < X < 1, we obtain portfolios between Z and M on the curve. Portfolios above M on the curve requires short-selling of Z (X < 0) while those on the curve below Z involves short-selling of M (X > 1).

One important requirement of both the Sharpe-Lintner and the Black model is that the market portfolio be efficient i.e., it must lie on the upward-sloping part of the efficient frontier.

In equations (3.9) and (3.10), β_i is, in fact, a measure of the 'systematic risk' of the ith asset which arises due to some common factor, like changes in economic and political environment that affect all securities simultaneously. Another component of total risk, called the 'unsystematic risk', arises due to events unique to the firm that issues the security, such as strikes, management errors, inventions etc. Systematic and unsystematic risk sum to total risk as measured by the variance of returns of a security. The systematic and unsystematic risks can be better explained in terms of the market model described

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[7]Since both Z and M are minimum variance portfolios, any linear combination of them will also be a minimum variance portfolio.

earlier. According to this model[8], total variability of ith asset's return is

$$\mathrm{Var}(R_{it}) = \beta_{it}^2\ \mathrm{Var}(R_{mt}) + \mathrm{Var}(\epsilon_{it})$$

$$= \beta_{it}\ \mathrm{Cov}(R_i, R_{mt}) + \mathrm{Var}(\epsilon_{it})$$

(using equation for β_{it} in 3.11 above)

= Systematic Risk + Unsystematic Risk

Diversification can remove all of the unsystematic risk so that in an efficient portfolio, risk of a security is really its systematic risk which cannot be gotten rid off. The market pays premium only for the systematic risk, as is evident in equation (3.10) above.

How is the market model related to the SML? Although the market model is essentially a time-series regression model for a single security and in contrast, the SML is a cross-sectional equilibrium relationship between expected return and systemstic risk of many securities, the expected values of the two models may be equated to gain insight into the intercept term of the market model. Taking expectation of the market model (equation 3.5 above), the two models are

$$E(R_i) = \alpha_i + \beta_i E(R_m) \qquad : \text{Market Model}$$

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[8]See equation (3.5) above.

$$E(R_i) = R_f + \beta_{im}\{E(R_m) - R_f\}$$

$$= (1 - \beta_{im}) R_f + \beta_{im}E(R_m) \qquad : \text{SML}$$

Technically, putting $\alpha_i = (1 - \beta_{im})R_f$ in the expectation of the market model we get the SML but these are two different models and the SML does not imply anything about the validity of the market model. All we can say is that if the capital market is in equilibrium, the intercept term (α_i) of the market model is a negative function of the asset's systematic risk (β_{im}) and positive function of the risk-free rate (R_f) when $\beta_{im} < 1$.

International Pricing of Risk: The International Capital Asset Pricing Model

Does the stochastic generating process that determines domestic security prices carry over to the international capital market as well? In other words, is there an international counterpart of the domestic SML as defined in equation (3.10)? Two key variables in the return generating process are the risk-free rate (or the return on the zero-β portfolio) and the return on the market portfolio. The market portfolio, in turn, depends on the risk-free rate as well as on the investors' subjective evaluations of the next period's return distribution. Now, does there exist an 'international risk-free rate' or an 'international market portfolio'?

One important characteristic of the international financial market is the presence of exchange risk that makes the same asset look different to investors of different nationalities and that makes the domestic risk-free asset risky to foreigners. In the presence of a forward market, however, the exchange risk can be hedged by entering into forward contract. Therefore, at least on a theoretical level, an international risk-free rate can be defined on a covered basis under the following assumptions[9]: (a) A risk-free rate exists in each national capital market (b) International capital flows are completely unrestricted (c) All investors have the sigle-period horizon, irrespective of nationality (d) Spot and forward markets are perfect (e) No default risks and transaction costs exist.

Solnik (1974c) defined such a rate as the weighted average of national risk-free rates where the weights were determined by the relative market value of each country's stocks. He, however, did not explain the utility of this 'composite' rate i.e., whether and how borrowing and lending can take place at this rate and whether the international money market will be in equilibrium at this rate. Since such a rate does not exist in practice, it is nothing more than a theoretical abstract, like the market portfolio.

Defining an 'international market portfolio' is even more difficult. In addition to the assumptions mentioned in connection with the international risk-free rate, we will have

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[9]See Adler and Horesh (1974).

to assume that all investors, irrespective of their nationalities, hold same expectation about the future security returns and exchange rate changes. Aside from the investor's subjective evaluation which differs from investor to investor, the large volume of information which must be made available to all investors to make this happen may make the assumption quite unreasonable. If all investors do not have identical expectations, there cannot be any 'international market portfolio'. Even if they do and a world market portfolio can be defined, its efficiency may be questioned. It may be recalled here that a market portfolio should include 'all' assets, not merely securities and it must be efficient. The world market portfolio, therefore, should include all assets in the world!

In spite of the practical limitations of defining international risk-free rate and the market portfolio and similar other problems, there have been attempts in the past to describe 'International Capital Asset Pricing Model'. These models (some of which are described in chapter one) are theoretically appealing but their testability very often poses problems. As such these are more relevant for class-room discussion than for practical research.

CHAPTER IV

DATA AND DEFINITION OF VARIABLES

The time period covered by this study extends from 1959 to 1982. Choice of this period is primarily dictated by the availability of data. There are 18 countries in the sample namely, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, S. Africa, Sweden, Switzerland, the U.K. and the U.S.

Published studies on international portfolio diversification report three major sources of data on international stock prices. These are the Capital International Perspective, the Eurofinance and the International Financial Statistics. Among them, the Eurofinance is out of business and their data file also disappeared with them.[1] The Capital International data, published from Geneva, Switzerland is available only from 1970 from a source accessible to me. Since one of the objectives of this thesis is to estimate the effects of exchange rate fluctuations on portfolio risk and return, data from this more reliable source could not be used throughout because they were not available for the fixed exchange rates period. The only other source having data for the fixed as well as flexible exchange rates periods was the International Financial Statistics (IFS) and therefore, monthly and quarterly stock

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[1]I came to learn this through personal correspondance with Bruno Solnik who mentioned and used this data source. See Solnik (1974).

price index data for the 18 countries were taken from various issues of this source. Unless otherwise stated, all calculations were done using the IFS data. Description of country indices as mentioned in the IFS issues are mentioned below.

1. Australia: all ordinaries -- indexes are averages of daily Sydney quotations.
2. Austria: average Friday quotations of 41 shares on the Vienna stock exchange
3. Belgium: data refer to 10th of month quotations for all industrial shares on the Brussels and Antwerp exchanges
4. Canada: data on closing quotations at the end of the month on the Montreal stock exchange for 65 industrial shares
5. Denmark: index covering a sample of shares on the Copenhagen exchange
6. Finland: industrial share price index
7. France: industrial share price index based on a sample of 180 shares on Paris exchange. Price data refer to the opening quotations on the last Friday of the month
8. Germany: sample covers approximately 90 p.c. of common shares of industrial companies with headquarters in Germany
9. Ireland: index of share prices based on begining of month quotations on the Dublin stock exchange
10. Italy: the index is an average of daily spot closing quotations of common shares of 40 major companies on the Milan exchange
11. Japan: the index is an average of daily closing prices for all shares listed on the Tokyo exchange

12. Netherlands: the index covers a sample of 25 industrial shares quoted on the Amsterdam exchange and is compiled daily

13. Norway: the index refers to mid-month prices of manufacturing and mining shares quoted on the Oslo exchange

14. S. Africa: index of gold mining shares

15. Sweden: the general index refers to prices of all shares on the Stockholm exchange as of the end of the month.

16. Switzerland: prices are Laspeyres averages of Friday quotations of 49 industrial shares in Zurich, Basel and Geneva.

17. U.K.: data refer to the average of daily quotations of 500 industrial ordinary shares

18. U.S.: Laspeyres index of Standard and Poor Corporation for 400 industrial shares on the New York stock exchange based on daily closing quotations.

Monthly and quarterly data on end-of-period spot exchange rates, quarterly GNP and the U.S. Treasury Bill rate were also obtained from the IFS, various issues.

Dollar-adjusted rate of return on ith country's asset in period t is defined as

$$R_{it} = \ln(P_{it}/ E_{it}) - \ln(P_{it-1}/ E_{it-1})$$

$$= \ln(P_{it}/ P_{it-1}) - \ln(E_{it}/ E_{it-1}) \qquad (4.1)$$

where P_{it} = stock price index of country i in period t, E_{it} =

end-of-period spot exchange rate between ith country's currency and the U.S. dollar, defined as the price of one U.S. dollar in national currency.

Since dividend data were not available for all countries and for the entire period under investigation, I had to omit them from this study. The rates of return thus calculated, therefore, underestimate the true returns on this account. However, to see the effect of excluding dividend yields on portfolio risk and return, monthly data from the Capital International Perspective which reports dividend yields were used for 1970-1981.

The expected return and variance of ith country's asset in period t are calculated using the marginal distribution for the return of this asset in period t. Using the methodology described in chapter 2, these are calculated as

Expected Return of ith asset in period t,

$$E(R_{it}) = \sum_{k=1}^{T} R_{it-k} \cdot \pi_{it-k}$$

$$= \sum_{k=1}^{T} R_{it-k} / T \qquad (4.2)$$

where $\pi_{it-k} = 1/T$ is the estimated probability associated with R_{it-k} and T is the no. of observations used to estimate this probability.

Variance of ith asset in period t,

$$V(R_{it}) = E\{R_{it-k} - E(R_{it})\}^2$$

$$= \sum_{k=1}^{T} \{R_{it-k} - E(R_{it})\}^2 / T \qquad (4.3)$$

where $E(R_{it})$ is given by (4.2) above

Pairwise covariances between returns of asset i and j in period t,

$$Cov(R_{it}, R_{jt}) = E[\{R_{it-k} - E(R_{it-k})\}\{R_{jt-k} - E(R_{jt-k})\}]$$

$$= \sum_{k=1}^{T} \{R_{it-k} - E(R_{it})\} \cdot \{R_{jt-k} - E(R_{jt})\}/T, \qquad i \neq j \qquad (4.4)$$

Expected and realized return and variance of a portfolio in period t are defined as,

Expected return, $$ER_{pt} = \sum_{i=1}^{n} X_{it} E(R_{it}) \qquad (4.5)$$

Realized return, $$RR_{pt} = \sum_{i=1}^{n} X_{it} RR_{it} \qquad (4.6)$$

Portfolio Variance,

$$V_{pt} = V(ER_{pt})$$

$$= V(\sum_{i=1}^{n} X_{it} E(R_{it}))$$

$$= \sum_{i=1}^{n} X_{it}^{2} V(R_{it}) +$$

$$\sum_{i=1}^{n} \sum_{j=1}^{n} X_{it} X_{jt} Cov(R_{it}, R_{jt}), \quad i \neq j \qquad (4.7)$$

where X_{it} is the portfolio weight of asset i in period t and

RR_{it} is actual or realized return of asset i in period t and

n is the number of assets in the portfolio.

Portfolio variance may simply be written as

$$V_{pt} = X'\Omega X$$

where X is a nx1 column vector of portfolio weights

and Ω is a nxn matrix of variances and covariances.

For the special case of the equally weighted portfolio, $X_{it} = X_{jt} = 1/n$ and portfolio expected return and variance are simply,

$$ER_{pt} = 1/n \; \Sigma \; E(R_{it})$$

$$= \text{Arithmatic Average of } E(R_{it}) \qquad (4.8)$$

$$V_{pt} = Var\{1/n \; \Sigma \; E(R_{it})\}$$

$$= 1/n^2 \; \Sigma \; \sigma_{it}^{2} + 1/n^2 \; \Sigma\Sigma \; \sigma_{ij}, \qquad i \neq j$$

$$= 1/n \{\Sigma (\sigma_{it}^2)/n\} + (n-1)/n \{\Sigma\Sigma \sigma_{ij}/ n(n-1)\}$$

= 1/n (Average of n variances) +

(n-1)/n (Average of n(n-1) covariances)

(4.9)

where σ_{it}^2 and σ_{ij} are the variance of the ith asset and covariance between ith and jth asset respectively. As n gets larger, 1/n gets closer to 0 and (n-1)/n gets closer to 1. The contribution of the security variances to portfolio variance declines and portfolio variance approaches to the arithmatic average of the pairwise covariances. How large n has to be to make this happen depends on the size of the average of the variances and of the covariances relative to total portfolio variance and can be determined empirically.

CHAPTER V

ACTIVE PORTFOLIO MANAGEMENT AND THE GAINS FROM INTERNATIONAL PORTFOLIO DIVERSIFICATION

Ideally, portfolio choice under uncertainty should be undertaken by considering the ex ante distribution of the rates of returns of assets under consideration. Since at the time of making portfolio decision investors do not know what future has in store for them with regard to the performance of the assets in their portfolios, they make their choice on the basis of ex ante expectation of the performance of the assets. Modeling expectations is one of the most difficult tasks. Expectation varies from person to person and, in fact, there could be as many expectations as there are investors. The problem is often made tractable by assuming homogeneous expectation for all investors i.e., every investor is assumed to hold the same common expectation about the future performance of the assets. If past is any guide into the future, past information on assets may be used to form expectations about the future performance of these assets.

Though researchers recognize the importance of the ex ante return distribution for portfolio choice, for reasons not very clear (except, of course, for 'making life easier'), almost everybody, with the exception of a notable few, ignored this expectation. Rather, previous research followed the 'custom' of using ex post data in place of the ex ante expectation.[1] To quote Levy (1981),

> In this (his) paper, the use of ex post data serves as a proxy for the potential gain from diversification. Note that by the construction of the mean-variance efficient frontier with ex post data, we have a sampling bias in favour of assets that are characterized by a low variance (or a high mean) in the sample. .... Obviously, for investment decisions, one should use ex ante prediction. (p.326)

As mentioned earlier, this procedure is valid only if the underlying stochastic process that generates data is stationary over time.

The use of ex post data to calculate the expected returns and the variance-covariance matrix also ignores the 'estimation risk' i.e., the risk or uncertainty in estimating the parameters of the ex ante return distribution. Leaving this uncertainty out is to use the parameter estimates as their true values. This leads to an underestimation of portfolio variance as can be shown by the following:

Let $R_t = \{R_{1t}, R_{2t}, \ldots, R_{nt}\}'$ be a vector of random returns and $\mu_t = \{\mu_{1t}, \mu_{2t}, \ldots, \mu_{nt}\}'$ and $V_t = \{\sigma_{ij}\}$, i=1, 2, ..., n and j=1, 2,..., n be vector of expected returns and variance-covariance matrix respectively. As of period (t-1), R_t, μ_t and V_t are unknown and must be estimated. Usually these are estimated from ex post data and used as the 'true' parameter

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[1]See, for example, Grubel (1968), Levy and Sarnat (1970), Solnik (1974b,c), Levy (1981). For an exception to this practice, see Von Furstenburg (1981), Logue (1982), Jorion (1983).

values. The portfolio expected return and variance which follow from this 'perfect foresight' model are

$$P = X'R_t \quad \text{and} \quad E(P) = X'\mu_t \qquad (5.1)$$

and

$$V(P) = V(X'R_t) = X'\hat{V}_t X \qquad (5.2)$$

where X is a vector of portfolio weights and $\hat{V}_t$ is the sample variance-covariance matrix.

We now take the uncertainty about the parameter estimates into account. Let $\hat{\mu}_t$ be an unbiased estimator of μ_t. Then

$$E(\hat{\mu}_t) = \mu_t \qquad (5.3)$$

and

$$V(\hat{\mu}_t) = V_t^* = E(\hat{\mu}_t \hat{\mu}_t') \qquad (5.4)$$

where

$$\hat{\mu}_t = \{\hat{\mu}_{1t}, \hat{\mu}_{2t}, \ldots \ldots, \hat{\mu}_{nt}\}$$

and

$$\hat{\mu}_{it} = (1/n) \Sigma R_{it}$$

Taking into account the uncertainty about $\hat{\mu}$ only, the portfolio expected return is

$$E(P) = E(X'R_t) = X'\mu_t \qquad \text{(using 5.3)} \qquad (5.5)$$

which is the same as in (5.1) above and portfolio variance

is given by[2]

$$V(P) = V(X'R_t) = X'V(R_t)X = X'V_tX$$

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[2]See Appendix I for derivation of this expression.

$$= X'\hat{V}_tX + X'V_t^*X + 2\ X'COV_tX \qquad (5.7)$$

where V_t and $\hat{V}_t$ are the true and sample variance-covariance matrix respectively of the security returns and V_t^* is the variance-covariance matrix of $\hat{\mu}_t$ and COV_t is the covariance matrix between R_t and $\hat{\mu}_t$. The covariances between R_t and $\hat{\mu}_t$ would be positive since $\hat{\mu}_t$ is a positive linear function of R_t. If uncertainty in estimating μ_t is ignored portfolio variance is underestimated since

$$X'(\hat{V}_t+V_t^* + 2\ COV_t)X > X'\hat{V}_tX \quad \text{where} \quad X'V_t^*X > 0 \qquad (5.8)$$

So far we have not taken into account the uncertainty in estimating the variance-covariance matrix, V_t. In fact, this has to be estimated along with μ_t. Estimation of this variance-covariance matrix is more difficult than estimating the mean return vector. The uncertainty about the variance-covariance matrix may be greater and therefore may have greater impact on portfolio risk.

Barry (1974) investigated the effect of uncertainty due to unknown means as well as variance-covariances. He showed that uncertainty about these parameters does not affect portfolio mean. However, portfolio variance increases as more and more uncertainty is introduced. Portfolio variance is higher with unknown mean and variance-covariance matrix than with unknown mean but known variance-covariance matrix.

As regards the effects of additional uncertainty on the efficient set, he showed that the portfolio which is efficient in the parameter-certainty model also remains efficient in the parameter-uncertainty model but the optimal portfolio changes due to shifts of the efficient frontier with additional uncertainty. The extent to which the optimal portfolio differs depends on the amount of information used to estimate the parameters i.e., on the sample size. As the sample size approaches infinity, the efficient set under parameter-uncertainty case tends to coincide with that under the parameter-certainty case.

Frankfurter, Phillips and Seagle (1971) investigated the simultaneous effects of error in estimating the means, variances and covariances of security returns which were assumed to be distributed normally. Using the Monte Carlo method of data analysis they found, quite interestingly but with no surprise, that portfolios which were extremely inefficient in terms of true parameter values (i.e., having low mean and high variance) appeared efficient in large proportion of sample trials. "In general, the efficient and inefficient portfolios seemed to appear on the efficient frontier with relative frequencies that would not distinguish them" (F-P-S, 1971). Also, these inefficient portfolios dominated the truly efficient portfolios in large proportion of the trials.

The above findings question the validity of portfolio selection models that ignored the uncertainty in estimating the parameters of the return distributions.

One approach to take care of the 'estimation risk', under multivariate normality of the return distributions, is to use a correction factor in the sample variance-covariance matrix (see Bawa and Brown, 1979, p.89). The appropriate variance-covariance matrix, with non-informative "Jeffrey's" prior and under the assumption that the true distribution is multivariate normal, would be

$$V = (1+1/T)\{(T-1)/T-m-2\}\hat{V} = C(T,m)\ \hat{V} \qquad (5.9)$$

where $\hat{V}$ is the sample variance-covariance matrix and T and m are number of observations and assets respectively. From (5.9), estimation risk leads to a proportional increase in portfolio variance. With T=60 and m=20, the portfolio variance with C would be 1.58 times the variance without C. It may be noted, however, that the composition of the efficient portfolios would remain unchanged.

The dollar-converted returns of international assets which are basically product of two random variables are very unlikely to follow normal distribution so that the correction factor C(T,m) does not strictly apply to our case. In fact, we do not know, a priori, the functional form of the true return distribution so that portfolio choice must be made with unknown distribution in a non-parametric setting. The unknown distribution is approximated by means of a Bayesian predictive distribution using prior and sample information. In the special case of non-informative prior and when the true distribution follows Dirichlet process, Bawa (1979) has shown that the predictive distribution can be approximated by the empirical distribution function.[3]

For the sake of simplicity, I would assume the non-informative prior case and estimate the predictive distribution using the empirical distribution function. More specifically, using the most recent past T periods observations on returns, the joint empirical distribution function for the current period is estimated by assigning an equal probability (1/T) to each of the T past joint realizations to occur in this period. For example, with quarterly data and using the most recent past 40 quarters observations (T=40), the joint return distribution for 1965 (1) is estimated by giving each of the 40 past joint realizations over 1955(1) to 1964(4) an equal probability (1/40) to occur in 1965(1). In the next period, 1965(2), one more set of observations becomes available and is added to the information set and one set of observations from the other end is dropped so that joint realizations over 1955(2) to 1965(1) are used to estimate the joint distribution for 1965(2). In this moving fashion, the joint return distribution for each period is estimated. The procedure updates the information set in each period on the basis of most recent past information available and is, therefore, efficient.

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[3]See Bawa (1979), pp. 98-100, for details.

Having estimated the joint return distribution for a given period, the expected returns and the variance-covariance matrix are calculated using the marginal distributions and used as inputs in the portfolio selection problem for that period. The process is repeated for every other period in the sample.

Non-stationarity of the Expected Returns and/or the Variance-covariances

Maldonado and Saunders (1981) tested for the intertemporal stability of the international correlation structure with data from Japan, Germany, Canada, U.K. and U.S. over the period 1957-78. Dividing the sample period into two equal sub-periods, they found significant changes in the correlation coefficients in three out of four cases.

An indirect test for stability of the expected returns and/or variance-covariances has been proposed by Fung (1979) who argued that if these are stationary overtime, this should be reflected in similar portfolios being selected in different time periods. Based on this, Yallup (1982) suggested comparison of portfolio compositions in different time periods with a certain level of risk or return. In table 5.1, I compared the composition of the optimal portfolio with SD=4.0 and SD=5.0 using ex ante data and 28-quarter estimation period.

First, consider the behaviour over time of the portfolio with SD=4.0. In 1966(2) and (3), Ireland is the dominant

Table 5.1

Composition of the Optimal Portfolio with SD = 4.0 & SD=5.0, Ex ante Data, 28-qtr Estimation Period, Selected Periods

Period	Portfolio Composition (p.c)	Expected Return (p.c)
	SD = 4.0	
1966-2	IR=93.53, SA=6.47	2.79
3	I=1.78, IR=88.55, SA=6.78, US=2.89	2.15
4	IR=78.32, SA=1.57, US=20.11	2.00
....	....	....
1968-4	A=37.79, IR=41.79, SA=10.32, US=10.11	2.19
1969-1	A=24.61, IR=47.36, J=3.71, SA=5.44, US=18.88	2.12
2	A=33.22, C=14.78, IR=40.84, SA=8.68, US=2.48	2.12
.....	....	.....
4	A=41.45, G=3.5, IR=3.78, US=50.02 J=1.25	2.09
1970-1	A=44.95, G=6.56, J=19.39, US=29.09	2.20
2	A=41.00, C=28.90, G=8.90, US=0.42 J=20.77	2.09
3	A=35.62, C=9.19, G=2.87, J=19.73, SA=0.81, US=9.76, NW=22.01	1.24
4	A=28.88, C=23.68, J=23.16, SA=1.10, NW=23.18	1.29
....	....	.....
1982-1	C=11.32, D=3.90, J=44.97, US=23.26, AU=0.28, FN=16.27	2.31
2	D=1.43, J=41.42, UK=10.22, US=25.89, FN=21.03	1.78

contd. next page

Table 5.1 contd.

3	D=1.13, J=43.02, UK=14.68, US=21.22,FN=19.94	1.59
4	D=7.85, J=29.07, SW=9.88, UK=23.90,US=14.54, FN=14.76	1.79
	SD = 5.0	
1979-2	C=2.93, J=2.74, SA=6.90, SW=2.35 US=42.64, AU=39.31, FN=3.14	1.35
3	C=6.17, J=2.03, SA=6.27, SW=0.61, US=39.37, AU=42.87,FN=2.68	1.32
4	C=5.34, J=3.63, SA=6.40, SW=0.43 US=39.38, AU=41.43,FN=3.37	1.32
1982-1	A=1.22, C=21.98, D=3.87, J=66.93, UK=4.78, US=1.22	3.25
2	C=0.52, D=0.55, J=56.52, UK=16.34,US=18.89, FN=7.18	2.37
3	J=57.93, UK=21.77, US=9.98, FN=10.32	2.01
4	D=8.74, J=36.27, SW=14.44, UK=34.29,US=2.19, FN=4.08	2.20

Legend: A=Australia, AU=Austria, C=Canada, D=Denmark, FN=Finland, G=Germany, I=Italy, IR=Ireland, J=Japan, NW=Norway, SA=South Africa, SW=Sweden, UK=United Kingdom, US=United States country. Just after one quarter, in 1966(4), its importance falls to less than one-half of what it was in 1966(2) and (3) and Australia gets in with almost equal weight as Ireland. In 1969(4), the weight of Ireland in the portfolio falls down to only about 4 p.c. and in the following period, it gets out of the portfolio altogether and now the U.S. occupies the dominant position. So, between 1966(3) and 1969(4) -- a period of little over 3 years -- we see a complete reversal of portfolio composition. In 1970(4), both Ireland and the U.S. drop out of the optimal portfolio. For the portfolio having the same risk, such instability and reversal of portfolio composition clearly points to the non-stationarity of the variance-covariance matrix and/or the expected returns.[4]

Comparison over longer time period also reflects instability of the portfolio. For example, compare the portfolio composition between 1968(4) where Australia and Ireland account for about 80 p.c. of the total weight and 1982(4) where Japan, U.K., U.S. and Finland -- a different set of countries -- account for more than 80 p.c. of the total weight. However, much of this instability could be due to the two different exchange rates systems involved. To see that even within the same exchange rates system, optimal portfolio having the same risk differs substantially between two points of time, we concentrate on the

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[4]Intertemporal behaviour of the minimum variance portfolio (M) would indicate if the variance-covariance matrix is stationary. As pointed out in chapter two, this portfolio is independent of the expected returns. Comparison of this portfolio over time indicates that the variance-covariance matrix is not stable.

portfolio with SD=5.0 under the flexible exchange rates regime.[5]

From the bottom panel of table 5.1, we see instability of the portfolio with SD=5.0. Compare the portfolio between, say, 1979(4) and 1982(4). In 1979(4), Austria and the U.S. account for over 80 p.c. of the total weight while in 1982(4) -- after the period of 3 years -- we see the dominance of Japan, U.K., and Sweden, accounting for 85 p.c. of the total weight.

Thus, within the same exchange rates regime, fixed or flexible, we see instability of the optimal portfolio having the same risk. This is reflected in the shifting ex ante efficient frontiers over time as shown in figure 5.1.[6] It appears that there had been a rightward shift of the frontiers over time which implies that for given risk, portfolio return decreased or for given return, portfolio risk increased. From the mid-1970's, the minimum portfolio SD for each quarter was 4.5 or higher whereas during the late 1960's and early 1970's the maximum portfolio SD was around 5.0. Comparing the significant shift of the efficient frontier between 1969(2) and 1982(4) we see that in order to have 2 p.c. expected return in 1969(2) the minimum portfolio SD required was 3.0. To have the same 2 p.c. return in 1982(4) the investor had to accept portfolio SD of 8.0.

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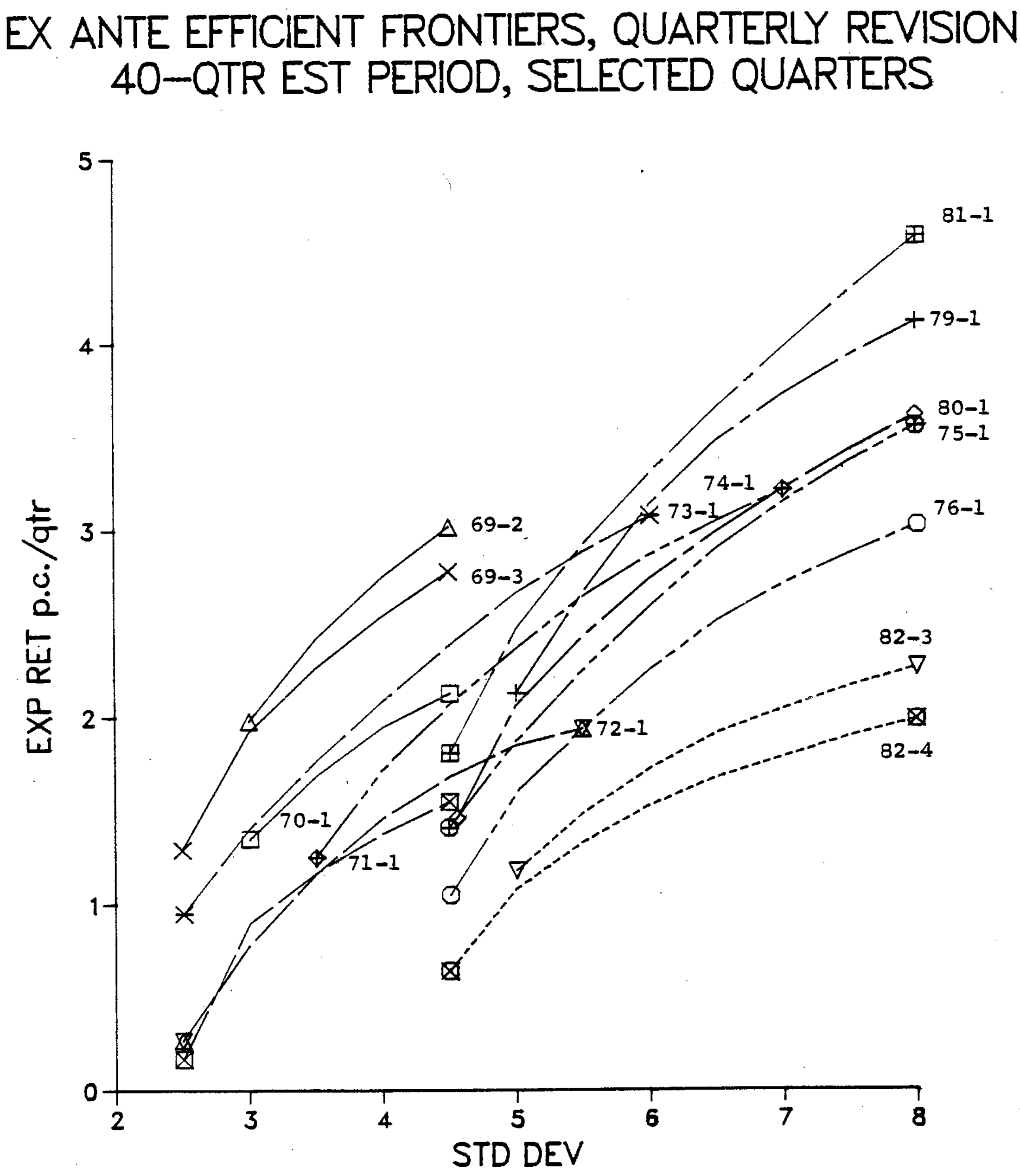
[5] We could not use the portfolio with SD=4.0 for the purpose because the minimum possible portfolio SD was higher than 4.0 in in many of the flexible exchange rates periods considered.

[6] This is based on the 40-quarter estimation period.


EX ANTE EFFICIENT FRONTIERS, QUARTERLY REVISION
40—QTR EST PERIOD, SELECTED QUARTERS
EXP RET p.c./qtr
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80-1
75-1
74-1
73-1
76-1
69-2
69-3
82-3
72-1
82-4
70-1
71-1

FIGURE 5.1

The dramatic increase in portfolio risk for given return evidenced above was partly due to the exchange rate fluctuations. Within the same exchange rate regime (fixed or flexible), the efficient frontiers shifted as well from period to period. This is evident from a comparison of frontiers for, say, 1981(1) and 1982(4). This was primarily due to the non-stationarity of the underlying stochastic process that generated the data.

Active Portfolio Management

In view of the instability of the expected returns and/or the variance-covariance matrix and consequently the mean-variance efficient frontiers evidenced above, it would be very misleading to use ex post data and select an optimal portfolio for the entire period. However, if portfolios are revised every period it is possible to take care of the shift of the efficient frontiers overtime. In that way the investor can 'internalize' the problem of non-stationarity and select an optimal portfolio for each period according to his risk-preference. The instability of the expected returns and the variance-covariances, therefore, is not a problem for the 'active' investors.

However, there is a little 'catch' --- revising portfolio every period is not without cost. There are transaction costs involved in each round of trading and active management must earn sufficient return to have competitive net returns. I will take up the issue of transaction costs later in the chapter. For the moment, I assume that trading is cost free.

Our primary objective is to demonstrate the advantages of international portfolio diversification over domestic diversification. Using active portfolio management policy, I want to accomplish this by comparing the performances of some internationally diversified portfolios with that of a domestic benchmark portfolio. The international portfolios investigated are discussed in chapter 2 and shown graphically in figure 2.1 which is reproduced here for convenience.

Non-Existence of the Portfolios

It should be mentioned here that except for portfolio M which has the smallest possible variance of risky assets only, all other portfolios may not exist for any period, given no short-selling of assets, under the following circumstances

1. Portfolio E will not exist if variance of the domestic portfolio (D) exceeds the maximum possible portfolio variance without leverage i.e.,

$$\text{Var}(D) > \text{Max portfolio variance}$$

   However, E' will exist if unlimited borrowing is allowed. (See figure 5.2a for an exposition).

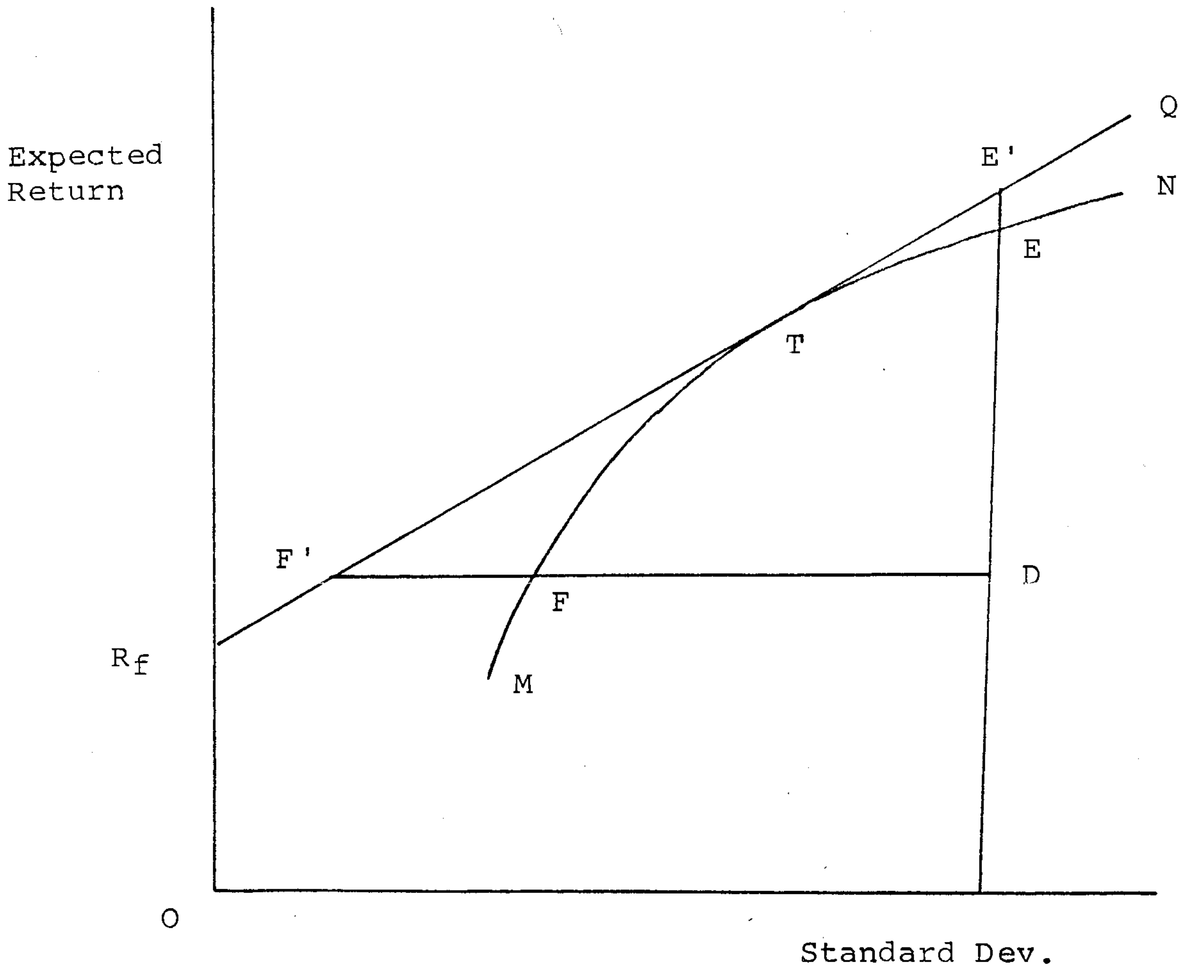

FIGURE 2.1 The Portfolios Investigated

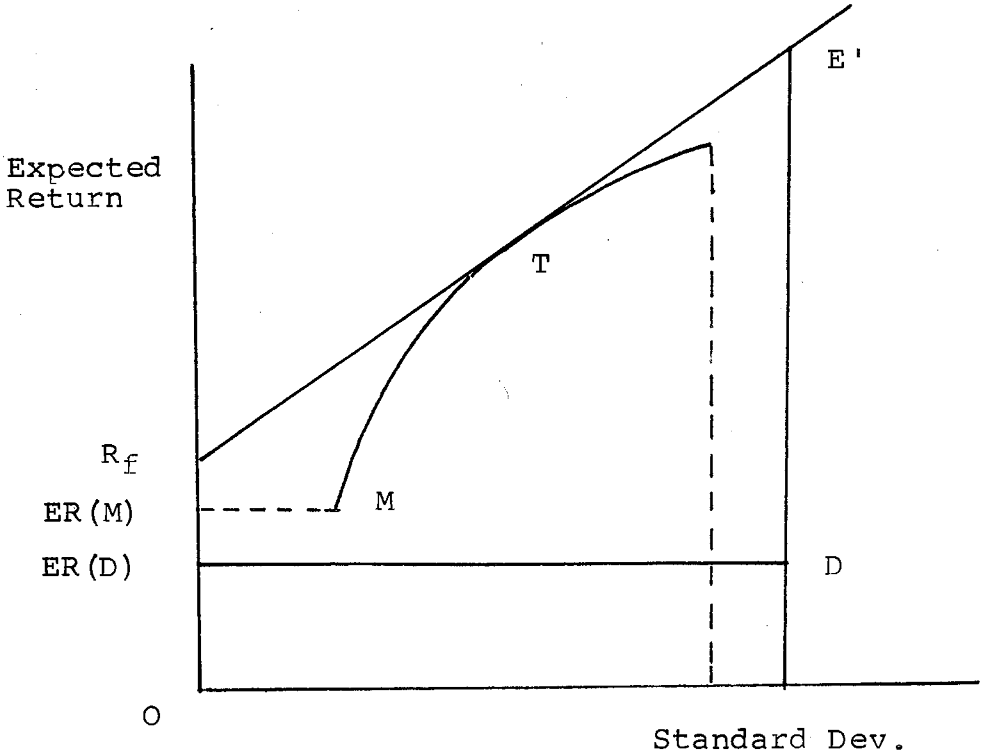

FIGURE 5.2a Non-existence of E, F

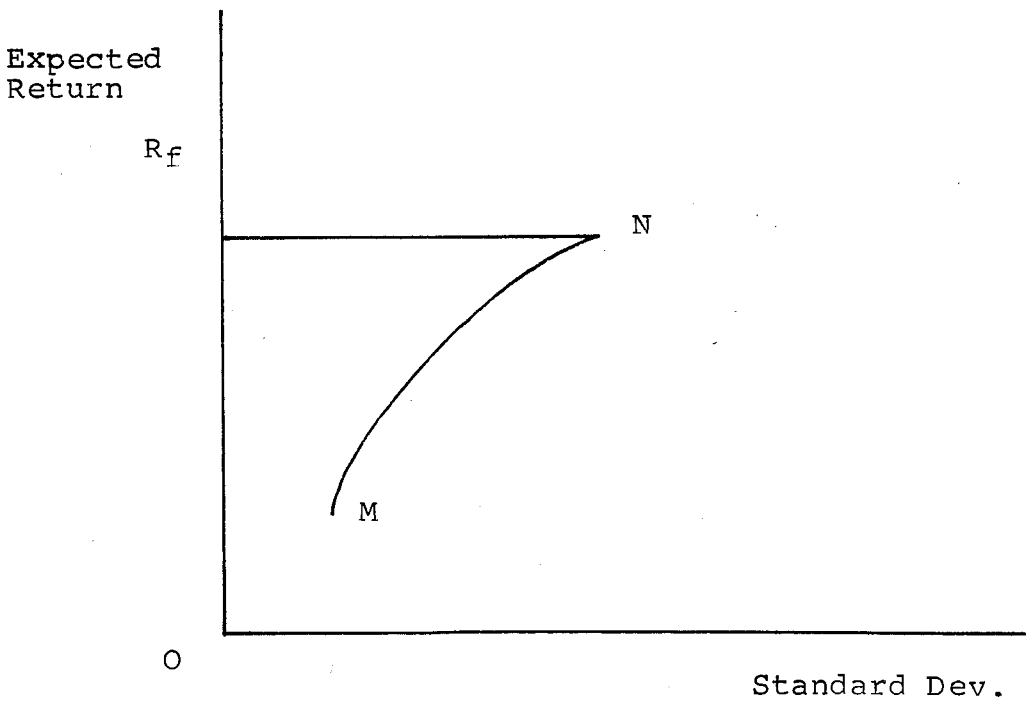

FIGURE 5.2b Non-existence of T

2. Portfolio F will not exist if expected return on the domestic portfolio falls short of the expected return on the minimum variance portfolio (M)

$$ER(D) < ER(M)$$

and portfolio F' will not exist if expected return on D happens to be lower than the domestic risk-free rate (R_f)

$$ER(D) < R_f$$

(See figure 5.2a)

3. Portfolio T will not exist if RF is greater than the maximum portfolio expected return

$$R_f > \text{Max portfolio expected return}$$

(See figure 5.2b)

<u>Comparison Between Internationally Diversified Portfolios (E and F) and the Domestic Portfolio (D)</u>

The international portfolios, E and F, were estimated for each period following the portfolio selection models described in chapter 2. Expected returns and variance-covariances, used as inputs in the problems, were computed from the empirical distribution function estimated from the most recent past T periods' observations. With quarterly data, three different estimation period (T) cases, namely, 20-quarter, 28-quarter and 40-quarter, were investigated.[7]

Portfolio F and D

For every period in the sample, portfolio F was estimated and its variance calculated. Since F and D have the same expected return, their variances are directly comparable. The additional reduction in portfolio variance made possible due to international diversification over domestic diversification was calculated for each period. Figure 5.3 displays these reductions in variance for the 20-quarter estimation period.[8]

Except for four quarters[9], the diagram shows that it was possible to reduce risk substantially in all periods by including foreign assets in the portfolio rather than holding the domestic assets only. The maximum reduction happened to be as high as 94 per cent of domestic risk in 1972-2 for this estimation period case.

Table 5.2 below provides summary statistics on risk reductions through international diversification for the three

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[7]With 18 assets, the minimum value of T would be 18, for, if T < 18, the variance-covariance matrix would be deficient in rank (i.e., be singular) and hence, not invertible with usual methods.

[8]See Appendix II (Figures A.1-A.2) for similar diagrams for the two other estimation period cases.

[9]For these quarters, namely, 1967-4 to 1968-2 and 1973-4, portfolio F and D happened to be the same.

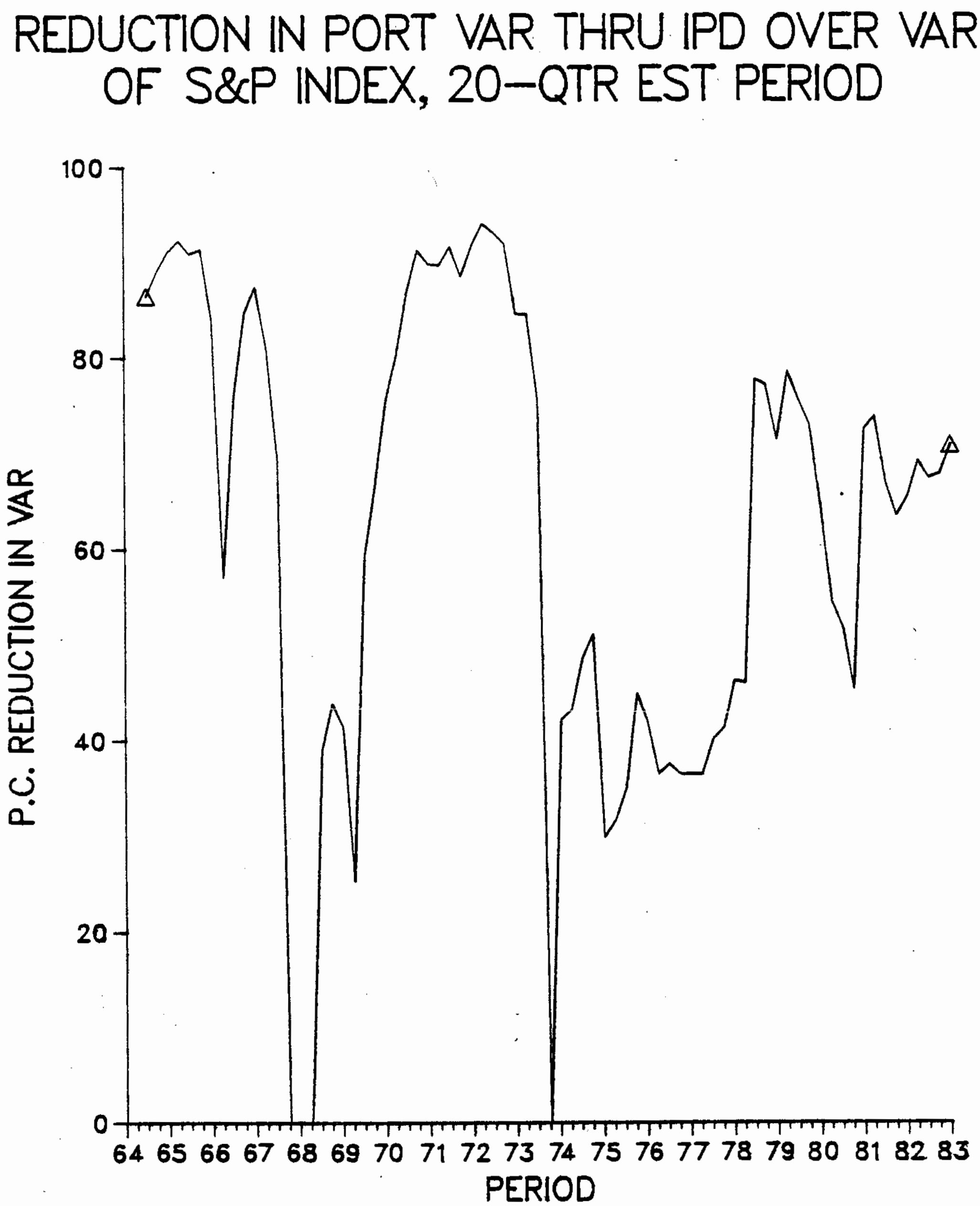
REDUCTION IN PORT VAR THRU IPD OVER VAR
OF S&P INDEX, 20-QTR EST PERIOD
P.C. REDUCTION IN VAR
100
80
60
40
20
0
64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD

FIGURE 5.3

Table 5.2

Average Reduction in Portfolio Variance due to International Diversification, Ex ante Data, Quarterly Revision, Various Estimation Period Cases, 1959(2) to 1982(4)

Est Period (qtr.)	Sample Period	No of obs.	Av. Reduction in Port Var (p.c.)	SD	Max Reduction (p.c.)	Min Reduction (p.c.)
20	1964(2) to 1982(4)	75	62.38	25.01	94.07	0.0
28	1966(2) to 1982(4)	67	56.18	18.66	86.04	0.0
40	1969(2) to 1982(4)	55	50.55	10.63	70.57	31.20

NOTE: The return data is from 1959(2) to 1982(4). With 20-quarter estimation period, first 20 quarters' data are used up in estimating the ex ante return distribution. Similar explanation applies to other two estimation period cases.

The optimal international portfolio investigated is the one that have same expected return as the domestic market portfolio (F in figure 2.1) estimation period cases. It appears that the U.S. investor could have reduced portfolio risk, on average over the sample period, by as much as 62 per cent or as low as 50 per cent of the domestic risk depending on the estimation period chosen by going international rather than holding the domestic assets alone. In other words, for the same return as of the U.S. index, international diversification offered him at least 50 per cent less risk as compared to domestic diversification. The benefits from risk reduction appears to be lower for longer estimation period cases than for the shorter period ones.

Portfolio E and D

Portfolio E was solved for at the begining of each period for the three estimation period cases. For the same risk (or standard deviation) as of the U.S. index, this internationally diversified portfolio offered significantly higher expected return in each period under investigation over return on the domestic portfolio, as can be seen from figure 5.4 which shows the results for the 20-quarter estimation period case.[10] The maximum increase happened to be 6.81 p.c. per quarter in 1975-1.

Summary statistics on expected returns (domestic and international) and the per cent increase in expected return are given in table 5.3. Column (3) and (4) report mean and SD of expected return of portfolio E while columns (5) and (6) report those on portfolio D. Column (9) which is column (7) expressed

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[10]For the 28- and 40-quarter estimation period cases, see Figures A.3-A.4 in the Appendix II.

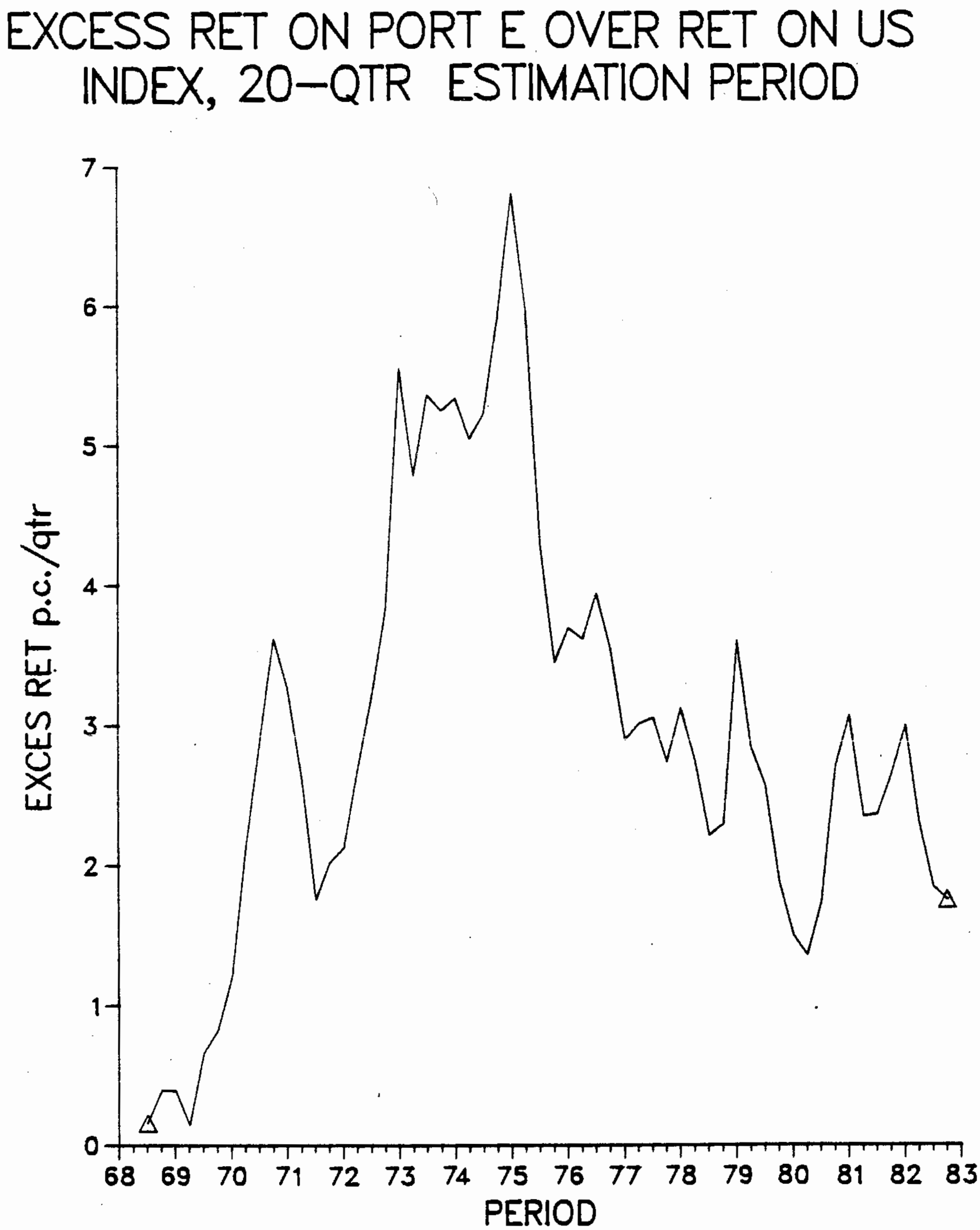
EXCESS RET ON PORT E OVER RET ON US
INDEX, 20-QTR ESTIMATION PERIOD
EXCES RET p.c./qtr
0
1
2
3
4
5
6
7
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD

FIGURE 5.4

Table 5.3

Average Expected Ret and SD on U.S. Index and on Portfolio E and E', Ex ante Data, Quarterly Revision, Various Estimation Period Cases, 1959(2) to 1982(4)

Est Period (qtr.)	No of obs.		Exp Ret on the Port (p.c/qtr)		Exp Ret on US Index (p.c/qtr)		Excess Exp Ret on Port (p.c/qtr)		P.C. Inc in Mean Expected Return
			Mean	SD	Mean	SD	Mean	SD	
1	2		3	4	5	6	7	8	9
20	75	E	3.49	1.24	0.63	0.95	2.86	1.60	454.56
		E'	3.82	1.47			3.19		506.35
28	67	E	2.95	0.82	0.67	0.74	2.28	1.31	342.13
		E'	3.23	0.85			2.56		382.09
40	55	E	2.70	0.61	0.68	0.56	2.02	0.96	298.33
		E'	3.02	0.78			2.34		344.12

as per cent of column (5), shows per cent increase per quarter in mean expected return over the mean return of the domestic portfolio that was made possible due to international diversification. Just how potentially lucrative international diversification could be over domestic diversification is seen from the three-digit numbers in column (9)!

As with the benefits from risk reduction, these potential benefits appear to be more pronounced in the shorter estimation period cases as can be seen from table 5.3 and figure 5.5. This is in line with the findings of Grubel and Fadner (1971) who found benefits from international diversification as a decreasing function of the holding period. However, these benefits were more stable for the longer estimation period cases.

The basic conclusion of tables 5.2 and 5.3 is not new -- the potential benefit of international portfolio diversification is now an established fact. If the tables have anything new to offer, it lies in the fact that the potential benefits remain quite significant even after using the ex ante return distribution as opposed to the use of ex post data which tends to overestimate the benefits of diversification.

At least 300 per cent increase in average expected return in table 5.3 brings forth an immediate and natural question: to what extent these expected benefits actually materialize if the investor chooses this portfolio. This can be seen after

EXP RET ON PORT E THAT HAS SAME RISK AS THE US INDEX, VARIOUS ESTIMATION PERIOD(t)CASES

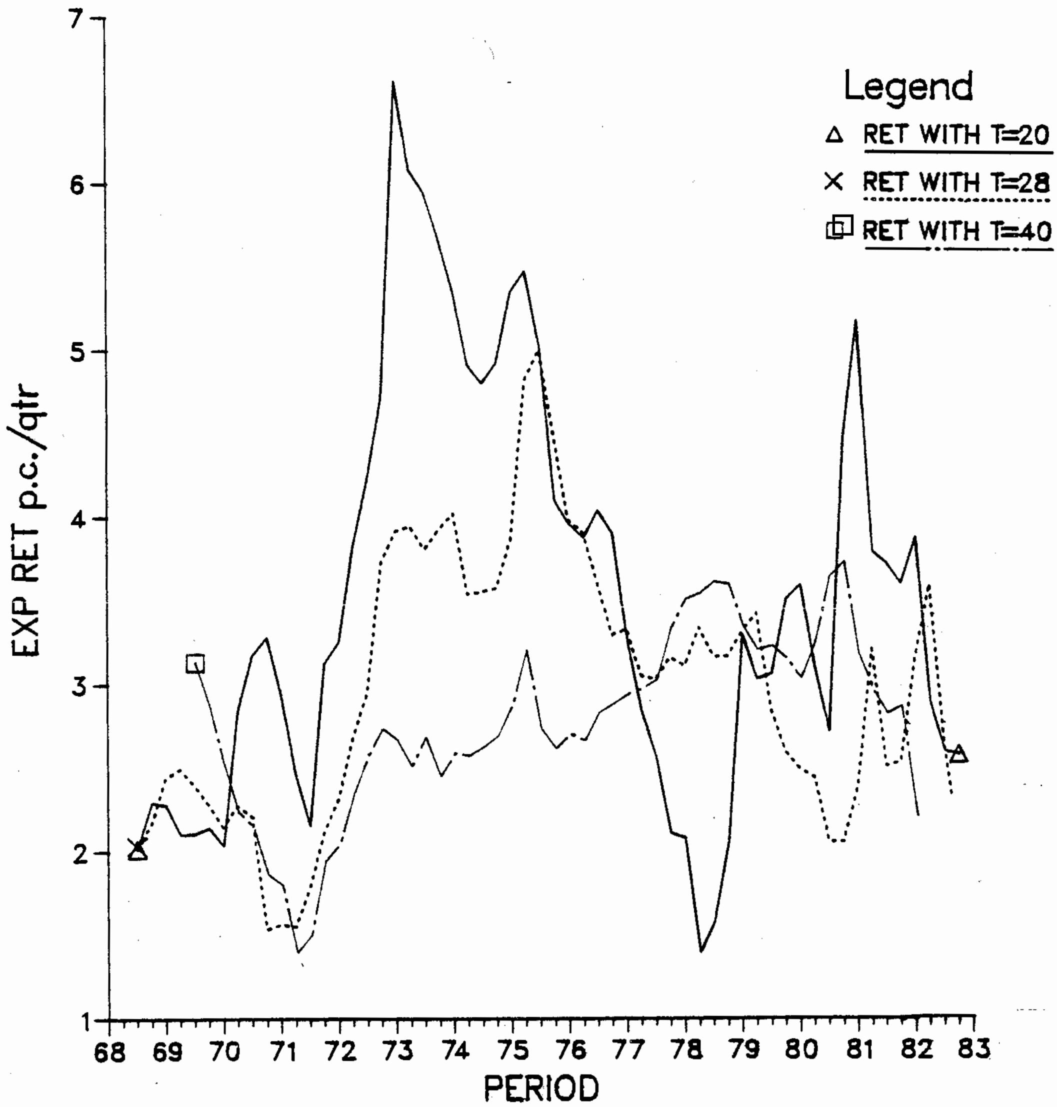

FIGURE 5.5

calculating realized or actual returns on this portfolio during the period.

At the end of every period when realized returns on assets become available, the realized return which the international portfolio E earned during the period was calculated using the portfolio weights decided at the begining of the period. For the 20-quarter estimation period case, figure 5.6 plots these realized returns against time. As expected, there is no unique pattern in the relationship. For some periods, the portfolio gained, for others, it lost. However, on average, over a long period of time, the international portfolio was a net gainer as compared to the domestic portfolio. This is seen from table 5.4 which reports average realized returns on the international and domestic portfolios as well as the per cent increase in average realized returns over the return on the domestic portfolio.

The message is clear: for the same risk as of the domestic portfolio, the actively managed, internationally diversified portfolio earned at least 100 per cent more return than the domestic portfolio for two of the three estimation period cases. Expectations in table 5.3 did, in fact, materialize, if not fully, but, to an extent sufficient to establish realized benefits of international portfolio diversification.

An alternative way to look at the benefits of international diversification is the following. Suppose that at the begining of a period our investor puts an equal amount of money, say, 100

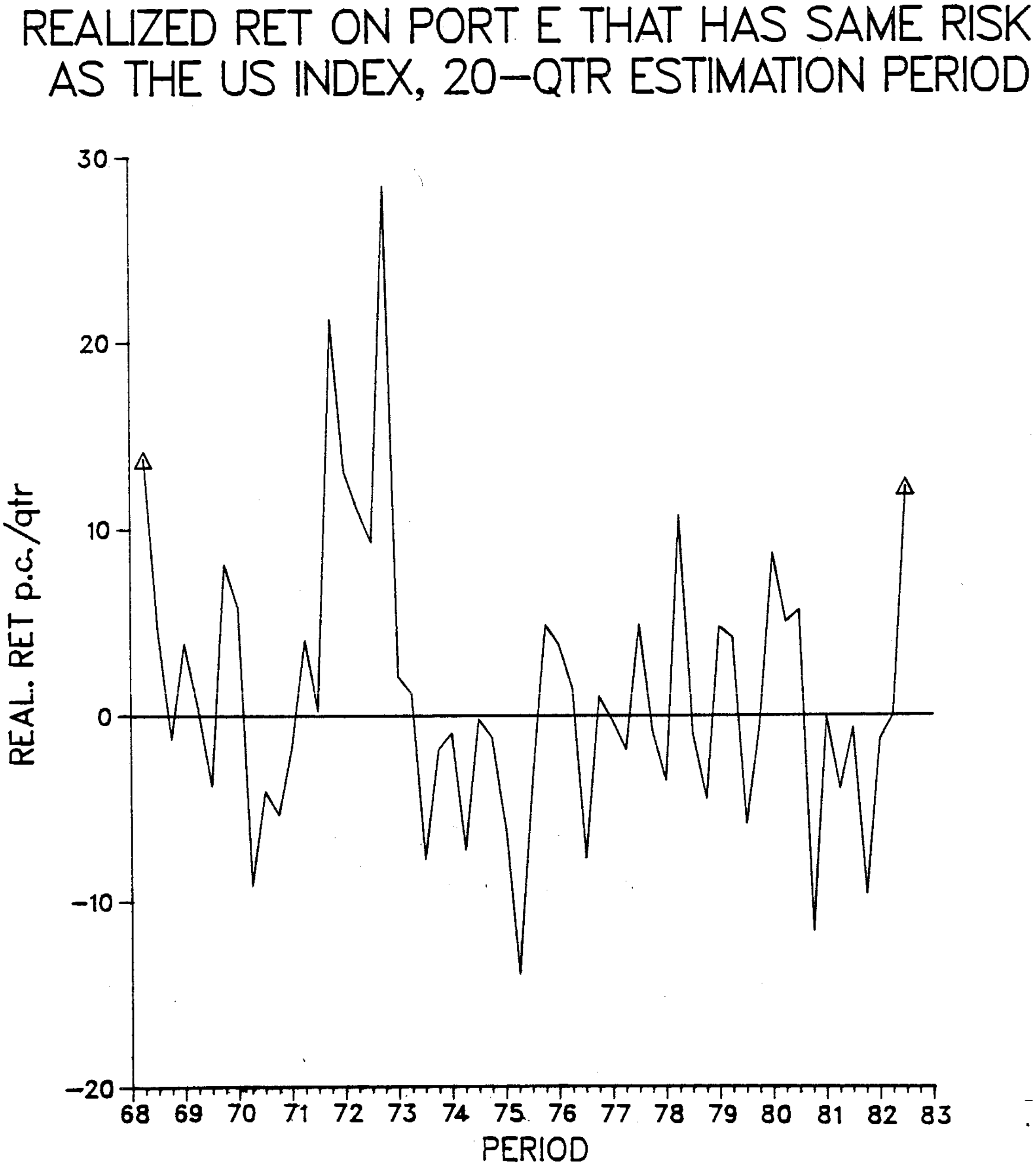
REALIZED RET ON PORT E THAT HAS SAME RISK
AS THE US INDEX, 20-QTR ESTIMATION PERIOD
REAL.. RET p.c./qtr
30
20
10
0
-10
-20
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD

FIGURE 5.6

Table 5.4

Average Realized Return and SD on the U.S. Index and on Portfolio E, Ex ante Data, Quarterly Revision, Various Estimation Period Cases, 1959(2) to 1982(4)

Est Period (qtr.)	No of obs.	Real Ret on Port E (p.c/qtr)		Real Ret on US Index (p.c/qtr)		Excess Real Ret on Port (p.c/qtr)		P.C. Inc in Mean Realized Return
		Mean	SD	Mean	SD	Mean	SD	
1	2	3	4	5	6	7	8	9
20	75	1.17	7.49	0.72	6.68	0.45	8.03	62.44
28	67	1.78	7.51	0.66	6.69	1.12	7.69	171.24
40	55	1.20	6.98	0.60	6.85	0.60	7.45	99.53

dollars, in the international portfolio E and the domestic portfolio D which are equally risky. At the end of the period, he calculates his total wealth which is 100 dollars plus any return earned on this capital over the period. At the begining of the next period, he decides to re-invest his total wealth from each portfolio in the same portfolio and at the end of the period, calculates total wealth from each. In this way, if he follows continous re-investment of total wealth in each period, his total wealth at the end of each period is given by table 5.5 and shown in figure 5.7 for the 28-quarter estimation period case.

The 100 dollars invested in portfolio E at the begining of 1968 would grow into about 255 dollars at the end of 1982 (with T=28) at an implicit growth rate of 1.59 p.c. per quarter (table 5.5). For the same estimation period case, investment of the same amount in the domestic portfolio would grow into only about 135 dollars, the implicit growth rate being only 0.51 p.c. per quarter. Similar results were obtained for the two other estimation period cases.[11] The U.S. investor, therefore, could have done substantially better by investing in the international portfolio rather than in the domestic market portfolio.

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[11]See Figures A.5-A.7 in Appendix II.

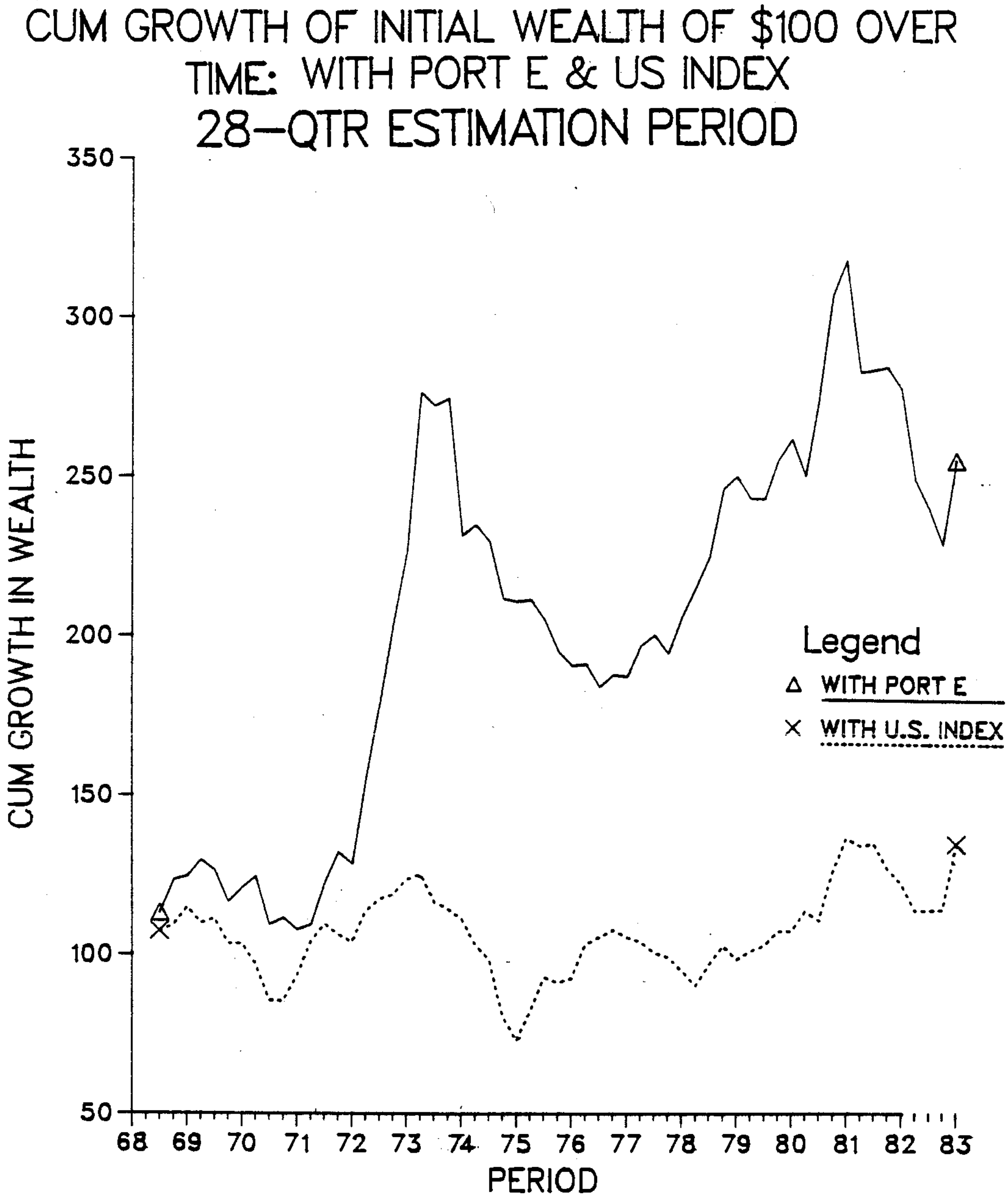
CUM GROWTH OF INITIAL WEALTH OF $100 OVER
TIME: WITH PORT E & US INDEX
28-QTR ESTIMATION PERIOD
CUM GROWTH IN WEALTH
350
300
250
200
150
100
50
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD
Legend
WITH PORT E
WITH U.S. INDEX

FIGURE 5.7

Table 5.5

Cumulative Growth of Initial Investment of $100 at the end of Each Quarter, International Portfolio E and the U.S. Index, Various Estimation Period (T) Cases

	T=20		T=28		T=40	
Period	Port E	U.S. Index	Port E	U.S. Index	Port E	U.S. Index
68-1	100.00	100.0	100.0	100.00		
2	113.7316	107.3900	113.2007	107.3900		
3	119.0721	109.1191	123.5114	109.1191		
4	117.5567	114.8709	124.6301	114.8709		
69-1	122.1167	109.8307	129.7951	109.8307	100.00	100.0000
2	122.6240	111.3655	126.4217	111.3655	97.7943	101.3974
3	117.9993	103.4611	116.5571	103.4611	89.9562	94.2005
4	127.5751	103.4611	121.0057	103.4611	87.4032	94.2005
70-1	134.9134	97.0019	124.5158	97.0019	88.2892	88.3195
2	122.5947	85.6968	109.3490	85.6968	80.9640	78.0263
3	117.6306	85.4101	111.5562	85.4101	81.9418	77.7652
4	111.3480	93.2463	107.8473	93.2463	79.9441	84.9000
71-1	109.4541	103.9223	109.4574	103.9223	-----	-----
2	113.9080	109.6206	122.3974	109.6206	81.0464	89.5553
3*	-----	-----	132.1435	106.2681	89.6292	86.8164
4	114.1629	107.1615	128.3951	103.8841	93.0054	84.8688
72-1	138.4745	117.2690	154.8779	113.6825	109.8501	92.8737
2	156.5159	121.0798	178.7074	117.3768	127.4236	95.8918
3	173.7775	122.5230	203.8427	118.7758	144.1675	97.0347
4	189.8757	127.4550	226.7171	123.5570	154.6534	100.9407
73-1	243.9188	129.0884	276.4811	125.1404	177.0387	102.2343
2	248.9931	120.1822	272.3289	116.5066	165.3805	95.1809
3	251.8279	117.8448	274.6460	114.2407	165.7436	93.3297
4	232.3471	114.6185	231.3093	111.1131	149.1908	90.7746
74-1	228.1156	106.3245	234.8077	103.0727	156.3805	84.2060
2	225.9483	101.6069	229.4704	98.4994	150.5276	80.4698
3	209.6396	83.2353	211.5912	80.6897	135.9371	65.9200
4	209.2251	75.3304	210.6371	73.0266	131.3887	59.6596
75-1	206.7146	84.8362	211.3371	82.2417	135.0111	67.1879
2	194.1411	95.7444	205.2168	92.8162	135.6239	75.8268
3	167.0615	94.1603	195.1610	91.2805	118.8213	74.5722
4	161.0105	95.5363	190.7284	92.6144	118.1583	75.6620
76-1	168.8088	106.4391	191.1763	103.1838	124.3992	84.2967
2	175.2271	108.8004	184.0006	105.4729	123.7778	86.1668
3	177.7272	111.1618	187.8584	107.7621	128.8191	88.0370
4	164.0952	108.8429	187.3391	105.5141	126.5048	86.2005
77-1	165.7504	107.4576	196.9560	104.1712	134.2561	85.1033
2	165.2121	103.9126	200.4155	100.7346	136.0325	82.2958
3	162.1575	102.4347	194.4522	99.3019	136.7251	81.1254
4	170.0605	98.1270	206.1055	95.1260	145.4880	77.7138
78-1	168.5775	93.2431	215.5073	90.3914	154.0428	73.8459
2	162.6761	100.1205	224.9566	97.0585	165.4294	79.2926
3	180.1108	106.2278	246.2835	102.9790	181.8153	84.1294

* See note at the end

Contd.

Table 5.5 contd.

	T=20		T=28		T=40	
Period	Port E	U.S. Index	Port E	U.S. Index	Port E	U.S. Index
78-4	178.3488	101.7622	250.1882	98.6500	186.0239	80.5928
79-1	170.3352	104.4569	243.1839	101.2623	178.8747	82.7269
2	178.4268	106.2610	243.1316	103.0112	176.3561	84.1557
3	185.8801	110.9766	255.2207	107.5826	180.5218	87.8903
4	175.0071	111.0675	261.9552	107.6707	181.6108	87.9623
80-1	174.1033	117.3401	250.2305	113.7515	178.9827	92.9300
2	189.2647	114.3996	275.0244	110.9009	198.5067	90.6012
3	198.7014	130.1396	307.2820	126.1595	212.1208	103.0669
4	209.8914	141.0879	317.9305	136.7730	218.1433	111.7376
81-1	185.4636	138.5555	282.7810	134.3180	199.8388	109.7320
2	185.4223	139.2707	283.4559	135.0113	195.7956	110.2984
3	178.0803	130.9618	284.4314	126.9565	190.8434	103.7180
4	176.8803	126.3182	277.5612	122.4549	196.2233	100.0404
82-1	159.8132	117.4306	248.9605	113.8392	172.6166	93.0017
2	157.7804	117.4306	239.7315	113.8392	164.7932	93.0017
3	157.7664	117.6088	228.4884	114.0119	163.1241	93.1428
4	177.0429	138.9920	254.9809	134.7411	182.0775	110.0777
Growth Rate Per Quarter	0.9845	0.5677	1.5865	0.5054	1.1097	0.1778

Note: For 1971-3, portfolio E was not available to be held for the T=20 quarter case (see figure 5.2a and the relevant discussion for non-existence of portfolio E). For comparability, this quarter was excluded from calculation of cumulative growth of wealth for the U.S. Index.

The Dividend Effect

So far, we have not taken into consideration the dividend yields in calculating rates of return. This is because dividend yields were not available for all countries in the sample over the period investigated. This is an important omission, no doubt, though many of the published studies were done without this important component of rate of return, perhaps because of the difficulty in getting the information. Nevertheless, it is imperative, at least, to have a feel about the consequences of excluding dividend yield on the benefits of diversification.

Towards this end, I selected a new sample of countries which contained most of the countries in the original sample, a new sample period which was a subset of the original period and new periodicity of data which was different from the old periodicity. Monthly stock price index and dividend yields data for 16 countries over 1972 December to 1982 March were taken from the various issues of the Capital International Perspective.

Effect on Portfolio Variance

The optimal portfolio investigated for the purpose was the one that minimizes portfolio variance for a given expected return equal to that on the U.S. asset (portfolio F in figure 2.1). This portfolio was solved for each period in the sample and the reduction in portfolio variance over the variance of the

U.S. index was calculated and finally, the mean and SD of the reduction in variance was calculated. The whole exercise was carried out, first, without dividend yields included and afterwards, with it included. Table 5.6 provides comparison of the results under the two cases for different estimation periods.

Omission of dividend yields does not appear to be as important as is usually thought of as far as its effects on portfolio variance is concerned. Leaving dividends out slightly overestimates the gains arising from risk reduction -- the average reduction in portfolio variance without dividends is slightly higher than that with dividends and this is true regardless of the estimation period used in calculating the ex ante return distribution. Therefore, for people who believe that gains from international portfolio diversification emerge from risk reduction only, exclusion of dividend yields does not seem to make any significant difference.

Effect on Portfolio Expected Return

To see the effect of excluding dividend yields on portfolio return, portfolio E was solved for with and without taking account of dividend yields. As before, average expected and realized returns on the portfolio were calculated over the period and compared to those of the U.S. domestic portfolio. Table 5.7 reports these numbers.

Table 5.6

Reduction in Portfolio Variance through International Diversification: With and Without Dividend Yields Included, Monthly Revision, Various Estimation Period Cases, 1972-Dec to 1982-March

Estimation Period (months)	P.C. Reduction in Port Variance: With Dividend		Without Dividend	
	Mean	SD	Mean	SD
36	51.7864	16.7854	52.2105	17.3188
48	56.2773	8.9240	56.4288	9.3429
60	54.3465	5.9789	54.6025	6.0624
72	51.2031	6.0055	51.9638	5.7324
84	50.0417	5.1645	51.0005	5.4774

Note: The optimal portfolio investigated is F which minimizes portfolio variance for the same expected return as that of the U.S. asset

Table 5.7

Average Expected and Realized Return on Portfolio E and on the U.S. Asset: With and Without Dividend Yields Included, Monthly Portfolio Revision, 60-month Estimation Period, 1977-Jan to 1981-Dec

	Expected Return					Realized Return				
	Average on Portfolio (p.c./month)	SD	Average on U.S. Asset (p.c./month)	SD	Excess Exp Ret on Port (p.c./month)	Average on Portfolio (p.c./month)	SD	Average on U.S. Asset (p.c./month)	SD	Excess Realized Return (p.c./month)
With Dividend	1.3519	0.2726	0.4847	0.3732	0.8672	0.6750	5.2314	0.3231	4.0108	0.3519
Without Dividend	1.0360	0.2768	0.1033	0.3406	0.9327	0.3533	5.2132	-0.1555	4.0795	0.5088
Loss of Return due to exclusion of Dividend	0.3159		0.3814		-0.0655	0.3217		0.4786		-0.1569
Loss as p.c. of return without Div	30.49		369.2		-7.02	91.06		307.78		-30.84

For the U.S. asset, it appears that exclusion of dividend amounts to serious underestimation of both expected and realized returns. However, the underestimation is not as serious with portfolio returns as with the U.S. asset return. Leaving dividends out leads to underestimation of average expected portfolio return by only 30 p.c. of the return without dividend. For realized return, the corresponding number is about 91 p.c. With portfolio return, much of the underestimation simply averages out.

As regards the additional benefits of international over domestic diversification, the dividend effect leads to an apparently startling conclusion: exclusion of dividend yields 'overestimates' the extra gains in returns (expected as well as relized)! This is seen from the column showing excess return in table 5.7. However, this is resolved when we take note of the earlier finding that exclusion of dividends led to very large underestimation of U.S. return while the underestimation of portfolio return was relatively small. This explains why benefits from international diversification seem to have been overestimated when dividend yields are left out. This overestimation, however, is quite small - only 7 p.c. for expected return and about 35 p.c. for realized return.

The Tangent Portfolio and the Minimum Variance Portfolio: Comparison With Some Published Studies

In order to see how our results compare with those of some published studies, we also investigated two commonly used portfolios, namely, the tangent portfolio (T), and the minimum variance portfolio (M). Using quarterly data and 28-quarter estimation period these portfolios were solved for every period and the realized returns calculated. The geometric mean and SD of these realized returns were then calculated and compared to those of the domestic market portfolio used as the benchmark.

Following Sharpe (1970), a measure of performance, defined as mean/SD, was calculated to compare the performance of the domestic and internationally diversified portfolios. The following hypothesis was tested.

$$H_0 : (\mu_d/\sigma_d) = (\mu_i/\sigma_i)$$

$$H_a : (\mu_d/\sigma_d) < (\mu_i/\sigma_i)$$

where μ and σ represent the 'true' mean and standard deviation respectively of the excess return distribution and subscripts d and i represent domestic and international portfolio. A test statistic was developed by Jobson and Korkie (1981) to compare the Sharpe ratio between two portfolios. This statistic uses the transformed difference (TD) of the sample ratios ($\bar{r}/s$) for the two portfolios which is given by

$$TD = s_n \bar{r}_i - s_i \bar{r}_n$$

where $\bar{r}$ and s are sample mean and standard deviation respectively of excess returns on two portfolios, i and n. The asymptotic distribution of TD was shown to be normal with

$$\text{mean} = \sigma_n \mu_i - \sigma_i \mu_n$$

and

$$\text{variance} = \frac{\sigma_i^2 \sigma_n^2}{2T} \{4(1-\rho) + (\mu_i/\sigma_i)^2 + (\mu_n/\sigma_n)^2 - (\mu_i/\sigma_i)(\mu_n/\sigma_n)(1+\rho)^2\}$$

where $$\rho = \frac{\sigma_{in}}{\sigma_i \sigma_n}$$

Using the asymptotic normality of the distribution of TD, Jobson and Korkie suggested the following test statistic

$$z = \frac{TD}{s(TD)}$$

where s(TD) is the sample standard deviation of the TD. We calculated the z-statistic for each pair of domestic and international portfolio. The z-values are reported in table 5.8 along with the mean and SD of realized returns for individual country assets and portfolios.

From the table it appears that the domestic U.S. market portfolio was outperformed by each of the two internationally diversified portfolios. However, the difference in performance between them is statistically significant only for portfolio T.

Table 5.8

Comparison of Ex post Portfolio Performances for the U.S. Index, Tangent Portfolio and Minimum Variance Portfolio and also for other country indices, Quarterly Revision, 28-quarter Estimation Period, 1966(2) to 1982(4)

Assets/ Portfolios	Geom mean (p.c./Qtr)	SD	Mean/SD	z-value (between dom & int'l port)
Assets:				
Australia	0.52	10.92	0.05	
Austria	0.76	6.29	0.12	
Belgium	0.29	7.52	0.04	
Canada	0.55	8.07	0.07	
Denmark	0.93	9.62	0.10	
Finland	1.22	8.91	0.14	
France	-0.05	10.20	-0.005	
Germany	0.64	8.20	0.08	
Ireland	-0.12	10.67	-0.01	
Italy	-1.61	9.59	-0.17	
Japan	2.76	8.83	0.31	
Netherlands	0.19	8.99	0.02	
Norway	-0.27	11.16	-0.02	
S.Africa	1.42	17.40	0.08	
Sweden	1.03	7.68	0.13	
Switzerland	1.05	8.47	0.12	
U.K.	0.76	11.41	0.07	
Portfolios:				
M	0.86	5.16	0.17	0.0246
T	2.44	10.96	0.22	1.9053
D(U.S)	0.55	6.63	0.08	

NOTE:
The Tangent Portfolio (T) was not available for two quarters, namely, 1981(1) and 1981(2). Hence these two quarters were excluded in the calculation of returns for all the assets and portfolios for comparability among themselves.

The z-value is calculated using the test statistic developed by Jobson and Korkie. See main text for the statistic and the hypothesis tested.

For z = 1.91, the p-value is approximately .03 which implies that with at least 95 p.c. level of confidence we reject H_0 and accept H_a. The internationally diversified portfolio T, therefore, significantly outperformed the domestic market portfolio.[12] The U.S. investor could have earned about 3 times more return per unit of SD by diversifying his portfolio internationally rather than holding domestic assets only had he followed the simple probability assessment rule as was used here and revised his portfolio quarterly over the period under investigation. This clearly demonstrates the 'actual' as opposed to the 'potential' benefits from international over domestic diversification under active management.

From the table it also appears that the U.S. investor could have done significantly better by holding the Japanese market only in every period rather than holding a portfolio of foreign assets as represented by T or M or by holding domestic market only. But ex ante, the Japanese asset did not appear to be as promising so as to command 100 p.c. weight in the portfolio.

The results mentioned above differ significantly from Jorion (1983). With monthly data for 7 countries over 1971 to 1982 and with 60-month estimating period, he found that the minimum variance portfolio (M in our discussion) significantly

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[12] It may be noted here that Jobson and Korkie (1981) mentioned very low power of their test statistic. For a typical simulation experiment with μ_1=1.2, μ_2=0.6, σ_1=4.0, σ_2=3.0 and ρ=0.5, the power of the test was only 14 p.c. for a type I error of 5 p.c. and sample size of 60. Thus, even if the H_0 were false, the test would not reject it 86 p.c. of the time.

outperformed the tangent portfolio (T). Jorion's results are reproduced in the following table for comparison (Table 5.9).

While Jorion's claim that the Bayes-Stein approach leads to better results than the classical approach may be true (a point on which I do not comment), his claim that portfolio M significantly outperforms portfolio T may not be accepted without qualification in view of the results mentioned here. There could be significant gains in realized return over and above the gains from risk reduction and our view is strengthened by the 'partial segmentation' nature of the international stock market (see Levy and Sarnat, 1975, Errunza and Losq, 1985). Due to the imperfect arbitrage process, expected returns cannot be equalized across countries and, therefore, room for 'super risk-premium' exists. This can be enjoyed by choosing portfolio T that maximizes expected return and not by M that pays no attention to expected return.

Transaction Cost and the Benefits of International Portfolio Diversification

So far we disregarded one essential element of active portfolio management --- transaction costs involved in trading. The omission sounds more important than it actually is, specially for large institutional investors for whom transaction costs are only a minimal fraction of the value of investment. Nevertheless, since trading is not free of cost, we make an

Table 5.9

Comparison of Portfolio Performances Between Jorion's and the Present Study: The Tangent Portfolio (T), the Minimum Variance Portfolio (M) and the World Portfolio

Portfolio Strategy	Jorion's: T=60 months, ex post Performance over 1976-Jan to 1982-Dec			This Study: T=28 quarters, ex post Performance over 1966(2) to 1982(4)		
	Mean (p.c/month)	SD	Mean/SD	Geom Mean (p.c/qtr)	SD	Mean/SD
U.S.	0.88	4.176	0.211	0.55	6.63	0.08
M	1.141	3.591	0.318	0.86	5.16	0.17
T	0.162	12.964	0.012	2.44	10.96	0.22
World (MV wts)	0.909	3.655	0.249	---	---	---
World (Equal wts)	---	---	---	0.88	6.05	0.15

NOTE: Jorion's world portfolio is constructed from market valuation (MV) weights while the world portfolio in this study is constructed using equal weights attempt in this section to incorporate it in a simple way.

Transaction costs involved in stock trading are generally defined as the sum of three components

1. brokerage commissons
2. taxes and Securities and Exchange Commission fees on sales
3. market impact

Of the three components, the market impact is difficult to measure. It is defined by some people as the stock's price movement from the time the order was received by the trading desk until its execution, with the effect of changes in the market level in the interim adjusted out. More specifically,

$$U_i = \ln(P_{ix} + D_i)/P_{is} - \beta_i \ln(I_x/I_s)$$

where U_i is the market impact of the ith stock, P_{ix} and P_{is} are execution and 'strike' or entry price respectively of stock i. D_i is any dividend accrued between strike and execution, β_i is the short-term beta and I_x and I_s are execution and strike level of the market index.

It is very difficult, if not impossible, to obtain information required to measure costs in the international stock market transactions. For example, no published data are available on the 'strike' and 'execution' price of stocks trading in different stock exchanges around the world. This might be one of the reasons why no previous published study took this essential element into account while estimating the benefits of international diversification. But since transaction costs do exist, any analysis should try to approximate and take them into account.

In the present analysis, we introduce transaction cost in a very simple and straightforward manner. We assume that the cost involved in each transaction is a constant proportion of the value of investment. We also make the simplifying assumption that costs involved in buying and selling are same. Net return (r) in period t is calculated as follows:

$$N \left(\frac{P_t}{E_t} - C \frac{P_t}{E_t} \right) = N \left(\frac{P_{t-1}}{E_{t-1}} + C \frac{P_{t-1}}{E_{t-1}} \right) e^r$$

$$(1-C) \frac{P_t}{E_t} = (1+C) \frac{P_{t-1}}{E_{t-1}} e^r$$

Taking natural logarithm of both sides and rearranging,

$$r = \ln\left(\frac{P_t}{P_{t-1}}\right) - \ln\left(\frac{E_t}{E_{t-1}}\right) + \ln(1-C) - \ln(1+C) \qquad (5.10)$$

where N is the number of shares, P is price per share, E is exchange rate between U.S. dollar and other currencies, C is transaction cost expressed as p.c. of the value of investment and e is base of the natural logarithm.

Since for large institutional investors transaction costs are a very small fraction of their investments, we assume the following values for C.

1. C = 0.001 p.c. of the value of investment
2. C = 0.01 p.c. of the value of investment
3. C = 0.1 p.c. of the value of investment

We re-calculated returns on the domestic portfolio (S&P index) and two international portfolios, namely, the tangent portfolio T and portfolio E using expression (5.10) above under each of the three assumed rates for transaction cost. Table 5.10 reports these results.

From the table it follows that after allowing for the assumed transaction costs, the two actively managed international portfolios yielded higher returns (both expected and realized) than the domestic market portfolio, demonstrating once again the advantage of international over domestic diversification. The international portfolios have higher risk-adjusted returns as compared to the domestic portfolio. In fact, if the investor holds portfolio E and revises it every period paying 0.2 p.c. transaction cost in each round of trading, he nets about 0.14 p.c. return per quarter per unit of risk as opposed to only about 0.07 p.c. in the case of domestic portfolio over the sample period studied. The investor could have enjoyed about double 'realized' return from going international rather than holding the domestic portfolio alone.

Table 5.10

Transaction Costs and the Benefits of International Portfolio Diversification, Tangent Portfolio (T) and the Portfolio that Maximizes Expected Return for the same Variance as that of U.S. Returns (E), 40-Quarter Estimation Period, 1969(2) to 1982(4)

Arithmatic Mean and Standard Deviation of Returns on

Portfolio Return	U.S. Index with 0.1 p.c. Trans. Cost		Actively Managed Tangent Portfolio T with Transaction Cost (as p.c. of value of inv.) of 0.1 %		0.01 %		0.001 %		U.S. Index with 0.1 p.c. Trans. Cost		Actively Managed E with Trans. Cost (as p.c. of value) 0.1 %	
	mean p.c./qtr	SD	mean p.c./qtr	SD	mean p.c./qtr	SD	mean p.c./qtr	SD	mean p.c./qtr	SD	mean p.c./qtr	SD
Expected	0.698	0.57	3.2580	0.9596	3.3959	0.9467	3.3690	0.9815	0.6563	0.5655	2.5869	0.5710
Realized	0.7656	6.964	1.1117	10.5959	1.3992	9.8364	1.5963	9.7468	0.4629	6.7958	0.9821	7.1284
Realized Ret/SD	0.1099		0.1049		0.1422		0.1638		0.0681		0.1378	
N	52		52		52		52		53		53	

Note: Portfolio T was not available for 3 quarters for transaction costs of 0.1 and 0.01 p.c. These quarters were excluded from calculation of mean and SD for the other case and also for the U.S. return for comparability

Portfolio E was not available for 2 quarters for under transaction cost of 0.1 p.c. These two quarters were excluded from calculation of mean and SD for the U.S. return

Active vs. Passive Portfolio Management

Under 'active' portfolio management, we saw that there were significant additional benefits for an U.S. investor from holding international portfolios. How would the benefits compare had he followed a 'passive' management approach? Should he engage in portfolio revision every period in the light of market developements or should he keep quiet, closing his eyes in the face of market changes? These questions are meaningful, specially, in the presence of transaction costs involved in revising portfolios.

Logue (1982) compared the performance of an actively managed international portfolio (which was the same as our T except that his risk-free rate was zero) with that of an U.S. market index. He found that there was no significant difference between two the performances and concluded that active management might not bring about any noticeable benefit over passive management. Cuddington and Gluck (1983) also obtained similar results about the comparison of portfolio rebalancing and the buy-and-hold portfolio strategy. Neither of these studies, however, took into account the transaction costs involved in trading.

To contribute to the controversy over active vs. passive management of portfolios, a comparison has been made here between the performances of some actively managed international portfolios with those of passive buy-and-hold portfolios taking into account the arbitrarily assumed values for transaction cost mentioned earlier.

The actively managed portfolios were those mentioned earlier, namely, portfolio T and portfolio E. The buy-and-hold portfolio was constructed using equal portfolio weight for each of the assets included.[13] Table 5.11 shows comparison of performances between the two actively managed portfolios and the buy-and-hold portfolio for different holding periods.

An interesting message of the table is that in all three transaction cost cases (0.1 p.c., 0.01 p.c. and 0.001 p.c. of the value of investment), the two actively managed portfolios offered significantly more average net return than the net return of the passive buy-and-hold portfolio in almost all the holding periods studied.

During the 5-year holding period covering 1974-2 to 1979-1 and with transaction cost of 0.1 p.c., the buy-and-hold portfolio yielded a net return of only 0.32 p.c. per quarter while the actively managed T earned an average net return of 2.19 p.c. per quarter --- an increase of about 600 p.c! Similarly for the 3-year holding period (1972-2 to 1975-1) where additional return from T was 178 p.c. more than the return from the passive portfolio over the same period. Similar results were obtained for portfolio E.

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[13]The buy-and-hold portfolio was also constructed in another way --- using GNP of each country as proportion of the world GNP as its weight. But this portfolio performed poorly relative to the equally weighted portfolio in almost all of the holding periods considered and hence these results are not reported.

Table 5.11

Comparison of Portfolio Performances: Buy-and-Hold vs. Actively Managed Portfolios (Quarterly Revision, 40-quarter Estimation Period), Selected Transaction Costs and Holding Periods, 1969(2) to 1982(4)

With Transaction Costs of

Actual Holding Period	0.1 p.c. of value					0.01 p.c. of value			0.001 p.c. of value		
	B-H Port Return (p.c./qtr)	Tangent Port Ret		Port E Return		B-H Port Return (p.c./qtr)	Tangent Port Ret		B-H Port Return (p.c./qtr)	Tangent Port Ret	
		mean (p.c./qtr	SD	mean (p.c./qtr)	SD		mean (p.c./qtr)	SD		mean (p.c./qtr)	SD
N=55 1969-2 to 1982-4	0.7791	1.1117 (N=52)	10.5959	0.9821 (N=52)	7.1284	0.7824	1.3992 (N=52)	9.8364	0.7827	1.5963 (N=53)	9.7468
N=40 1969-2 to 1979-1	1.1192	2.0371 (N=39)	8.8084	1.3457 (N=39)	7.2679	1.1237	2.0196 (N=39)	8.6232	1.1242	2.2307	8.5920
N=20 1969-2 to 1974-1	2.1242	1.8790 (N=19)	10.5981	2.0679 (N=19)	8.8046	2.1332	1.8688 (N=19)	10.3188	2.1341	2.2972	10.1885
1974-2 to 1979-1	0.3159	2.1872	6.9798	0.6723	5.8614	0.3249	2.1629	6.9139	0.3256	2.1643	6.9075
N=12 1969-2 to 1972-1	0.7243	-0.4857 (N=11)	6.9614	0.0064	7.7283	0.7393	-0.4298 (N=11)	6.7483	0.7408	0.4991	7.1635
1972-2 to 1975-1	0.8884	2.4672	12.2967	1.8673	9.3825	0.9034	2.4640	12.0127	0.9049	2.4469	11.9590
1975-2 to 1978-1	-0.6980	2.7999	6.3455	1.0265	5.4762	-0.6830	2.6352	6.2251	-0.6815	2.6251	6.2127
1978-2 to 1981-1	2.4876	3.5492	12.4647	2.1659	5.8820	2.5026	3.3929	11.3806	2.5041	3.3692	11.2834

Note: Port T was not available to be held in 1982-2 and 1982-3 quarters under all three transaction cost cases. In addition, it was available for 1971-3 under transaction cost of 0.1 p.c. and 0.01 p.c. Similarly, portfolio E was not available for 1971-3, 1982-2 and 1982-3 quarters under the 0.1 p.c. transaction cost case studied.

Portfolio T, however, incurred an average loss during 1969-2 to 1972-1 (with 12 quarter holding period) under transaction costs of 0.1 p.c. and 0.01 p.c. but not under transaction cost of 0.001 p.c. Average loss in these two cases was, perhaps, due to the non-availability of return for this portfolio in one period (1971-3).[14] This is apparent from the average return of this portfolio in the same period under transaction cost of 0.001 p.c. when portfolio return was available for the full 12 quarters.

Thus, we see that in the presence of small transaction costs as may be applicable to large institutional investors, active portfolio management yielded higher return, on average, than the passive management. Our findings thus subscribe to the view that information generated in the international stock market can be used to have superior portfolio performance over passive management. Though we have not done any formal test of efficiency of the international capital market, the evidence presented here lends support to the view that this market is not efficient. This agrees with the evidence of partial segmentation of the international capital market found by Errunza and Losq (1985) and Levy and Sarnat (1975).

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[14]Note that N=11 quarters for these two cases instead of 12.

Summary

In this chapter we have demonstrated the potential as well as realized benefits of international portfolio diversification from a policy of active portfolio management. Such a policy is desirable, specially in the international context, due to non-stationarity of the expected returns and the variance-covariance matrix of international asset returns, inefficiency of the international stock market and the like. The portfolios were revised in every period using the most recent past information available.

Benefits of international diversification for a representative risk-averse U.S. investor were shown by comparing the risk-return characteristics of several internationally diversified portfolios with those of a U.S. benchmark portfolio. From the single-period, mean-variance portfolio selection model used, it appeared that substantial 'additional' risk reduction as well as increase in expected return were possible in every period under investigation from diversifying portfolios across countries. What is more important, these potential benefits could have been realized had the investor followed the methodology used in this chapter.

It was also seen that the same amount of money invested in international portfolio offered much higher growth rate than the domestic portfolio.

The effect of excluding dividend yields from calculation of rates of return was also analysed. It was seen that such omission was not of considerable importance as far its effect on portfolio variance was concerned. It was, however, of some importance as regards its impacts on portfolio return was concerned.

In view of the presence of transaction costs involved in stock trading, the analysis was repeated incorporating some arbitrarily selected transaction costs. It was seen that with small transaction costs (e.g., 0.1 p.c. of the value of investment) as may be applicable to large institutional investors, benefits of international diversification were retained.

In view of the controversy over active vs. passive portfolio management, a comparison was also made between the performances of some actively managed portfolios and passive buy-and-hold portfolios in the presence of transaction costs. Several holding period cases were investigated and it was seen that some actively managed portfolios significantly outperformed the passive portfolio in almost all the holding period cases considered. These findings question the efficiency of the intarnational capital market.

CHAPTER VI

INVESTORS' RISK-PREFERENCES AND THE GAINS FROM INTERNATIONAL PORTFOLIO DIVERSIFICATION

In the previous chapter I have demonstrated the potential as well as realized gains that a representative U.S. investor could have earned under active portfolio management. But I haven't said anything in particular about the investor's risk-preference except, implicitly, that he is a risk-averse investor who makes decision solely on the basis of mean and variance of the return distribution. All mean-variance, risk-averse investors aren't alike, however, with regard to their aversion to risk. Some are highly risk-averse, others are less risk-averse than them, still others are less risk-averse than the preceding group and so on. In fact, from a set of risk-averse investors, one can define many sub-sets depending on the investors' aversion to risk. The utility function representing each sub-set would be different from others though the difference is only a matter of degree. In the mean-variance space, the indifference curves representing a highly risk-averse group of investors would be everywhere steeper than those of a less risk-averse group, as discussed in chapter 3 above.

How do the gains from international portfolio diversification differ among the different sub-sets or classes of risk-averse investors? Or how does optimal portfolio change due, solely, to the difference in the attitude towards risk? In the international context, nobody so far tried to investigate these issues. In this chapter I make an attempt to analyse them.

The Model

The theoretical model requires a generalized utility function capable of representing preference pattern for a wide class of risk-averse investors. Each of the commonly used utility functions, e.g., quadratic, logarithmic, exponential functions describes preference pattern for a particular group of risk-averse investors. A generalized power utility function which is basically non-linear in character and which represents preferences of a wide class of risk-averse investors, starting from risk-neutrality to infinite risk-aversion, has been used by Grauer and Hakanson (1982).[1] Non-linear functions, though theoretically more appealing, are computationally difficult to optimize.

A simple and computationally more efficient expected utility function has been derived by Pulley (1981) by taking mean-variance approximation of expected utility. Though simple in form, this approximation yields results which are identical

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[1]The power function used by these authors is of the form

$$u(w)=(1/\gamma)w^{\gamma}, \qquad \gamma \leq 1$$

Here $(1-\gamma)$ measures relative risk-aversion. By assigning different values to γ, they analysed portfolio behaviour of a wide class of risk-averse investors.

or almost identical to those obtained using the full expected utility function. Besides Pulley, there are other studies in the literature that demonstrated the robustness of the mean-variance approximation to expected utility. Tsiang (1972) and Ohlson (1975) have shown that under certain assumptions, expected utility can be described reasonably well by a function of mean and variance only. Later on, Levy and Markowitz (1979) and most recently Kroll, Levy and Markowitz (1984) have shown that the mean-variance approximation yields results that are identical or almost identical to those obtained from direct expected utility maximization using some well-known, widely-used utility functions (namely, logarithmic, power and exponential).

In fact, for 'practical' as opposed to 'theoretical' purposes, the mean-variance approximation has a definite edge over the direct utility functions in that with the former one does not have to bother about the exact shape of the utility function which may be very difficult to ascertain. On the contrary, investors' risk-preferences can be introduced easily into the mean-variance approximation of the expected utility function. Different values for the risk-aversion coefficient in this function would represent investors of different risk classes. If, at least for practical purposes, investors are better classified according to their risk perferences as opposed to their specific utility functions, the mean-variance approximation is capable of handling investment behaviour of a wide class of risk-averse investors.

In the present analysis, the mean-variance approximation to the expected utility function will be used to analyse investment behaviour of a wide class of investors. Using Taylor series approximation, the expected utility function, in terms of mean and variance only, is derived as follows:

Let w_0 denote initial wealth and $\tilde{r}$ denote rate of return on risky investment. The investor's terminal wealth is

$$\tilde{w} = w_0(1+\tilde{r})$$

Expected terminal wealth and its variance are

$$E(\tilde{w}) = m = w_0(1+\mu) \quad \text{where } \mu = E(\tilde{r})$$

$$V(\tilde{w}) = E\{\tilde{w} - E(\tilde{w})\}^2 = w_0{}^2\sigma_r{}^2 \quad \text{where } \sigma_r{}^2 = E(\tilde{r} - \mu)^2$$

Utility of terminal wealth

$$u = u(\tilde{w}) = u\{w_0(1+\tilde{r})\}$$

Taylor series expansion of $u(\tilde{w})$ around mean wealth, m, is

$$u(\tilde{w}) = u(m) + u'(m)(\tilde{w} - m) + 1/2\ u''(m)(\tilde{w} - m)^2 + \dots \dots$$

Since $(\tilde{w} - m) = w_0(1+\tilde{r}) - w_0(1+\mu) = w_0(\tilde{r}-\mu)$

$$u(\tilde{w}) = u(m) + u'(m)w_0(\tilde{r}-\mu) + 1/2\ u''(m)w_0{}^2(\tilde{r} - \mu)^2 + \dots$$

$$E\{u(\tilde{w})\} = u(m) + 1/2\ u''(m)w_0{}^2\sigma_r{}^2 + \dots\dots$$

If μ is small, then u(m) can be expressed as

$$u(m) \simeq u(w_0) + u'(w_0)\ w_0\ \mu$$

Similarly u''(m) can be expanded as

$$u''(m) \simeq u''(w_0) + u'''(w_0)\ w_0\mu$$

Substituting for u(m) and u''(m) in $E\{u(\tilde{w})\}$ and ignoring higher order terms beyond two,

$$E\{u(\tilde{w})\} \simeq u(w_0) + u'(w_0)w_0\mu + 1/2\ u''(w_0)\ w_0{}^2\sigma_r{}^2$$

Dividing through by $u'(w_0)w_0$ which is a constant

$$\frac{E\{u(\tilde{w})\}}{u'(w_0)w_0} \simeq \frac{u(w_0)}{u'(w_0)w_0} + \mu + 1/2 \frac{u''(w_0)}{u'(w_0)} w_0\sigma_r^2$$

$$\simeq k + \mu - 1/2 R \sigma_r^2 \qquad (6.1)$$

where $R = -\frac{u''(w_0)}{u'(w_0)} w_0$ and $k = \frac{u(w_0)}{u'(w_0)w_0}$ = Constant

Since utility function and hence the expected value of the same is unique upto positive linear transformation, expected utility can be written in an equivalent way as

$$G\{E(u(\tilde{w}))\} \simeq \mu - a\sigma_r^2 \qquad (6.2)$$

where $a = (1/2) R$

Maximising expression (6.2)[2] above is equivalent to maximising expected utility. Since $R = - u''(w_0)w_0/ u'(w_0)$ is evaluated at the initial wealth, w_0, it may be taken as a constant. For investors with different risk preferences a will be different. For example $a = 1$ will represent a less risk-averse investor than one with $a = 5$. In fact, $a = 1/2 R$ measures the price (in terms of expected utility) of an additional unit of risk (as measured by variance)

$$\frac{\partial\{G\{E(u(\tilde{w}))\}\}}{\partial\sigma_r^2} = - a$$

For risk-averse investors, a would be positive so that when

[2]Pulley (1981) derived the same expression in a slightly different way.

variance increases expected utility falls. Opposite is the case for risk-seekers. When $a = 0$, variance is no consideration to the investor and he is said to be risk-neutral. Since we are interested in the risk-averse investors only, we will consider positive values of a.[3]

Empirical Results

Using monthly data and the most recent past 84-months or 7 years observations (T=84) on asset returns, the joint return distribution for each period is estimated in a moving fashion as explained in chapter 2 above. For each period, the estimated return distribution is used as an input to maximize expression (6.2) above for different arbitrarily chosen values of a which represents investors of different risk classes. Portfolio weights were constrained to add up to unity and no short-selling was allowed.

At the end of each period when actual returns on assets were available, realized portfolio return for selected as were calculated using the weights calculated at the begining of the period. Table 6.1 below gives the geometric means and standard deviations (SD) of these realized returns over 1966-Feb to 1982-Dec. More particularly, the table shows the geometric means and SDs of realized returns for some actively managed portfolios based on maximization of expected utility that investors

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[3] It may be mentioned here that a which is one-half of the relative risk-aversion coefficient is related to Grauer and Hakanson's (1982) γ by $a = (1/2)(1-\gamma)$.

Table 6.1

Geometric Means and SDs of Realized Portfolio Returns based on M-V Approximation of Expected Utility, Different a-values, Monthly Revision, 84-month Estimating period, 1966- Feb to 1982-Dec*

a values	Geom mean (p.c/month)	SD	Mean/SD
0.10	0.95	5.45	0.17
0.25	0.97	5.12	0.19
0.40	0.91	4.88	0.19
0.50	0.85	4.69	0.18
0.75	0.78	4.39	0.18
1.00	0.72	4.26	0.17
1.50	0.64	4.13	0.15
2.50	0.54	3.89	0.14
4.00	0.46	3.66	0.13
5.00	0.42	3.56	0.12
6.00	0.37	3.45	0.11
7.50	0.33	3.32	0.10
10.00	0.29	3.17	0.09

* Actual data used are from 1959(2) to 1982(12). With T=84 the first month for which portfolio returns can be calculated is 1966(2) since the first 84 months observations are lost in estimating the future return distribution

belonging to different risk classes would have chosen had they followed monthly revision of their portfolios on the basis of most recent past 84 months observations.

The table shows a nice pattern in the relationship between risk-aversiveness (as reflected in a) and realized return -- as a increased, geometric mean of realized returns declined. In other words, as investors got more and more risk-averse, they earned less and less mean return and their more risk-aversiveness was reflected in the lower SD of portfolio return. In fact, as investors switched from lower risk classes to higher ones, they lost average return per unit of SD, as is evident from the falling mean/SD ratio. It seems, therefore, that relatively less risk-averse investors were benefitted more per unit of risk than their more risk-averse counterparts. Figure 6.1 displays these results.

For monthly portfolio revision, the upward-sloping curve relates the geometric mean and SD of actively managed portfolios for different values of the risk-aversion parameter, a. Each point on the curve represents average performance of portfolios selected by investors belonging to a specific risk class.[4] The upward slope indicates that the market actually paid for carrying more risk. If investors changed their risk class from,

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[4]A similar curve was derived in Grauer and Hakanson (1982). As shown earlier, the primary difference between Grauer and Hakanson's and the present study lies in the underlying portfolio selection model and also in that their study contained only U.S. financial assets. They used a non-linear utility function as opposed to the simple mean-variance approximation used in this study.

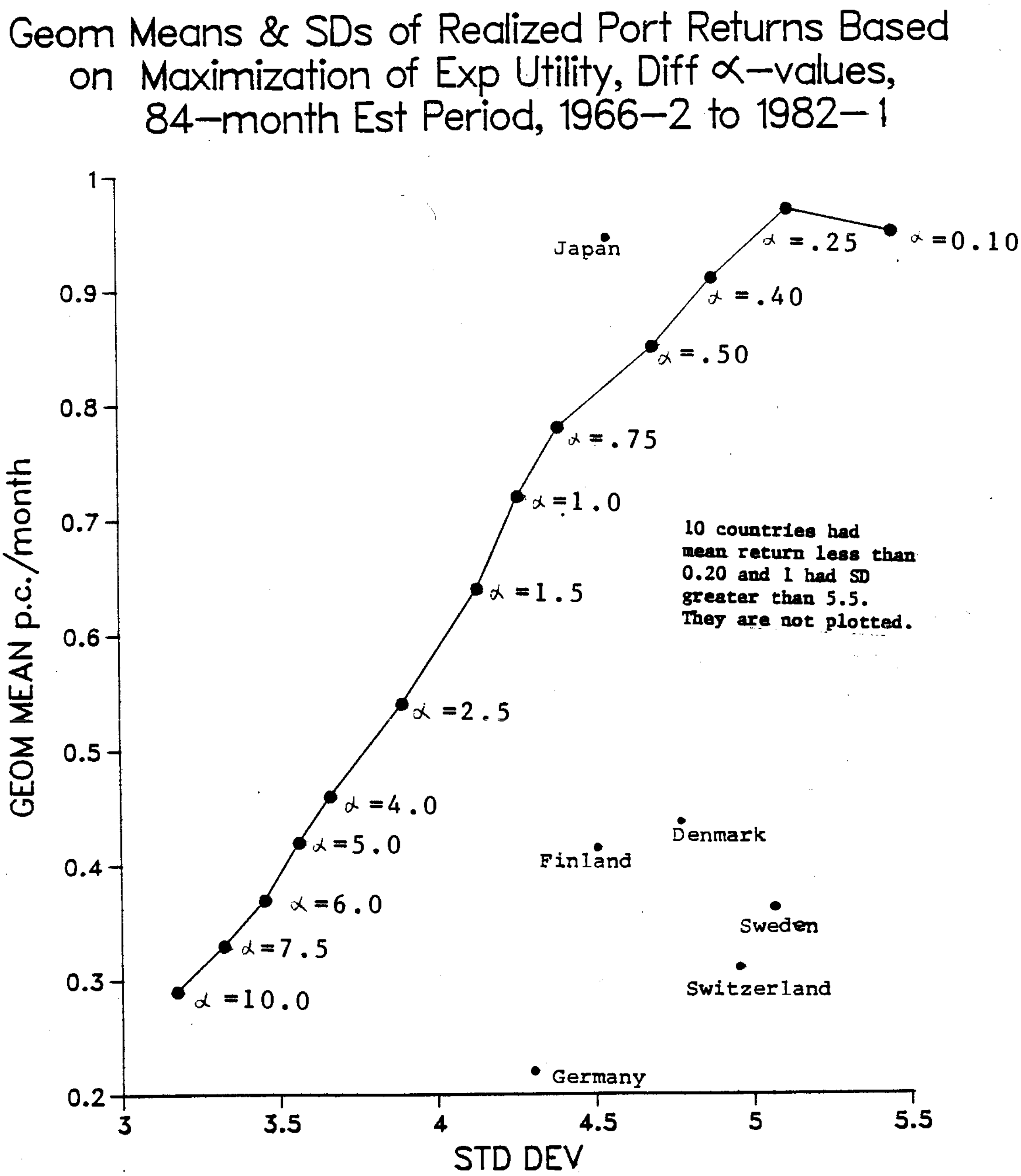
Geom Means & SDs of Realized Port Returns Based
on Maximization of Exp Utility, Diff α–values,
84–month Est Period, 1966–2 to 1982–1
GEOM MEAN p.c./month
STD DEV
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
3
3.5
4
4.5
5
5.5
α = .25
α =0.10
α = .40
α = .50
α = .75
α =1.0
α =1.5
α =2.5
α =4.0
α =5.0
α =6.0
α =7.5
α =10.0
Japan
Denmark
Finland
Sweden
Switzerland
Germany
10 countries had
mean return less than
0.20 and 1 had SD
greater than 5.5.
They are not plotted.

FIGURE 6.1

say, a = 10.0 to 2.5 (which means they preferred more risk), they were rewarded with more returns and their increased risk preferences were reflected in the higher SD of realized returns. The average portfolio performance, as measured by the slope of a ray from the origin to the curve, increased as a decreased.

Figure 6.1 shows another interesting point. For a range of a values displaying high risk-aversion the curve is convex from below (more explicit in figure 6.2 below). This indicates the fact that there was increasing rate of reward per unit of risk available at the margin for a very conservative class of investors had they lowered their aversion to risk. This makes sense because a highly conservative class of investors would not be willing to accept more risk unless they are offered high risk-adjusted return. For some other range of a values showing low risk-aversion the curve is concave from below implying a declining rate of reward per unit of risk for bearing extra risk. This also is consistent with common sense belief that it requires relatively lesser and lesser amount of reward per unit of risk at the margin to induce a relatively low risk-averse class of investors to bear additional risk.

Table 6.2 shows the results of repeating the same exercise under quarterly portfolio revision and using 28-quarter or 7 years estimation period. Figure 6.2 portrays the same information. The same analysis as above applies to the quarterly revision case. However, comparing the mean/SD ratio in the two estimating period cases it seems that for less risk risk-averse

Table 6.2

Geometric Means and SDs of Realized Portfolio Returns based on M-V Approximation of Expected Utility, Different a-values, Quarterly Revision, 28-qtr Estimation period, 1966(2)-1982(4)*

a values	Geom mean (p.c./qtr)	SD	Mean/SD
0.125	2.63	10.83	0.24
0.25	2.41	10.46	0.23
0.375	2.35	10.04	0.23
0.50	2.19	9.30	0.24
0.75	1.94	8.74	0.22
1.00	1.82	8.56	0.21
1.25	1.76	8.47	0.21
1.50	1.70	8.37	0.20
2.00	1.46	8.07	0.18
2.50	1.24	7.87	0.16
3.00	1.06	7.72	0.14
3.50	0.90	7.60	0.12
4.00	0.78	7.44	0.10
4.50	0.71	7.26	0.10
5.00	0.65	7.06	0.09
8.00	0.53	6.21	0.08
10.00	0.53	5.97	0.09

* Actual data used are from 1959(2) to 1982(4). With T=28, the first quarter for which portfolio returns can be calculated is 1966(2) since the first 28 quarters observations are lost in estimating the future return distribution

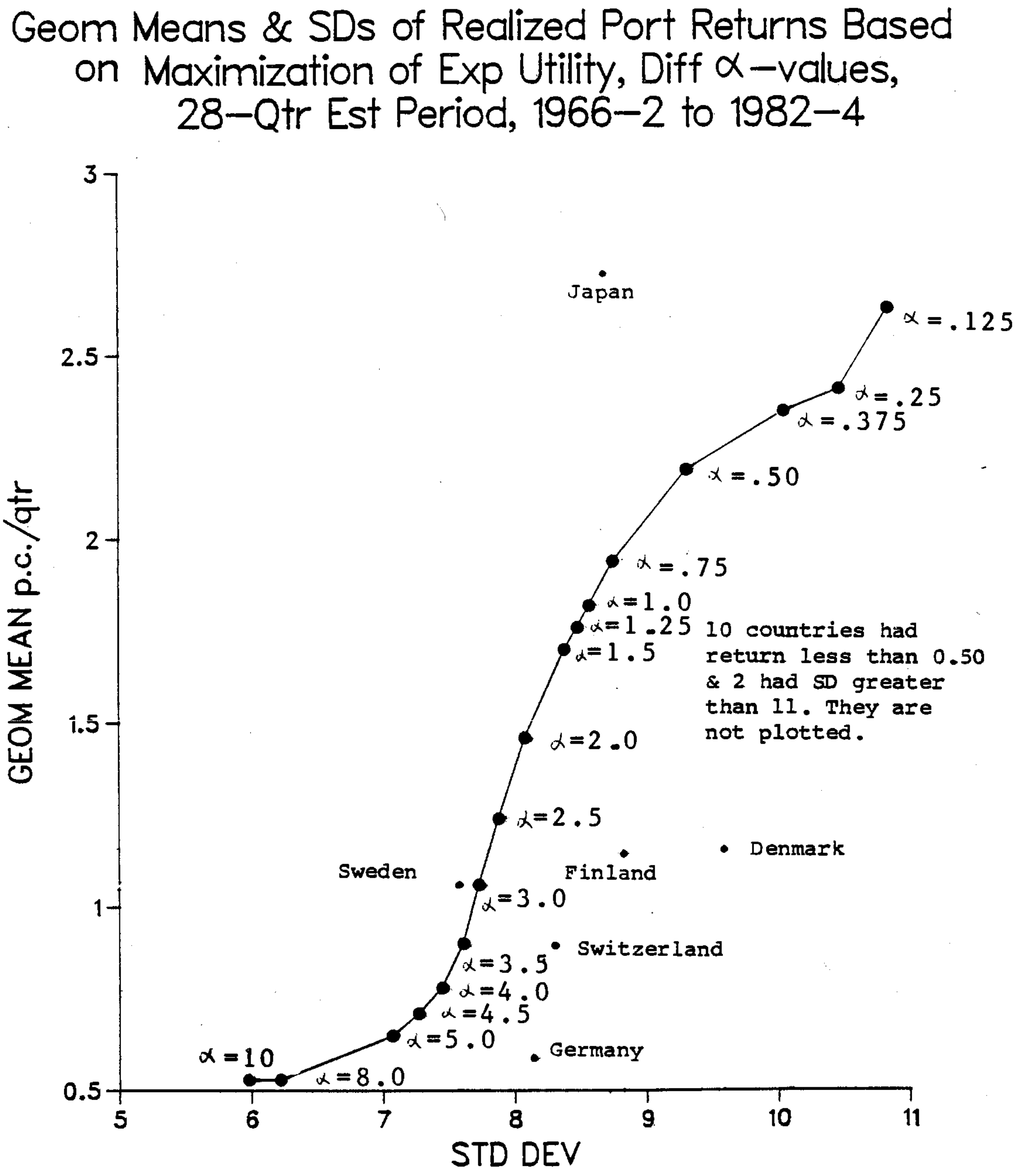
Geom Means & SDs of Realized Port Returns Based on Maximization of Exp Utility, Diff α–values, 28–Qtr Est Period, 1966–2 to 1982–4
GEOM MEAN p.c./qtr
STD DEV
3
2.5
2
1.5
1
0.5
5
6
7
8
9
10
11
Japan
α = .125
α = .25
α = .375
α = .50
α = .75
α = 1.0
α = 1.25
α = 1.5
α = 2.0
α = 2.5
α = 3.0
α = 3.5
α = 4.0
α = 4.5
α = 5.0
α = 8.0
α = 10
Sweden
Finland
Denmark
Switzerland
Germany
10 countries had return less than 0.50 & 2 had SD greater than 11. They are not plotted.

FIGURE 6.2

investors there was a choice in favour of quarterly revision whereas for more risk-averse investors the choice appears to be for monthly revision.

In the assumed mean-variance world, investors' decision making is governed by consideration of expected return and variance of the ex ante return distribution. Expected return has positive marginal utility and is desirable whereas variance is undesirable. Investors having high a are very much concerned about variance and try to avoid it. Their investment behavior is, therefore, governed primarily by consideration of portfolio variance. Since they know that portfolio variance can be minimized through diversification, these investors hold many assets in their portfolios. On the other hand, investors who are less concerned about risk (i.e. investors with low a), hold relatively less diversified portfolios. Basically this is the message conveyed by table 6.3 below which compares portfolio composition of two arbitrarily selected classes of risk-averse investors under quarterly portfolio revision and with 28-quarter estimation period.

The class of risk-averse investors represented by $a = 0.125$ has a very low risk-aversion (close to risk-neutrality). Their preferences are reflected in the undiversified portfolios in 55 out of 67 quarters under study. In other words, in about 82 p.c. of the time, these investors held undiversified portfolios -- holding the asset having the largest expected return without caring for its variance. The South African asset had the highest

Table 6.3

Composition of Optimal Portfolios for Investors Belonging to Two Risk-Classes, Quarterly Portfolio Revision, 28-Quarter Estimation Period, Selected Periods

	a = 0.125		a = 5.0	
Period	Portfolio Composition	Realized Return (p.c./qtr)	Portfolio Composition	Realized Return (p.c./qtr)
1966(2)	IR=1.0	-0.95	IR=0.98, SW=0.02	-1.01
1966(3)	IR=1.0	-3.25	IR=0.97, AU=0.03	-3.26
1966(4)	IR=1.0	-6.48	IR=1.0	-6.48
1967(1)	IR=1.0	-0.10	IR=0.98, SA=0.02	-1.03
1967(2)	IR=1.0	4.19	IR=0.78, SA=0.02, US=0.20	4.34
1967(3)	IR=1.0	5.01	IR=0.66, SA=0.09, US=0.25	3.55
1967(4)	IR=1.0	-7.82	IR=0.64, SA=0.07, US=0.29	-4.67
......		.....	.....	
1974(2)	SA=0.64 FN=0.36	9.06	C =0.11, J =0.23, SA=0.10, SZ=0.14, AU=0.16, FN=0.20, NW=0.06	-1.89
1974(3)	SA=1.0	1.72	J =0.30, SA=0.17, SZ=0.03, AU=0.28, FN=0.22	-7.17
1974(4)	SA=1.0	-0.02	J =0.27, SA=0.22, AU=0.27, FN=0.24	-2.06
1975(1)	SA=1.0	-14.24	J =0.05, SA=0.16, AU=0.21, FN=0.58	-0.36
1975(2)	FN=1.0	-3.77	J =0.08, SA=0.06, AU=0.31, FN=0.55	-2.22
....		....	....	
1979(1)	J =1.0	-4.49	J =0.47, SA=0.04, AU=0.49	-3.18
1979(2)	J =1.0	-4.93	C =0.01, J =0.41, SA=0.06, SW=0.02, SZ=0.04, AU=0.46	-0.53
1979(3)	J =0.50 SA=0.50	7.77	C =0.11, J =0.28, SA=0.04, SZ=0.05, AU=0.52	5.46
1979(4)	D =0.15 SA=0.85	23.26	C =0.14, J =0.22, SA=0.04, SZ=0.08, AU=0.52	2.19

Contd. on next page

Table 6.3 contd.

Period	a = 0.125 Portfolio Composition	Realized Return (p.c./qtr)	a = 5.0 Portfolio Composition	Realized Return (p.c./qtr)
1980(1)	SA=1.0	21.73	C =0.18, J =0.14, SA=0.07, SZ=0.07, AU=0.54	-2.35
1980(2)	SA=1.0	12.13	C =0.23, J =0.22, SA=0.12, AU=0.43	8.41
1980(3)	SA=1.0	37.73	C =0.23, J =0.27, SA=0.12, AU=0.38	5.21
1980(4)	SA=1.0	6.79	C =0.13, J =0.28, SA=0.16, US=0.12, AU=0.31	0.94
1981(1)	SA=1.0	-37.65	J =0.51, SA=0.16, US=0.06, AU=0.27	-9.27
1981(2)	J =1.0	2.18	C =0.06, J =0.52, SA=0.06, SW=0.10, US=0.06, AU=0.20	-2.73
1981(3)	J =0.70 UK=0.30	-1.65	C =0.27, J =0.58, SA=0.02, SW=0.08, AU=0.05	-2.01
1981(4)	A =0.22 UK=0.78	-1.56	A =0.19, C =0.16, D =0.14, J =0.51	-1.91
....		......	....	
Mean Ret over 66-2 to 82-4 (p.c./qtr)		2.63		0.65
SD		10.83		7.06

LEGEND: A=Australia, AU=Austria, B=Belgium, C=Canada, D=Denmark, FN=Finland, F=France, G=Germany, IR=Ireland, I=Italy, J=Japan, N=Netherland, NW=Norway, SA=S.Africa, SW=Sweden, SZ=Switzerland, UK=United Kingdom, US=United States variance in some periods, yet these investors committed fully to this asset in 9 periods because of its highest expected return. In rest of the cases, their portfolios consisted of top ranking two assets only (in terms of expected return) and the proportion invested in each was determined by consideration primarily of expected returns with little influence of the variances and covariances of the two assets.

The class of investors represented by a = 5.0, on the other hand, are very risk-averse. Except in 4 quarters (1966-2 -- 1967-1), they held well-diversified portfolios. Portfolio selection here seems to have been governed by consideration of both expected returns and variances-covariances. In about 55 p.c. of the time, these investors put the biggest proportion of their funds in the asset having highest expected return but unlike their a = 0.125 counterparts they did not fully commit themselves to that asset. In rest of the cases, we see deviation from this simple rule.

Most noteworthy is the case for 1979(3). More than 50 p.c. of the fund went to Austria which ranked only fourth in terms of expected return. Japan and S. Africa, the countries having the highest expected returns, together accounted for only a third of the total investment. Denmark, ranking third, did not receive any fund whereas Canada, being one of the lowest, got 11 p.c. of the total fund. In the next period, 1979(4), the country with the highest expected return (S. Africa) got only 4 p.c. whereas Austria, ranking third got 52 p.c. of the fund. In these and similar other cases, optimal portfolio choice was made by giving more emphasis on risk reduction rather than raising expected return.

The difference in the composition of optimal portfolios for these two groups of risk-averse investors is more explicit in periods 1974(3) -- 1975(1) and 1980(1) -- 1981(1). In these periods, a = 0.125 investors put all their money into S. African asset having highest expected return as well as highest variance. They are expected return maximizers who do not care much for risk. The more conservative investors, having a = 5.0, on the other hand, put only a small proportion of their funds into this asset in spite of its very promising expected return.

Over the period under study (1966-2 to 1982-4) investors belonging to a = 0.125 earned an average return of 2.63 p.c. per quarter with a SD of 10.83. The more conservative investors (with a = 5.0) earned significantly less on average (0.65 p.c. per quarter) with smaller SD (7.06). Per unit of SD, the less risk-averse investors earned significantly higher return than the more risk-averse investors. More exposure to risk did not prove to be bad and, in fact, paid for. From the point of view of portfolio management, less risk-averse investors also had the advantage that they did not have to switch their funds in and out of assets as frequently as the more risk-averse investors. Considering transaction costs, portfolio management was less costly for the less risk-averse investors than for the more risk-averse ones.

Benefits from international portfolio diversification are evident from both figure 6.1 and 6.2 where the geometric means and standard deviations of individual country assets are also plotted.[5] In figure 6.1, except for Japan, all national market indices are dominated by portfolios on the curve. The Japanese asset seems to have dominated portfolios having a approximately less than 0.50 but higher than 0.25. Therefore, except for investors having such relative risk-aversion, all risk-averse investors were benefitted from diversifying their portfolios internationally rather than holding only the domestic market index. Figure 6.2 conveys basically the same information as figure 6.1 except that it is done with 28-quarter estimation period.[6]

<u>Summary</u>

Incorporating the Pratt-Arrow measure of relative risk-aversion in the mean-variance approximation of expected utility function, we have analysed investment behaviour of a wide class of risk-averse U.S. investors. We found that there were significant 'extra' realized gains for all risk-averse investors from holding international portfolios rather than the

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[5]For the T=84 months estimation period case, 10 countries had mean return less than 0.20 p.c. and 1 had SD greater than 5.5. These 11 countries are not plotted in figure 6.1. For similar reason, 12 countries are not plotted in figure 6.2.

[6]Some other estimation periods were also tried, e.g., 40-quarter period under quarterly revision and 120-month period under monthly revision and similar conclusions were obtained as those mentioned.

domestic benchmark portfolio.

Realized benefits of international diversification for all risk-averse U.S. investors over the period follow from the evidence that the domestic market index was far below the curve that related risk-aversiveness and mean and SD portfolio returns (figure 6.1 and 6.2). The relatively less risk-averse investors were found to have benefitted more from diversifying their portfolios internationally than their more risk-averse counterparts.

As regards portfolio composition, it was seen that less risk-averse investors held more risky portfolios and were rewarded for carrying more risk than the more risk-averse investors who, in most of the cases, held undiversified portfolios and earned less return.

Grauer and Hakanson (1982) obtained similar results about the benefits of diversification with domestic portfolios of U.S. assets only. Compared to their non-linear maximization model, the performance of the simple mean-variance approximation model used here is quite robust and its real beauty lies in its simplicity.

CHAPTER VII

EXCHANGE RATE FLUCTUATIONS AND INTERNATIONAL DIVERSIFICATION OF PORTFOLIOS

One of the fundamental dimensions of international investment as opposed to domestic investment is the presence of exchange risk which arises due, primarily, to the uncertain future value of foreign currency in terms of domestic currency, unanticipated exchange control etc. Since exchange control is not practiced by many countries I will ignore the risk arising out of such policy. I will assume thet exchange risk arises due to the uncertainty in the future value of exchange rates only. The magnitude of risk on this account has increased significantly after the breakdown of the fixed exchange rate system in the early seventies. Under the fixed exchange rate system, movements in exchange rates between countries were infrequent and more predictable. The central bank of each country had the responsibility of maintaining the exchange rate at par value in the face of balance of payments deficit or surplus. International trade in goods and services and international flow of capital enjoyed the benefits of the stable exchange rate system. However, under the system domestic monetary authorities had little control over the money supply since the money supply became an endogenous variable - responding passively to changes in balance of payments.

During the late sixties and early seventies, several countries, notably Germany, experienced persistent and large balance of payments surplus while the U.S. and Britain experienced similar balance of payments deficits. Committed to the fixed exchange rates system, the Bundesbank had to buy large quantities of foreign exchange (dollar) in order to meet foreigners' demand for Mark and consequently the German money supply increased at an unprecedented rate. To save the country from further inflation and to gain control of money supply the Bundesbank decided not to intervene in the foreign exchange market and let the exchange rate be determined by the demand for and supply of foreign exchange.

The German decision to float the currency in 1973 sounded the death knell of the fixed exchange rate system and a new system where exchange rates were determined by demand and supply consideration took its place. Under the new 'flexible rate' system, exchange rate changes were very frequent and unpredictable. Many people were concerned about the impact of such unstable exchange rates on international business. Due to the added risk of exchange rate uncertainty, they feared that the volume of trade in capital and goods would be adversely affected with the consequent loss of welfare which the world enjoyed under the fixed exchange rate system. After more than a decade since the advent of the new system we are in a position to evaluate its impact on the volume of trade in goods and services and on the movement of capital. In this chapter we try to measure the effects of exchange rate fluctuations on the gains from international financial investment.

Additional uncertainty emanating from exchange rate fluctuations may increase the risk of international investment but it could be a source of additional gains as well. In fact, as Levy and Sarnat (1978), Levy (1981) have demonstrated, uncertain future exchange rate movements had given rise to a new instrument of financial investment --- the non-interest bearing currency. By taking speculative position in foreign currencies, there are potential benefits to the reaped --- benefits which might even exceed those from investment in the stock markets. This accounts for the growing importance of the phenomenon of "currency substitution".

Central banks of many developing countries, due to the nature of their economic activities, can and do hold part of the country's monetary reserves in the form of a portfolio of major foreign currencies. The same is true with international investment trusts and large multinational corporations. Levy and Sarnat (1978) found that over November, 1970 to April, 1973, a period characterised by de facto fluctuating exchange rates, foreign currencies, (along with foreign equities) occupied a significant proportion of the efficient portfolio of U.S. investors.

Using a larger sample period (1970- 1978) and carrying out the analysis from the point of view of U.S. as well as non-U.S. investors, Levy (1981) reported unusual significance of Danish Krone in the optimal portfolios of currencies (in 7 out of 17 cases, Danish Krone alone occupied more than 90 p.c. of total portfolio weight).

The Exchange Risk

It appears quite reasonable to think that uncertain and unpredictible changes in exchange rates make international investment more risky than in the absence of these changes. This follows from the simple fact that the exchange rate enters as an additional random variable having a probability distribution whose form and/or parameter values is unknown. However, the existence and nature of exchange risk in international investment depend on the particular model and its assumptions one has in mind as well as the definition of exchange risk. Solnik (1973), investigating the financial investment decisions of investors belonging to different nationalities recognized this risk.

> When considering an international investment, a fundamental dimension should be added to the analysis: the exchange risk. Anyone investing abroad will bear not only the risk due to the real characteristics of the investment, but also an exchange risk (p.8)

In his model, Solnik assumed that the exchange risk was purely real, arising out of changes in relative prices.[1] He assumed that taste patterns were different in different countries and that consumptions were limited to home country only. It was, in fact, the difference in taste patterns that gave rise to

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[1]As explained below, real exchange risk may be interpreted as deviations of the spot exchange rates from the PPP rate. If exchange rates follow the parity rate, then fluctuations in the former rates would be compensated for in the form of price level changes and real exchange risk would be zero.

difference in asset choices and hence in relative prices which in turn gave rise to exchange rate changes.

Grauer, Litzenberger and Stehle (1976), on the other hand, argued that the component of exchange risk which was due to changes in relative prices was the key factor in any trade in capital and goods and it was not something unique to international investment only.

> Exchange risk attributable to the variation in relative prices across states of the world is redundant, however, since the variation in relative prices across states is a causal factor determining asset and consumption choices (P.252)

The other component of exchange risk which arises due to the difference in absolute prices across countries does not affect consumption-asset choices. Thus

> there is no added dimension to international investment which creates a new type of risk for individual investors, hence, given our assumption, exchange risk has no independent identity (P.252)

The difference between Solnik's and Grauer, Litzenberger and Stehle (henceforth G-L-S)'s analysis of exchange risk may be explained as follows. Let

$$T = ep^*/p \qquad (7.1)$$

be the relative price between two countries where e is the exchange rate between them, P* is the price level in the foreign country and P, that in the home country.[2] Differentiating (7.1) with respect to time and expressing it in rate of change form,

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[2]When the absolute or static form of PPP holds, T would be equal to unity.

$$\dot{T} = \dot{e} + \dot{p}^* - \dot{p}$$

$$\text{or} \quad \dot{e} = \dot{T} + (\dot{p} - \dot{p}^*) \qquad (7.2)$$

where the dot over a variable indicates time rate of change, e.g., $\dot{x} = (1/x)(dx/dt)$.

From (7.2), exchange rate change has two components, the change in relative prices ($\dot{T}$) and the difference in inflation rates between the two countries ($\dot{p} - \dot{p}^*$). When the absolute PPP holds, $\dot{T} = 0$ and $\dot{e} = (\dot{p} - \dot{p}^*)$. Solnik (1973) assumed zero or equal inflation rate in both countries and argued that exchange rate changes were due to changes in the relative prices.[3] Difference in taste patterns of consumers and investors accounted for the difference in relative price.

G-L-S, on the other hand, asserted that changes in relative prices ($\dot{T}$)determined trade and the consequent change in e was a necessary by-product of free trade and was not exchange risk (note the first quotation on previous page). As regards difference in the inflation rates between countries, this would change e but changes in these 'monetary' variables would not affect consumption-asset choices.[4] Due to nominal exchange rate changes nominal proceeds from investment in the same asset would be different to investors in two countries but the real proceeds would remain the same to them. This implies that the 'numeraire'

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[3]This is equivalent to assuming that the PPP does not hold in the short-run. That is, $\dot{T} \neq 0$ in equation (7.2).

[4]Note that the G-L-S's proposition of no real exchange risk is true when the absolute PPP holds.

currency does not matter. A given asset remains the same in terms of real risk and return to a foreign as well as to a domestic investor.

The Objective

Since the PPP was not found to hold in the short run by many earlier studies, I would assert that the real exchange risk exists in the short run. My objective in this chapter is, primarily, to investigate the effects of exchange risk as perceived by investors of a specific country (the U.S.) on the risks and returns of internationally diversified portfolios and, consequently, on the benefits of such diversification. More particularly, I address the following problem: to what extent does the exchange factor contribute to the risks and returns of the portfolios of U.S. investors who are confronted with an enlarged set of investment opportunities beyond their national boundary. I also investigate whether international diversification is desirable for them in the presence of exchange risk.

Our (implicit) model is, therefore, basically different from that of Solnik or G-L-S. We abstract from consideration of the determination of absolute and relative prices as well as exchange rates. These are determined elsewhere and our investors take them as given. The investors are assumed to be mean-variance decision makers who are concerned with the consequences of their choices in one period only. They can invest in the world capital market but are assumed to consume in their home country. They make decisions on the basis of the nominal proceeds from investment. Between two countries, if one offers more nominal return per unit of risk than the other, they would invest in the country with the higher risk-adjusted return. The investors' holding period of assets is assumed to be short -- a month or a quarter. This has the implication that (exogenous) changes in exchange rates cannot be fully reflected in absolute price level changes to maintain parity. In other words, there can be some real effects of changes in nominal variables in the short run. Though we will consider only 'nominal' as opposed to 'real' gains, there would be some 'real' gains as well in the short run due to the sluggish adjustment of absolute prices. Exchange risk, is therefore, a fundamental dimension of international investment for our investors.

There are two ways in the literature in which exchange risk can be hedged none of which is suitable for international stock market investment. The first one which involves entering into forward contract is not very useful for portfolio purposes because of the short-term nature and rigidity of the contract. The second one involves several transactions --- first, borrowing investment fund in the foreign money market and selling them immediately for domestic currency and finally, investing the fund in the home country. The usefulness of this method is also limited for our purposes since it will be very difficult for individual investors or small firms to borrow money in the foreign market. Even if borrowed funds are available, this method does not capture all diversification possibilities. For example, the investor cannot buy foreign securities and hence cannot enjoy the associated benefits.

The limitations of the existing methods of exchange risk hedging need not worry us, however. Since our main purpose is to disentangle the contribution of the exchange factor on portfolio risk and return, I do not assume any coverage for the exchange risk. I want to consider exchange rate as an instrument of risky investment.

To my knowledge, there has not been any rigorous effort to investigate the contribution of the exchange factor on the benefits of international portfolio diversification. Solnik and Noetzlin (1982)'s contribution to this end is limited mainly to the separation of the impact of the currency factor to the risk and return of individual country assets denominated in U.S. dollars. Some of their findings in this context are worth mentioning.

> The data reveal that exchange risk is always significantly smaller than the systematic risk of the respective stock markets. (p.14)
>
> Exchange risk broadly amounts to 15% of the aggregate risk involved in equity investments and 50% of that involved in bonds. (p.14)

As correctly asserted by these authors, the overall impact of the exchange factor can only be judged at the level of internationally diversified portfolios. But they did not seem to have estimated the contribution of the exchange factor for any efficient, internationally diversified portfolio. They, however, calculated the risk attributable to the exchange factor for various world indices. For the world stock index with 50 p.c. weighting of U.S. securities, the exchange risk was only a small amount of total risk. For the Capital International EAFE index which used non-U.S. equities weighted by their market capitalization, this risk was only 15 p.c. of total risk in U.S. dollars and for the EAFE stocks and bonds this figure was about 33 p.c. What these numbers mean is that for value-weighted internationally diversified portfolios, the exchange risk is only a small proportion of the total risk and with foreign bonds included, the contribution of exchange factor increases to about one-third of total risk.

The analysis by Solnik and Noetzlin suffers from several important limitations. First, they used ex post data and as such their results contain an upward bias for returns calculation and downward bias for risks. Their findings of small or insignificant contribution of exchange factor to total risks in flexible exchange rate system may be a reflection of this fact.

Second, market valuations as portfolio weights may not be appropriate in an international context where we have an extra random variable (exchange rate) which is not directly related to the stock market. Because of the high market capitalization, a country's asset may have high weight in the portfolio of an international investor but its currency may be expected to depreciate relative to home currency thereby making total home currency-adjusted expected return lower. On the other hand, portfolio risk would be higher because of an additional random variable. Thus, exchange rate changes should be incorporated directly in determining portfolio choice.

Third, their analysis cannot answer how risk and return from internationally diversified portfolio compare between the fixed vs. flexible exchange rate systems.

Fourth, their analysis does not show how optimal portfolios react to changes in exchange rates. In this chapter, I make an attempt to take these factors into account.

Analytical Decomposition of Portfolio Risk and Return

Investing in international stocks is basically investment in two different markets, namely, the foreign stock market and the foreign exchange market. However, since foreign currencies are not considered as separate assets in equity investments, their choice in portfolio is dependent on the choice of 'country' stocks. But since they enter as separate random variables they influence portfolio choice and hence portfolio risk and return. Depending on the exchange gain or loss, the 'uncovered' home currency-adjusted total return may be higher or lower than the return specific to stocks. But portfolio risk is very likely to be higher with exchange rate variations than in the absence of these random variables.

To separate out the contribution of the exchange factor and to see its importance in international portfolio analysis, we decompose portfolio risk and return as follows. Since the analysis will be done from the point of view of a representative U.S. investor, returns from foreign stocks are converted into U.S. dollar, using the end-of-period spot exchange rates.

The dollar-adjusted rate of return on asset i in period t (DR_{it}) is defined as

$$DR_{it} = \ln(P_{it}/ P_{it-1}) - \ln(e_{it}/ e_{it-1})$$

$$= cg_{it} - eg_{it} \tag{7.3}$$

where P_{it} represents stock price index of country i in period t, e_{it} represents end-of-period spot exchange rate between the home country (U.S.) and country i, defined as the price of one U.S. dollar in foreign currency and cg_{it} and eg_{it} are capital gains/losses and exchange gains/losses respectively from equity investment in country i.[5] $eg_{it} > 0$ implies depreciation of foreign currency relative to dollar and hence loss on exchange account for the U.S. investor. Conversely, $eg_{it} < 0$ implies exchange rate appreciation and hence exchange gain. The expected return and variance of DR_{it} are

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[5]Again, dividend information being unavailable for all countries in the sample are left out and hence rates of returns thus calculated would be an underestimation of true returns on this account. This underestimation, however, may not be serious, as we saw in chapter 5.

$$E(DR_{it}) = E(cg_{it}) - E(eg_{it}) \tag{7.4}$$

$$V(DR_{it}) = V(cg_{it}) + V(eg_{it}) - 2\,Cov(cg_{it}, eg_{it}) \tag{7.5}$$

From (7.4) it follows that exchange rate variations contribute to total expected return when $E(eg_{it}) < 0$ i.e., when there is an expected appreciation of ith country's currency relative to dollar. Conversely, when $E(eg_{it}) > 0$, some of the gains attributable to stocks are eaten up by adverse exchange rate movements and total expected return would be less than the expected capital gain.

The variance of total return would, in general, be higher than the variance of stock specific return unless the negative covariance effect is strong enough to outweigh the positive variance effect of exchange gains/losses in equation (7.5). The net effect of the second and the third term shows the contribution of the exchange factor on the total risk of an asset's dollar-rate of return.

Since the overall impact of the exchange factor must be evaluated from internationally diversified, efficient portfolios, we calculate the expected return and variance of such a portfolio as follows.

Expected portfolio return in period t,

$$EPR_t = \Sigma\, X_{it} E(DR_{it}) \tag{7.6}$$

$$= \Sigma X_{it} E(cg_{it} - eg_{it})$$

$$= ECG_t - EEG_t \qquad (7.7)$$

where X_{it} is the optimal portfolio weight of asset i in period t and ECG and EEG are expected capital and exchange gains/losses respectively of the portfolio. Total portfolio return has two components -- one part attributable to pure capital gains/losses and the other part, to pure exchange gains/losses.

Variance of portfolio return is given by

$$V(EPR_t) = V(\Sigma X_{it} DR_{it})$$

$$= V(\Sigma X_{it} cg_{it} - \Sigma X_{it} eg_{it})$$

$$= V(\Sigma X_{it} cg_{it}) + V(\Sigma X_{it} eg_{it})$$

$$- 2 \Sigma X_{it} \Sigma X_{it} Cov(cg_{it}, eg_{it})$$

$$= X'(VCG)X + X'(VEG)X - 2 X'(COV)X \qquad (7.8)$$

Or simply,

$$V(EPR) = V(X'DR)$$

$$= V\{X'(CG - EG)\}$$

$$= V(X'CG - X'EG)$$

$$= X'(VCG)X + X'(VEG)X - 2 X'(COV)X$$

where X is a column vector of optimal portfolio weights, DR, CG and EG are nx1 vectors of dollar-adjusted total return, caiptal gains/losses and exchange gains/losses respectively and VCG, VEG and COV are matrices defined as

$$
VCG = \begin{bmatrix}
V(cg1) & C(cg1,cg2) & C(cg1,cg3) & \ldots & C(cg1,cgn) \\
C(cg2,cg1) & V(cg2) & C(cg2,cg3) & \ldots & C(cg2,cgn) \\
C(cg3,cg1) & C(cg3,cg2) & V(cg3) & \ldots & C(cg3,cgn) \\
\ldots & \ldots & \ldots & \ldots & \ldots \\
C(cgn,cg1) & C(cgn,cg2) & C(cgn,cg3) & \ldots & V(cgn)
\end{bmatrix}
$$

$$
VEG = \begin{bmatrix}
V(eg1) & C(eg1,eg2) & C(eg1,eg3) & \ldots & C(eg1,egn-1) & 0 \\
C(eg2,eg1) & V(eg2) & C(eg2,eg3) & \ldots & C(eg2,egn-1) & 0 \\
C(eg3,eg1) & C(eg3,eg2) & V(eg3) & \ldots & C(eg3,egn-1) & 0 \\
\ldots & \ldots & \ldots & \ldots & \ldots & .. \\
C(egn-1,eg1) & C(egn-1,eg2) & & \ldots & V(egn-1) & 0 \\
0 & 0 & 0 & & 0 & 0
\end{bmatrix}
$$

$$
COV = \begin{bmatrix}
C(cg1,eg1) & C(cg1,eg2) & C(cg1,eg3) & \ldots & C(cg1,egn-1) & 0 \\
C(cg2,eg1) & C(cg2,eg2) & C(cg2,eg3) & \ldots & C(cg2,egn-1) & 0 \\
C(cg3,eg1) & C(cg3,eg2) & C(cg3,eg3) & \ldots & C(cg3,egn-1) & 0 \\
\ldots & \ldots & \ldots & \ldots & \ldots & .. \\
C(cgn,eg1) & C(cgn,eg2) & C(cgn,eg3) & \ldots & C(cgn,egn-1) & 0
\end{bmatrix}
$$

Since one of the currencies is used as a numeraire currency (here nth currency -- the U.S. dollar) there are (n-1) exchange rates. The zeros in the nth column of VEG and COV matrices and in the nth row of VEG are introduced to take care of the numeraire currency.

As is evident from expression (7.8) and the matrices involved, variance of an internationally diversified portfolio depends on the following factors

1. Variances of security rates of returns and pairwise covariances between them
2. Variances of exchange gains/losses and pairwise covariances between them
3. Pairwise covariances between security rates of returns and exchange gains/losses

The first term in equation (7.8) measures the component of total portfolio risk attributable to variations in security returns only while the net effect of the second and third term measures the contribution of the exchange rate fluctuations. Depending on the net effect of the exchange factor, total portfolio risk may be smaller or greater than the risk specific to security returns only. In a regime of fixed exchange rates, the second term in equation (7.8) would be small and the net effect of the exchange factor might reduce total portfolio risk. Conversely, highly volatile exchange rates of the flexible rates regime would most likely cause the total portfolio risk to rise.

Decomposition of Risk and Return: The Minimum Variance, Tangent and the Equally Weighted Portfolios

The international portfolios investigated here are the minimum variance portfolio (M) and the tangent portfolio (T) described earlier. I also introduce an equally-weighted portfolio which is a world market index for comparability with the results obtained by Solnik and Noetzlin (1982) for a market value-weighted world portfolio.

For lack of space, the decomposition is not shown for all the periods under study. Since our purpose is to show the impact of the exchange factor, I have selected some periods from the fixed as well as the flexible rates regime. Since the flexible rates took effect from the early seventies and since our data were available only upto 1982, I have chosen to use 28-quarter estimation period and selected, for the flexible rates system, periods from 1978 and beyond where flexible exchange rates were well-represented in the ex ante distribution.[6]

Effects on Portfolio Expected Return

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[6]Ex ante return distribution for 1978 and beyond uses exchange rates of the flexible regime only while that for say, 1975, uses exchange rates of both the regimes.

The Tangent Portfolio (T)

Table 7.1 shows decomposition of the expected return for portfolio T. For this portfolio, the capital gain per quarter appears to be quite high. As we saw earlier, this portfolio was undiversified in most of the periods and in rest of the cases, it contained only two or three assets. Since these are the assets with the highest expected returns, naturally the capital gains would be higher. Total portfolio return would also be higher unless the currencies of the chosen few countries depreciate to a greater extent relative to the dollar. Since we are assuming quarterly portfolio revision, such a big change in exchange rates is unlikely to happen.

There was exchange loss of small magnitude in almost all of the fixed rates periods under study. During the two years period (1966-2 to 1967-4) it was very insignificant as compared to total return (see column 4). During the period of turbulence in the late sixties (notably 1968 to 1969), loss of return on the exchange account climbed quite high, to a maximum of about 17 p.c. of total return in 1968-2. Perhaps because of the attempts to save the system from total collapse, exchange rate disturbences calmed down thereafter and so did exchange loss for this portfolio.

Exchange losses for the U.S. investor during the late sixties may appear a little disturbing when we recollect that exchange rates of major trading partners of the U.S. actually

Table 7.1

Decomposition of Expected Portfolio Returns (p.c. per qtr), Tangent Portfolio (T) Weights, 28-Quarter Estimation Period

Period		Capital Gain (p.c.) (1)	Exchange Loss (p.c.) (2)	Total Return (p.c.) (3)	Exchange Loss as p.c. of Total Return (4)
1966	2	3.2777	0.0239	3.2537	0.73
	3	3.2230	0.0288	3.1942	0.89
	4	2.9814	0.0166	2.9648	0.56
1967	1	2.4207	0.0128	2.4079	0.53
	2	2.1039	0.0115	2.0924	0.55
	3	2.1159	0.0178	2.1017	0.84
	4	2.1815	0.0271	2.1544	1.24
1968	1	2.0954	0.1683	1.9271	7.82
	2	2.3672	0.4010	1.9662	16.94
	3	2.3571	0.2712	2.0860	11.51
	4	2.7730	0.3436	2.4294	12.39
1969	1	2.9485	0.4693	2.4792	15.92
	2	2.7576	0.3550	2.4026	12.87
	3	2.4637	0.1380	2.3257	5.60
	4	2.3311	0.0270	2.3041	1.16
1970	1	2.4956	0.0024	2.4932	0.10
	2	2.5353	-0.0097	2.5450	-0.38
	3	1.9756	0.0064	1.9692	0.32
	4	1.8414	0.0096	1.8318	0.52
1971	1	1.4925	-0.0432	1.5356	-2.89
	2	1.8336	-0.0448	1.8784	-2.44
	3	2.3170	-0.0515	2.3685	-2.22
	4	2.3607	-0.2724	2.6331	-11.54
...		...	...	...	...
1979	1	3.3920	-1.4087	4.8007	-41.53
	2	2.9305	-0.9925	3.9231	-33.87
	3	2.4571	-0.7646	3.2217	-31.12
	4	3.4125	0.0934	3.3191	2.47

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Table 7.1 contd.

Period		Capital Gain (p.c.) (1)	Exchange Loss (p.c.) (2)	Total Return (p.c.) (3)	Exchange Loss as p.c. of Total Return (4)
1980	1	4.7092	0.1954	4.5138	4.15
	2	5.0076	0.4960	4.5116	9.90
	3	4.2710	0.4899	3.7810	11.47
	4	5.0017	0.4138	4.5879	8.27
1981	1	5.1087	0.3789	4.7298	7.42
	2*	----	----	----	
	3*	----	----	----	
	4	3.5063	0.1705	3.3357	4.86
1982	1	3.9241	-0.1353	4.0594	-3.45
	2	4.1730	1.0773	3.0957	25.82
	3	3.3307	0.8380	2.4927	25.16
	4	3.0628	0.3492	2.7137	11.40

* T does not exist for this period. All funds go to the risk-free asset

appreciated relative to dollar. This apparent puzzle may be solved when we recognize that exchange gains/losses in a portfolio depend on the countries included in it i.e. on the exchange gains/losses on the currencies of these countries and their relative importance in the portfolio. Since portfolio T was not well-diversified, exchange loss on this portfolio means that the few countries included in it experienced depreciation of their currencies relative to dollar.

In the flexible rates period under investigation, we again see losses on the exchange account in majority of the cases (10 out of 14). In spite of losses on this account, these countries were chosen by this portfolio because of their high 'total' expected returns. The importance of the exchange factor on portfolio return follows from the high p.c. of exchange gain/loss (column 4) in the flexible rates system. In 1979-1, the exchange factor contributed more than 41 p.c. to total return while in 1982-2 it ate up about 26 p.c. from it.

The Equally Weighted Portfolio

One important difference between the equally-weighted and the tangent portfolio is that the former is very well-diversified while the latter is not. The equally-weighted portfolio is not mean-variance efficient by construction and hence does not maximize expected return. As such it does not offer high expected capital gains, as does the tangent portfolio. However, since it is well-diversified, it offers the benefits of diversification in the form of lower portfolio risk.

Like the tangent portfolio, it also has exchange losses in most of the fixed rates period (table 7.2). However, these losses are smaller and relatively more stable than the corresponding losses on the tangent portfolio. As is obvious, this relative stability is due to the well-diversification of this portfolio --- exchange gains and losses average out. Because of the smaller capital gains, exchange losses are more pronounced, as p.c. of the total, than in the tangent portfolio case. Since there was loss on the exchange account in the fixed rates period, it may be inferred that the foreign currencies, taken together, depreciated relative to the dollar during this period.

In the flexible rates period, we see exchange gain in majority of the cases (9 out of 16 periods) and what is more important, these gains weighed very high as compared to capital gains. In 1980-3, exchange gains contributed more than double the amount contributed by capital gain. Similar are the cases in 1979-4 and 1980-1. Exchange losses, on the contrary, appeared relatively smaller though in 1982-2, they almost ate up the capital gain. Exchange rate changes, therefore, could be a source of significant positive or negative gains in the flexible rates period. On average, over 1977-1982, the net contribution of this factor was, however, positive.

Table 7.2

Decomposition of Portfolio Expected Returns (p.c. per qtr), Equally Weighted Portfolio (EWP) Weights, 28-Quarter Estimation Period

Period		Capital Gain (p.c.) (1)	Exchange Loss (p.c.) (2)	Total Return (p.c.) (3)	Exchange Loss as p.c. of Total Return (4)
1966	2	1.4888	0.0154	1.4726	1.03
	3	1.1222	0.0179	1.1043	1.59
	4	0.6114	0.0169	0.5945	2.76
1967	1	0.2871	0.0164	0.2707	5.71
	2	0.2422	0.0136	0.2286	5.64
	3	0.1734	0.0079	0.1655	4.56
	4	0.0107	0.0144	-0.0037	-134.58*
1968	1	0.1187	0.1298	-0.0111	-109.35*
	2	0.0199	0.1495	-0.1295	-751.26*
	3	0.1157	0.1429	-0.0272	-123.51*
	4	0.3470	0.1496	0.1974	43.11
1969	1	0.4151	0.1458	0.2693	35.12
	2	0.5435	0.1501	0.3934	27.62
	3	0.8305	0.1477	0.6828	17.78
	4	0.8334	0.1589	0.6745	19.07
1970	1	0.9375	0.1403	0.7972	14.96
	2	0.8621	0.1365	0.7256	15.83
	3	0.5361	0.1290	0.4071	24.06
	4	0.4874	0.1238	0.3636	25.40
1971	1	0.4404	0.1185	0.3218	26.91
	2	0.4761	0.1079	0.3682	22.66
	3	0.5964	0.0826	0.5138	13.58
	4	0.5504	-0.0166	0.5706	-3.00
1972	1	0.3847	-0.0872	0.4719	-22.67
	2	0.7009	-0.1586	0.8595	-22.63
	3	1.1241	-0.1410	1.2651	-12.54
	4	1.4448	-0.1130	1.5578	-7.82
...		...	...	...	...

Contd. on next page

Table 7.2 contd.

Period		Capital Gain (p.c.) (1)	Exchange Loss (p.c.) (2)	Total Return (p.c.) (3)	Exchange Loss as p.c. of Total Return (4)
1979	1	0.9637	-0.6672	1.6309	-69.23
	2	0.7421	-0.5463	1.2884	-73.61
	3	0.5269	-0.5794	1.1063	-109.96
	4	0.3765	-0.7276	1.1041	-193.25
1980	1	0.3505	-0.6991	1.0496	-199.46
	2	0.2477	-0.1522	0.3999	-61.44
	3	0.0988	-0.2146	0.3134	-217.21
	4	0.3420	-0.2056	0.5476	-60.12
1981	1	0.6746	-0.2547	0.9293	-37.76
	2	0.6419	0.0732	0.5687	11.40
	3	0.9161	0.4243	0.4918	46.32
	4	1.3105	0.3322	0.9782	25.35
1982	1	1.5681	0.4515	1.1166	28.79
	2	1.2463	0.8255	0.4208	66.24
	3	0.9501	0.8925	0.0576	93.94
	4	1.0500	0.6703	0.3797	63.84

* The exchange loss as a p.c. of total return is negative due to the negative total return and not due to negative exchange loss, as in the cases 1971(4)--1981(1)

Effect on Portfolio Variance

The decomposition of portfolio variance into constituent parts is shown by equation (7.8). In this equation, the net effect of the second and third term measures the contribution of the exchange factor on portfolio variance. The second term involves the variance-covariance matrix of exchange gains/losses and is non-negative while the third term involves a matrix of covariances between exchange gains/losses and capital gains/losses and could be positive or negative. The net effect of the exchange factor, therefore, could be positive or negative depending on the sign and magnitude of the third term. For the three international portfolios mentioned earlier, the following tables (7.3 to 7.5) show decomposition of portfolio variance into constituent parts.

Column (1) of these tables shows the variance of pure capital gains/losses and column (2) shows that of pure exchange gains/losses. The third column shows covariances between capital and exchange gains/losses. In column 5, exchange risk which is measured by column 2 and 3 combined, is expressed as p.c. of total risk. For the fixed rates period, 1966(2) to 1967(4), the exchange risk was very insignificant for each of the three portfolio strategies. This can be explained by the very low variability of exchange gains/losses relative to that of the stock factor. One very interesting finding for this period is that for portfolio T and in some cases, for M, the exchange

Table 7.3

Decomposition of Portfolio Variance for the Tangent Portfolio (T), 28-Quarter Estimating Period, Selected Periods

Period		V(cgi) (1)	V(egi) (2)	Cov(cgi,egi) (3)	Total Var (4)	Exch. Risk (5)*
1966	2	0.132281	0.000537	0.001697	0.129424	-2.21
	3	0.169642	0.000661	0.002619	0.165065	
	4	0.195819	0.000682	0.002765	0.190971	-2.54
1967	1	0.210337	0.000676	0.002395	0.206223	-1.99
	2	0.187377	0.000548	0.002457	0.183011	-2.39
	3	0.175793	0.000468	0.002193	0.171875	-2.28
	4	0.170958	0.000404	0.002048	0.167266	-2.21
...		...	...	...	...	...
1978	1	0.631566	0.145401	-0.079947	0.936956	32.59
	2	0.642826	0.158815	-0.084194	0.970029	33.73
	3	0.639000	0.177541	-0.100155	1.016851	37.16
	4	0.580862	0.168030	-0.097375	0.943642	38.44
1979	1	0.532384	0.163653	-0.103813	0.903663	41.09
	2	0.438625	0.170795	-0.088007	0.785434	44.16
	3	0.394453	0.160240	-0.096491	0.747675	47.24
	4	2.435051	0.219627	-0.186655	3.027988	19.58
1980	1	2.621591	0.216083	-0.201852	3.241378	19.12
	2	2.684653	0.175918	-0.190028	3.240627	17.16
	3	2.496864	0.176581	-0.150580	2.974605	16.06
	4	2.755978	0.178893	-0.175178	3.285227	16.11
1981	1	2.754394	0.179509	-0.175866	3.285635	16.17
	2**	---	---	----	---	
	3**	---	---	---	---	
	4	0.411088	0.134864	-0.020860	0.587672	30.05
1982	1	0.452898	0.216466	0.018041	0.633282	28.48
	2	0.817010	0.304747	0.052639	1.016479	19.62
	3	0.600193	0.281495	-0.019083	0.919854	34.75
	4	0.326357	0.230612	0.010549	0.535871	39.10

* Exchange risk, measured as p.c. of the total, is calculated as (column 4 - column 1)/column 4 x 100

** T does not exist for this period. All funds are invested in the risk-free asset factor led to a reduction (!) of portfolio variance from the level attributable to security returns only. This was due to the fact that the negative covariance effect (third term in equation 7.8) outweighed the positive variance-covariance effect (second term in the same equation) of the exchange factor. This was possible only in a regime of stable exchange rates. Studies on international portfolio diversification done in a period characterized by stable exchange rates, therefore, could have enjoyed the favourable impact of exchange factor on portfolio risk.

The situation dramatically changed as soon as exchange rate variations were introduced. For each of the three portfolio strategies, the exchange factor contributed positively and significantly to total portfolio variance. The impact varies between portfolio strategies and warrants separate analysis for each.

Portfolio T: This portfolio, being governed primarily by expected return consideration, was not well-diversified. The ex ante total portfolio variance was, therefore, high. The exchange risk, as p.c. of the total, was, in general, more than one-third of total variance, except for the period 1979(4) to 1981(1) where it fell to 16-20 p.c. (table 7.3 above). This significant fall in exchange risks, was mainly due to the very high total risk which, in turn, was attributable to the very high variance of capital gains. Note the surprisingly high variance of capital gains/losses during 1979(4) to 1981(1) (column 1). During this period, T contained only one asset -- that of S. Africa -- which had a very high expected capital gain (as high as 5.11 p.c. per quarter) and no other asset had rates any closer to this (Australia had the second highest rate -- 2.92 p.c. per quarter) but the return from S. African asset was highly volatile as well. The volatility of exchange gains/losses for S. Africa was very low compared to its volatility of capital gains/losses and thus exchange risk, measured as p.c. of the total, was low during this period.

Covariances between capital and exchange gains/losses were positive in the fixed rates period and mostly negative in the flexible rates period.

Portfolio M: By construction, it minimizes portfolio variance without any regard to expected return. It would, therefore, be interesting to see the impact of exchange factor on the total risk of such a portfolio. As with portfolio T, exchange risk was very insignificant for the fixed rates period and it increased dramatically as soon as exchange rate variations were introduced (table 7.4). From the table we see that the exchange factor accounted for, on average, over 30 p.c. of total risk for this very conservative strategy (column 5) .

The EWP: For this portfolio, the exchange factor contributed, on average, more than 40 p.c. of total variance during the 1978(1) to 1982(4) period (column 5, Table 7.5). The covariance effect was positive and quite significant in each of

Table 7.4

Decomposition of Portfolio Variance for the Minimum Variance Portfolio (M), 28-Quarter Estimating Period, Selected Periods

Period		V(cgi) (1)	V(egi) (2)	Cov(cgi,egi) (3)	Total Var (4)	Exch. Risk (5)*
1966	2	0.042080	0.000129	0.000168	0.041873	-0.49
	3	0.039663	0.000131	0.000487	0.038820	-2.17
	4	0.039204	0.000205	0.000224	0.038961	-0.62
1967	1	0.043276	0.000260	-0.000149	0.043834	1.27
	2	0.040810	0.000298	-0.000010	0.041128	0.77
	3	0.034195	0.000391	-0.000107	0.034800	1.74
	4	0.031492	0.000280	0.000270	0.031232	-0.83
...		...	...	...	...	...
1978	1	0.170475	0.054748	-0.009390	0.244003	30.13
	2	0.173801	0.048794	-0.008822	0.240239	27.65
	3	0.174533	0.049900	-0.006717	0.237867	26.63
	4	0.180722	0.053028	-0.008950	0.251650	28.19
1979	1	0.182188	0.052027	-0.008093	0.250401	27.24
	2	0.176552	0.042165	-0.006771	0.232259	23.89
	3	0.172865	0.040951	-0.007934	0.229684	24.74
	4	0.161424	0.045298	-0.013301	0.233324	30.82
1980	1	0.161869	0.047255	-0.011928	0.232980	30.22
	2	0.106639	0.101810	0.028704	0.151041	29.40
	3	0.098722	0.105812	0.023757	0.157020	37.13
	4	0.098662	0.112024	0.026856	0.156974	37.15
1981	1	0.092020	0.103581	0.021659	0.152283	39.57
	2	0.098047	0.113108	0.023758	0.163639	40.08
	3	0.111636	0.123433	0.029474	0.176121	36.61
	4	0.102885	0.095091	0.032428	0.133120	22.71
1982	1	0.082169	0.073981	0.017301	0.121548	32.40
	2	0.078105	0.076040	0.020749	0.112647	30.66
	3	0.071918	0.066829	0.017591	0.103565	30.56
	4	0.068319	0.066157	0.021091	0.092294	25.98

* Exchange risk, measured as p.c. of the total, is calculated as (column 4 - column 1)/column 4 x 100

Table 7.5

Decomposition of Portfolio Variance of the Equally Weighted portfolio (EWP), 28-Quarter Estimating Period, Selected Periods

Period		V(cgi) (1)	V(egi) (2)	Cov(cgi,egi) (3)	Total Var (4)	Exch. Risk (5)*
1966	2	0.122204	0.000235	-0.000273	0.122985	0.64
	3	0.116602	0.000232	0.000068	0.116698	0.08
	4	0.104501	0.000231	-0.000236	0.105204	0.67
1967	1	0.105859	0.000230	-0.000413	0.106916	0.99
	2	0.104236	0.000236	-0.000418	0.105308	1.02
	3	0.102353	0.000232	-0.000518	0.103621	1.22
	4	0.084733	0.000228	-0.000111	0.085183	0.53
...		...	...	...	...	...
1978	1	0.347682	0.118990	-0.037696	0.542064	35.86
	2	0.345149	0.119236	-0.037926	0.540237	36.11
	3	0.348635	0.119525	-0.036795	0.541750	35.65
	4	0.364037	0.124083	-0.047096	0.582312	37.48
1979	1	0.348630	0.123973	-0.049888	0.572379	39.09
	2	0.318801	0.124986	-0.042691	0.529169	39.75
	3	0.296423	0.124531	-0.045889	0.512734	42.19
	4	0.281668	0.126888	-0.051963	0.512482	45.04
1980	1	0.280637	0.127494	-0.051673	0.511477	45.13
	2	0.270021	0.125516	-0.023245	0.442027	38.91
	3	0.265821	0.134357	-0.013571	0.427320	37.79
	4	0.278250	0.134572	-0.010434	0.433690	35.84
1981	1	0.270005	0.129258	0.008161	0.382941	29.49
	2	0.270440	0.140344	0.005428	0.399928	32.38
	3	0.263516	0.172470	0.013541	0.408904	35.56
	4	0.190092	0.170405	0.026535	0.307427	38.17
1982	1	0.145776	0.161382	0.006532	0.294094	50.43
	2	0.124942	0.176153	0.012289	0.276517	54.82
	3	0.116305	0.178513	0.008048	0.278722	58.27
	4	0.112259	0.153655	0.018135	0.229644	51.12

* Exchange risk, measured as p.c. of the total, is calculated as (column 4 - column 1)/column 4 x 100

the periods over 1978-1980, measuring about 14-20 p.c. of the total portfolio variance and therefore, reinforced the variance effect. During the 1982's the exchange factor accounted for more than one-half of total variance. For these periods, variance of exchange gains/losses exceeded that of capital gains/losses (column 1 and 2). Covariance effect was negative (but small), yet the contribution of the exchange factor to total variance was more than that of the stock factor.

For each of the three portfolios, the contribution of the exchange factor to portfolio variance was very small and even negative in some periods in the fixed exchange rates regime. However, with flexible rates, the exchange rate effects on portfolio variance became very pronounced, accounting for more than one-third of the total variance.

Effects on Portfolio Composition

Next, I investigate how an optimal portfolio reacts to changes in exchange rates. To see the effects of pure exchange rate changes, I have hypothetically created a world devoid of any exchange rate fluctuations and compared the composition of an efficient portfolio under this system to that of the same portfolio under the real world, flexible exchange rates system. Since other things were held constant, comparison of portfolio weights between these two cases was expected to show the effects of exchange rate variations.

The optimal portfolio chosen was the minimum variance portfolio (M) which was well-diversified. Table 7.6 below shows this comparison for some selected periods where the effects of flexible rates were well-represented in the ex ante portfolio weights calculation. In the table 'S' represents the 'perfectly' stable exchange rate system and 'F' represents the 'flexible' rate system.

The most glaring effects of exchange rate variations on optimal portfolio choice can be seen by comparing the weights for Austria and the U.S. for each of the periods reported. The important points of the table may be summarized as follows

1. Austria occupied a very important position in all the periods under the stable rates system. But, its weight fell down dramatically as exchange rate changes were introduced.
2. Except for the small weight in 1977, the U.S. asset did not appear in the optimal portfolio under stable rates. That is, with perfectly stable exchange rates, the domestic asset was not attractive to the U.S. investors. But it occupied a very significant weight in the flexible rates period. This significant shift in weight was primarily due to the increased variance of non-U.S. asset returns under flexible rates.
3. The Swiss asset was never chosen under flexible rates while it was in the optimal portfolio under stable rates during 1977(1)--1980(1).
4. The Finish asset appeared to be attractive under flexible

Table 7.6

Optimal Minimum Variance Portfolio Weights (p.c.) under Perfectly Stable (S) and Flexible (F) Exchange Rates, 28-Qtr. Estimating Period, Selected Quarters

Period		AU	C	D	FN	G	IR	J	SA	SW	SZ	US
77-1	S	78.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	4.0	9.6
	F	37.7	3.8	0.0	15.8	0.0	0.0	0.0	0.0	5.7	0.0	37.0
2	S	77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	5.3	8.5
	F	34.3	0.6	0.0	15.1	0.0	0.0	0.0	0.9	8.9	0.0	40.1
3	S	73.5	0.0	0.0	0.0	1.9	0.0	0.0	0.0	11.4	3.3	9.9
	F	38.1	7.7	0.0	5.4	0.0	0.0	0.0	0.5	9.8	0.0	38.6
4	S	76.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	8.6	7.5
	F	43.3	8.7	0.0	1.6	0.0	0.0	0.0	2.1	2.0	0.0	42.4
78-1	S	75.4	0.0	0.0	0.0	2.9	0.0	0.0	0.0	7.8	13.9	0.0
	F	42.6	7.5	0.0	1.2	0.0	0.0	0.0	3.0	0.0	0.0	45.6
2	S	68.9	0.0	0.0	0.0	2.4	0.0	0.0	0.0	14.5	14.2	0.0
	F	30.2	0.0	0.0	4.7	0.0	0.0	0.0	5.3	7.1	0.0	52.7
3	S	68.8	0.0	0.0	0.0	2.3	0.0	0.0	0.0	14.7	14.2	0.0
	F	32.5	0.0	0.0	3.5	0.0	0.0	0.0	5.3	5.5	0.0	53.2
4	S	69.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	14.6	15.6	0.0
	F	32.7	0.0	0.0	6.0	0.0	0.0	0.0	4.0	5.3	0.0	52.0
79-1	S	69.8	0.0	0.0	0.0	5.8	0.0	0.0	0.1	9.8	14.5	0.0
	F	34.3	0.0	0.0	6.0	0.0	0.0	0.0	4.6	2.2	0.0	53.0
2	S	65.7	0.0	0.0	0.0	10.9	0.0	0.0	1.0	8.7	13.6	0.0
	F	25.8	0.0	0.0	8.7	0.0	0.0	0.0	7.2	2.8	0.0	55.6
3	S	62.4	0.0	0.0	0.0	14.3	0.0	0.0	2.0	7.6	13.7	0.0
	F	24.1	0.0	0.0	8.7	0.0	0.0	0.0	7.7	3.8	0.0	55.8
4	S	70.9	0.0	0.0	0.9	7.6	0.0	0.0	2.3	4.9	13.4	0.0
	F	26.4	0.0	0.0	8.4	0.0	0.0	0.0	7.3	3.2	0.0	54.7
80-1	S	70.2	0.0	0.0	3.5	8.3	0.0	0.0	0.7	5.2	12.1	0.0
	F	26.6	0.0	0.0	10.5	0.0	0.0	0.0	5.8	3.4	0.0	53.7

Contd. next page

Table 7.6 contd.

Period		AU	C	D	FN	G	IR	J	SA	SW	SZ	US
2	S	64.4	0.0	0.0	19.0	12.7	0.0	3.8	0.0	0.0	0.0	0.0
	F	23.8	0.0	0.0	42.3	0.0	0.0	17.6	0.8	0.0	0.0	15.4
3	S	73.9	0.0	0.0	17.6	8.5	0.0	0.0	0.0	0.0	0.0	0.0
	F	34.0	0.0	0.0	34.4	0.0	0.0	3.2	1.7	0.0	0.0	26.7
4	S	73.2	0.0	1.2	17.6	7.7	0.0	0.0	0.3	0.0	0.0	0.0
	F	34.7	0.0	0.0	35.6	0.0	0.0	3.5	1.3	0.0	0.0	24.9
81-1	S	74.6	0.0	4.9	14.3	5.4	0.0	0.0	0.8	0.0	0.0	0.0
	F	38.5	0.0	0.0	24.3	0.0	0.0	9.2	1.8	0.2	0.0	26.0
2	S	74.9	0.0	5.9	14.6	3.8	0.0	0.0	0.8	0.0	0.0	0.0
	F	34.0	0.0	0.0	27.2	0.0	0.0	8.3	0.0	6.1	0.0	24.5
3	S	74.4	0.0	5.7	14.3	4.6	0.0	0.0	1.0	0.1	0.0	0.0
	F	26.2	0.0	0.0	31.6	0.0	0.0	10.7	0.0	7.3	0.0	24.2
4	S	68.9	0.0	7.3	13.3	5.3	0.0	2.5	1.0	1.9	0.0	0.0
	F	21.9	0.0	0.2	28.1	0.0	0.0	13.5	0.0	5.6	0.0	30.7
82-1	S	59.5	0.0	8.3	16.9	0.0	1.6	12.3	1.5	0.0	0.0	0.0
	F	13.3	0.0	0.0	32.0	0.0	0.0	22.0	0.0	0.0	0.0	32.7
2	S	57.6	0.0	6.5	13.0	8.1	0.0	13.0	1.0	0.7	0.0	0.0
	F	9.1	0.0	1.0	34.0	3.0	0.0	17.4	0.0	0.0	0.0	35.3
3	S	56.2	0.0	7.1	14.7	6.2	3.1	12.7	0.2	0.0	0.0	0.0
	F	7.4	0.0	3.9	30.7	1.0	5.0	11.6	0.0	0.0	0.0	40.4
4	S	55.2	0.0	8.1	15.6	5.2	3.6	11.4	0.9	0.0	0.0	0.0
	F	9.1	0.0	4.7	27.8	1.8	8.0	5.4	0.0	4.7	0.0	38.5

LEGEND: AU=Austria, C=Canada, D=Denmark, FN=Finland, G=Germany IR=Ireland, J=Japan, SA=S.Africa, SW=Sweden, SZ=Switzerland US=United States

Weights may not add up to 100 p.c. due to rounding rates. However, it gained special importance from 1980(2) and on under both exchange rate systems.

5. The Swedish asset was in the optimal portfolio, though small in weight, under both exchange rate systems upto 1980(1). Weight of this asset declined as a result of exchange rate variations.
6. Japan entered the optimal portfolio only from 1980(2). It appears that this asset was more attractive under flexible exchange rates than under the alternate system in most of the cases.

To see the exchange rate effects more closely, I analyse portfolio behavior for one period (1980-1) in greater detail. Choice of this particular period is arbitrary except for some unusual changes in portfolio weights in this period. Note that the ex ante return distribution for 1980(1) was estimated using capital and exchange gains/losses information from 1973(1) to 1979(4)[7] The ex ante variance-covariance and the corresponding correlation matrices of capital and exchange gains/losses for this period is shown in the appendix (Tables A.1 - A.4). Only the main points are summarized in table 7.7 below.

From the table, the unusually high weight occupied by Austria (AU) in the first quarter of 1980, under perfectly stable exchange rates, can be explained by the lowest variance of capital gains of the Austrian asset and its low covariance with other capital gains. The S. African asset (SA), having the

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[7]because of the 28-quarter or 7-year estimating period.

Table 7.7

Effects of Exchange Rate Changes on Optimal Weights for Portfolio M for 1980(1) and Summary of the Variance-Covariance and Correlation Matrices for this Period, 18 countries, 28-Quarter Estimation Period

Assets their weights under stable rates	Ranking of V(cgi) (1 being highest and 18, lowest)*	Correl Coeff r(cgi,cgj) (above 0.7) **	Ranking of V(egi) (1 being highest and 18, lowest)*	Weights under flexible rates	Correl Coeff r(egi,egj) (above 0.7) **
AU 70.2	18 (0.10)	Nil. Highest correl with Italy (0.43)	4 (0.30)	26.6	Nil. Highest correl with SA (0.53)
FN 3.5	11 (0.55)	Nil. Highest correl with B (0.41)	16 (0.17)	10.5	B(.80), D(.84), F(.68), G(.80), N(.77),SW(.85),SA(.69) AU(.83), NW(.88)
G 8.3	17 (0.29)	N(.83),UK(.68)	2 (0.35)	0.0	B(.97), D(.95), F(.80), N(.96), SW(.84), SZ(.78), AU(.98), FN(.80), NW(.87)
SA 0.7	1 (2.62)	Nil. Highest correl with NW(.36).Negative correl in 10 out of 18 cases	12 (0.22)	5.8	NW(.76)
SW 5.2	14 (0.426)	Nil. Highest correl with N(.53)	8 (0.25)	3.4	B(.85), D(.90), F(.74), G(.84), N(.84), AU(.85), FN(.85), NW(.87)
SZ 12.1	15 (0.418)	UK(.75), US(.71)	1 (0.47)	0.0	B(.76), D(.74), F(.70), G(.78), N(.70), AU(.78), NW(.70)
US 0.0	12 (0.435)	A(.71), C(:71) J(.69), SZ(.71), UK(.73)	---	53.7	----

* V(cgi) and V(egi) are variances of capital gains/losses and exchange gains/losses respectively. Estimated variances are in the parentheses.

** Correlation between returns of the asset in the 1st column and the asset mentioned before the correlation coefficient in this column. Only coefficients around/above 0.70 are mentioned.

highest variance, got small proportion of the total fund because of its low and negative correlation with most of the asset returns. The U.S. asset (US) which ranked 12th from above in terms of variance did not get any fund.

The situation changed dramatically as soon as exchange rate variations were introduced. Austrian weight fell down from 70 p.c. to about 27 p.c. -- more than 60 p.c. fall -- in the same quarter primarily because of the very high variance of its exchange gains/losses.[8] The U.S. weight jumped from zero to about 54 p.c. because for the U.S. investors, domestic assets did not have any exchange risk.

Next dramatic change occurred with Swiss asset (SZ) which had the highest exchange gains/losses variance and primarily because of this, was left out of the optimal portfolio under flexible rates. Similar thing happened to the German (G) asset. The S. African asset commanded a higher weight under flexible rates than under the alternate system because of the relatively low variance of its exchange gains/losses.[9]

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[8]The variance of exchange gains/losses was three times the variance of capital gains/losses.

[9]An interesting finding of the table is that exchange gains/losses of the West European countries were very highly correlated. This is, most probably, due to the various exchange rates agreements that prevailed during the period considered among these countries.

Exchange Rate Changes and the Benefits of International Portfolio Diversification

Now, how do the benefits of international portfolio diversification compare between the fixed and flexible exchange rates system? Since I do not have enough data prior to the breakdown of the fixed rates system and, since the exchange rates during the late sixties were not representative of the fixed rates system, I have compared the risk-return characteristics of some optimal portfolios under the hypothetical world with perfectly stable exchange rates (mentioned earlier) with those of the same portfolios under the real-world, flexible exchange rates system. As before, since all other things were assumed same, the difference in results was attributed to the exchange rate variations.

For each of the two exchange rates systems, reduction in variance for portfolio F (see figure 2.1) over the variance of the U.S. index was calculated using ex ante data. For the 28-quarter estimation period case, figure 7.1 shows these reductions for each of the periods during 1966-2 to 1982-4.[10]

Except for 1968-1, exchange rate changes of the fixed rates period did not appear to have any significant effect on the benefits from risk reduction.[11] For the flexible rates period,

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[10]See Appendix II for a similar diagram (Figure A.8) for the 20-quarter estimation period.

[11]In 1968-1, the optimal portfolio consisted of investment in the U.S. index only.

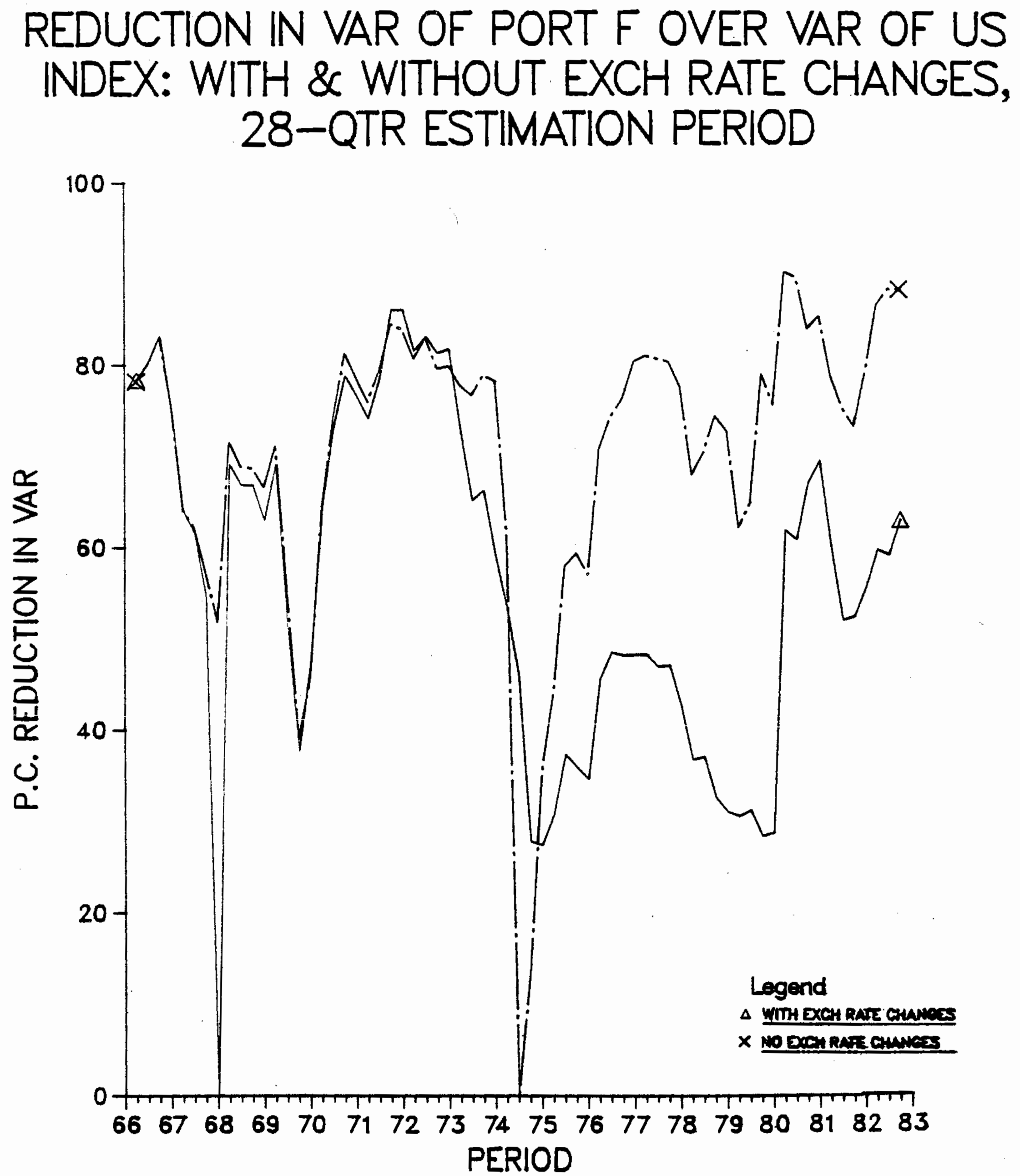

REDUCTION IN VAR OF PORT F OVER VAR OF US INDEX: WITH & WITHOUT EXCH RATE CHANGES, 28—QTR ESTIMATION PERIOD
100
80
60
40
20
0
P.C. REDUCTION IN VAR
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD
Legend
WITH EXCH RATE CHANGES
NO EXCH RATE CHANGES

FIGURE 7.1

exchange rate fluctuations of the mid-1970s and on seem to have reduced these benefits.

As regards the effects of exchange rate changes on the benefits from increased return are concerned, nothing conclusively can be said. For the 40-quarter estimation period case, figure 7.2 shows excess realized returns on portfolio T over those of the U.S. index under the two exchange rate systems. It appears that for some periods the exchange factor contributed positively to the benefits from increased return while for others it lowered them (more clear in figure 7.3).

However, on average, over the period studied, the exchange factor seemed to have contributed positively to total return as can be seen from table 7.8 which shows the geometric means and SDs of realized returns on the U.S. index and on some international portfolios under the two exchange rate systems considered.

Most noteworthy is the case for the tangent portfolio (T) for which the exchange factor alone accounted for more than 320 p.c. of the average return without exchange rate changes. Volatility of returns also increased but per unit of SD, portfolio T earned much higher return (0.22) with exchange rate changes than without (0.13). Similar is the case for portfolio M. Holding the domestic market alone in the face of exchange rate fluctuations offered an average return of only 0.55 p.c. per quarter with a SD of 4.28. Per unit of SD, it earned much

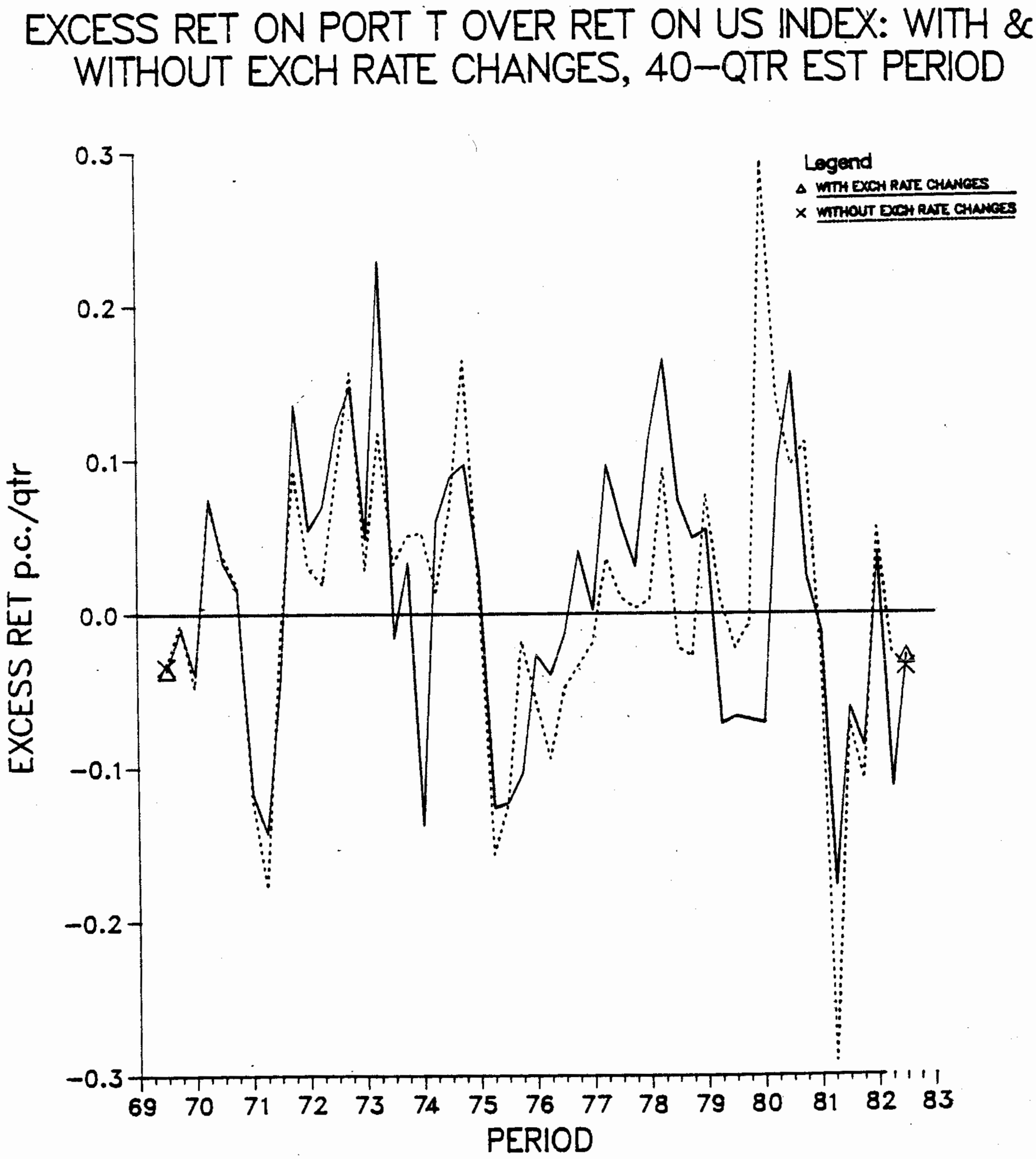
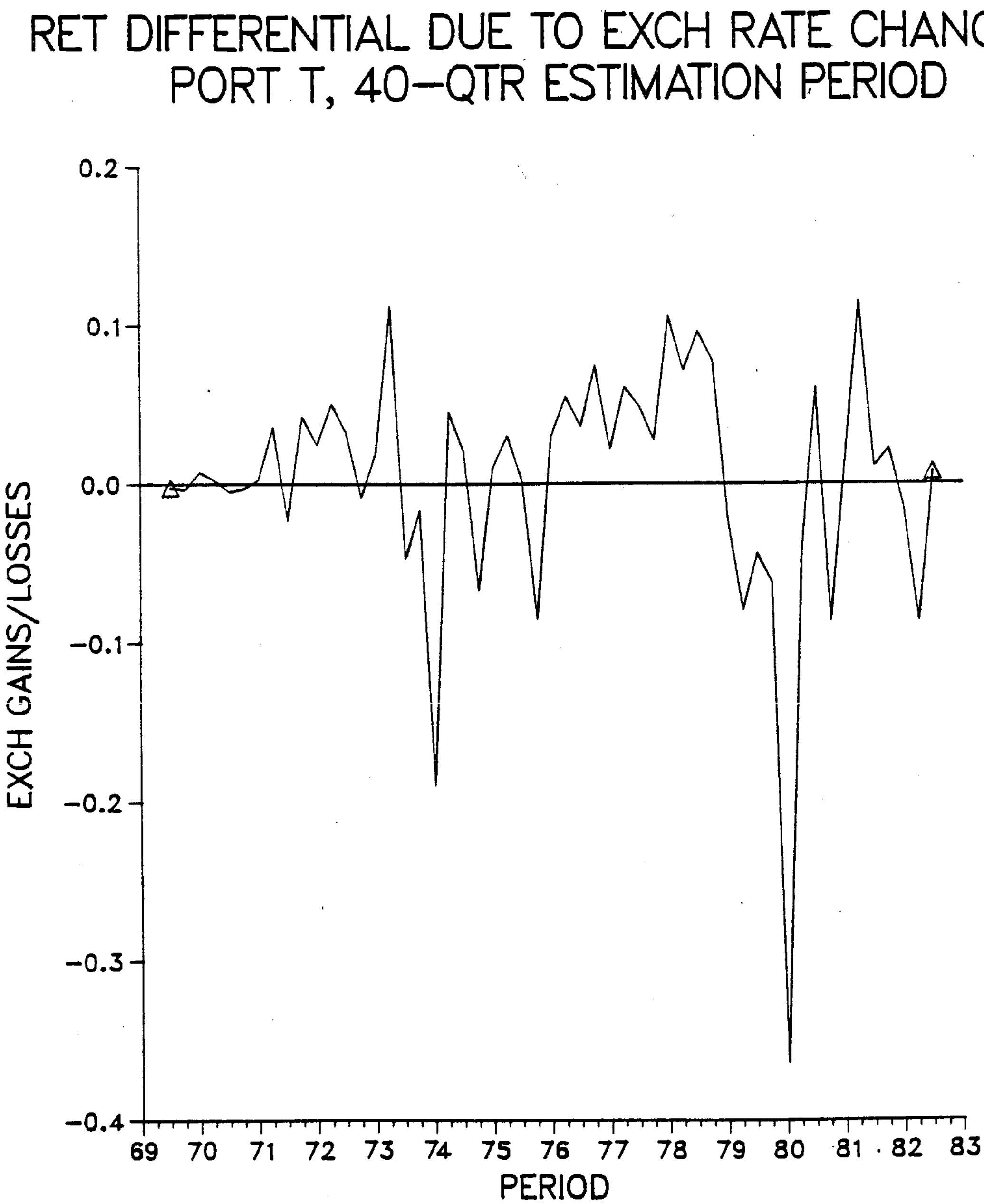

EXCESS RET ON PORT T OVER RET ON US INDEX: WITH & WITHOUT EXCH RATE CHANGES, 40–QTR EST PERIOD
Legend
WITH EXCH RATE CHANGES
WITHOUT EXCH RATE CHANGES
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
EXCESS RET p.c./qtr
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD

FIGURE 7.2



RET DIFFERENTIAL DUE TO EXCH RATE CHANGES,
PORT T, 40–QTR ESTIMATION PERIOD
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
EXCH GAINS/LOSSES
69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD

FIGURE 7.3

Table 7.8

Comparison of Average Realized Returns Relative to Risk for the U.S. Index and for Some International Portfolios Under Perfectly Stable and Flexible Exchange Rates Systems, 28-quarter Estimating Period, 1966-2 to 1982-4

	No Exchange Rate Changes			With Exchange Rate Changes		
Portfolio Strategy	Geom Mean of Realized Ret (p.c.)	SD	Mean/ SD	Geom Mean of Realized Ret (p.c.)	SD	Mean/ SD
EWP	0.9024	4.733	0.1907	0.7117	6.0418	0.1178
M	0.4087	3.6024	0.1134	0.7188	5.1635	0.1392
T	0.5777	4.2831	0.1349	2.4400	10.9600	0.2200
US	0.55	6.63	0.08			

lower return than portfolio T and M. Exchange rate fluctuations, thus, seem to have enhanced the desirability of international portfolio diversification.

Summary

In this chapter, I explored the impact of exchange rate variations on portfolio choice and consequently on risk and return and on the benefits of international diversification. Whether exchange risk matters is debatable and depends on the specific model one assumes. Since I used nominal return in the analysis, I expected the exchange factor to affect portfolio choice.

Using some optimal international portfolios, portfolio risks and returns were decomposed into parts attributable to securities and to exchange rate changes. It appeared that during the periods of fixed exchange rates the contribution of the exchange factor on portfolio risk and return was insignificant except for the turbulent days in the late sixties. Quite surprisingly, for some portfolios, the exchange factor led to a reduction in portfolio variance though by a small percentage.

In the flexible rate system, during 1977-1982, the impact of the exchange factor on portfolio risk and return was quite significant. Total portfolio variance increased in every period while the impact on expected return was mixed. Whether expected return increased or declined on this account depended on the countries chosen in the portfolio and on the relative strength of their currencies vis-a-vis dollar.

Exchange rate changes were found to affect portfolio choice, as expected. This was evident from a comparison of portfolio weights in a hypothetical world devoid of exchange rate changes with those in the real world with fluctuating exchange rates.

International diversification of portfolios appeared to be more attractive than domestic diversification even in the presence of exchange rate fluctuations. Exchange rate fluctuations are, therefore, not necessarily bad and could be a source of significant additional gains.

CONCLUSION

In this thesis I have investigated the benefits of international portfolio diversification using a policy of active portfolio management. Over the period under study, I found substantial additional benefits from international over domestic diversification for a representative risk-averse U.S. investor who followed the portfolio selection method described in this thesis. These additional benefits accrued in the form of both higher return and lower risk. What is even more interesting, these benefits were retained after allowing for some transcation costs which were not unreasonable for large institutional investors.

The benefits of active management were compared to those under passive management and it was seen that revising portfolio every period using recent past information earned more average return, net of transaction costs, than the buy-and-hold strategy. This lends support to the inefficiency of the international financial market found by some previous studies.

The effects of the exchange rate fluctuations on portfolio risk and return were investigated at the level of some efficient international portfolios. Exchange rate fluctuations were found to raise portfolio risk. They were also found to raise portfolio return and for some portfolios the increase in returns were more than proportional to the increase in risk. Thus, if portfolio could be selected carefully, it would be possible to have additional risk-adjusted return. International diversification also appeared to be more attractive for some portfolios than domestic diversification in the presence of exchange rate changes.

The findings of this thesis has important implications for international stock market investment. Though these results are subject to some qualifications mentioned below, they point to an important area of financial investment and the strategy to use. These findings strenthen the potential benefits of international portfolio diversification found by numerous earlier studies. What is even more, these potential benefits could have been realized had any one who followed the portfolio selection method used here. I have used a very simple probability assessment rule and it appears that it did better than the naive portfolio management strategy of letting the market 'do everything'.

The findings of this study are not surprising and are as expected. This follows from the growing number of foreign securities in the portfolio of large investment trusts who have access to the relevant information regarding the international financial market.

The flexible exchange rate system did not appear to have deterred international portfolio investment. In fact, taking speculative position in the spot exchange market might bring about additional benefits and in this sense the exchange rate changes might act as a positive factor. Portfolio risk would increase as well but it is possible to have higher risk-adjusted return in the presence of exchange rate fluctuations.

The evidence that exchange rate changes affected portfolio choice implies that the PPP theory did not hold in the simple world I postulated. Consequently, the exchange risk exists in such a world.

The above findings are subject to certain qualifications. First, the portfolio selection model used was a single-period model. In other words, the investor in the study was assumed to be concerned with the implications of his decisions for one period only. Put simply, our investor was myopic with regard to portfolio choice.

Second, the analysis was done from the point of view of a representative U.S. investor only and hence it did not attempt to explain determination of equilibrium stock prices and exchange rates which is an aggregate or market phenomenon. In this sense, the analysis is partial equilibrium in nature.

Third, the investor was assumed to be a mean-variance decision maker. As is well-known, his decisions would be consistent with the expected utility maximization principle only under the assumption of quadratic utility functions or normality of the return distributions. Quadratic utility functions, though simplify the model greatly, suffer from the limitation that after a certain level of wealth, marginal utility becomes negative. In other words, at some level of wealth further wealth becomes undesirable! This critical level of wealth varies from person to person and could be very large depending on the parameter values of the utility functions. Still, an upper limit on the level of wealth holdings could be disturbing to most people.

The assumption of normality of the return distributions is very unlikely to hold in the international context. This is due to the fact that security returns in terms of a numeraire currency are, in fact, product of two random variables and are very unlikely to be distributed normally.

Fourth, I have used national stock price indices as measures of stock prices since price data were not available for individual securities for the period under study. Use of indices as opposed to levels of security prices limits diversification possibilities. Also, due to their non-availability, I have excluded dividend yields in the calculation of rates of return. Both these factors served to underestimate the true benefits of international portfolio diversification.

Fifth, I have not taken into account taxation of capital gains. Different countries have diffrent withholding tax systems which made it difficult to incorporate this aspect into the model. However, as long as the rate of withholding tax is less than or equal to the tax rate applicable at home, existence of withholding taxes would not affect investment choice. This is because the domestic withholding tax credit will offset the tax withheld at the source of income in the foreign country. Only when the rate of withholding is higher than the domestic tax rate or the withholding tax credit is lower than the amount withheld will taxes affect investment choice.

Sixth, the analysis abstracted from consideration of political risks which are difficult to quantify.[1] It also excluded risks arising from unforseen exchange control, compulsory sale of foreign currency to the central bank of the host country at a premium and the like.

Finally and more importantly, the benefits found for the U.S. investor are attainable provided the foreign markets are deep enough to absorb his demand for securities without significant price effect. In other words, these substantial benefits would be there if the demand for foreign securities by the U.S. investor does not raise their prices so as to eliminate the potential gains.

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[1]Some idea of political risk associated with a country may be obtained fron an index called the Political System Stability Index defined by Haendel, West and Meadow. See Levi (1983), p.405 for the original source. This index is based on different socio-economic characteristics such as, social conflicts, riots, coups d'etat, frequency of public demonstration etc.

APPENDIX I

In chapter 5, the expression (5.7) is derived as follows. Taking account of the uncertainty in estimating μ, variance of R_t is

$$
\begin{aligned}
V(R_t) &= E\{(R - \mu)(R - \mu)'\} \\
&= E\{(R - \hat{\mu}) + (\hat{\mu} - \mu)\}\{(R - \hat{\mu}) + (\hat{\mu} - \mu)\}' \\
&= E\{(R - \hat{\mu})(R - \hat{\mu})' + (R - \hat{\mu})(\hat{\mu} - \mu)' \\
&\qquad + (\hat{\mu} - \mu)(R - \hat{\mu})' + (\hat{\mu} - \mu)(\hat{\mu} - \mu)'\} \\
&= E(R - \hat{\mu})(R - \hat{\mu})' + 2\, E(R - \hat{\mu})(\hat{\mu} - \mu)' \\
&\qquad + E(\hat{\mu} - \mu)(\hat{\mu} - \mu)' \\
&= \hat{V} + 2\, COV + V^*
\end{aligned}
$$

where $\hat{V}$ and V^* are the sample variance-covariance matrix of R_t and $\hat{\mu}$ respectively and COV is the covariance matrix between R_t and $\hat{\mu}$.

Portfolio variance would be

$$
\begin{aligned}
V(P) &= V(X'R_t) = X'V(R_t)X \\
&= X'\hat{V}X + 2\, X'(COV)X + X'V^*X \qquad (5.7)
\end{aligned}
$$

APPENDIX II

Additional diagrams and tables mentioned in the text appear in the following pages.

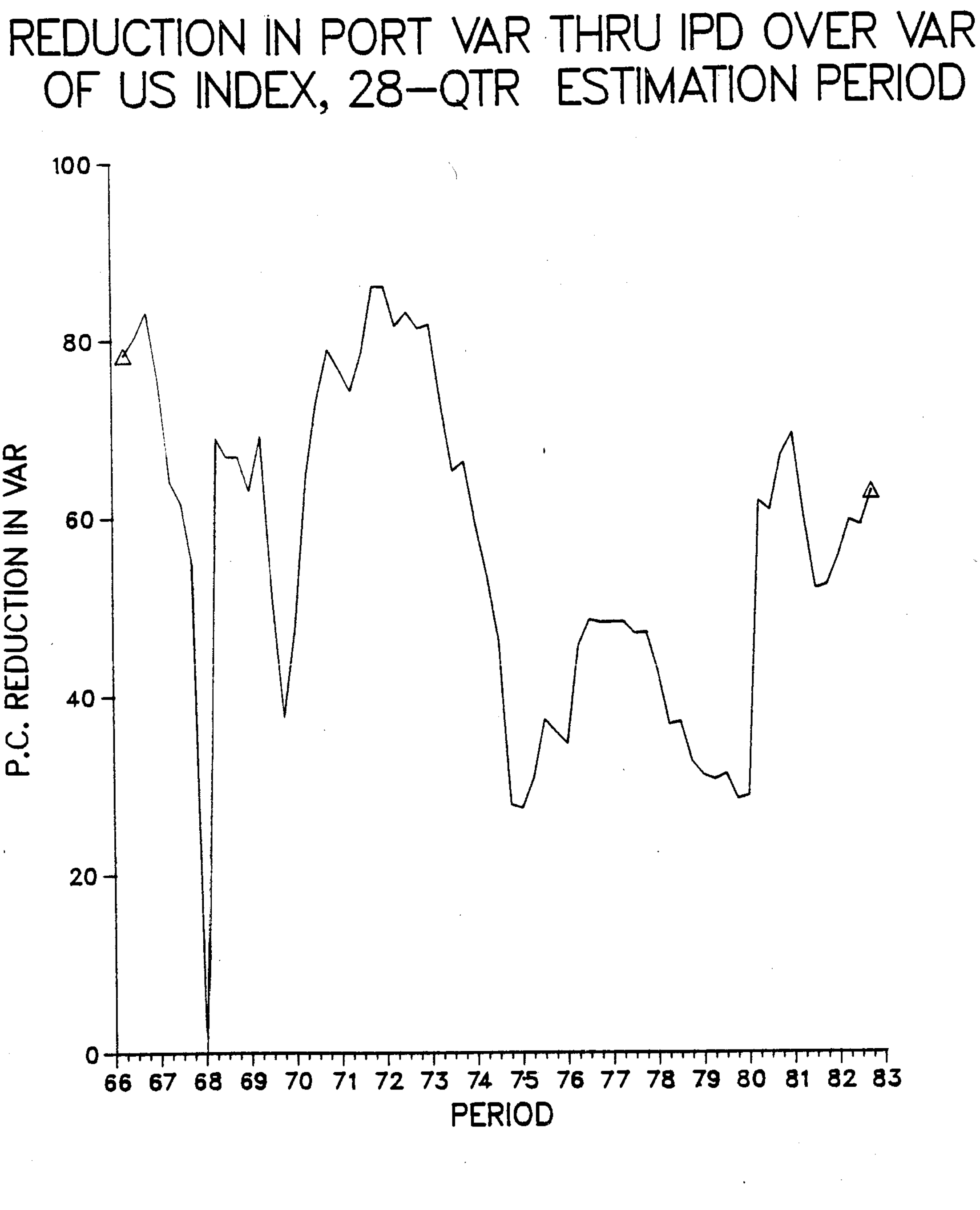

REDUCTION IN PORT VAR THRU IPD OVER VAR
OF US INDEX, 28–QTR ESTIMATION PERIOD
100
80
60
40
20
0
P.C. REDUCTION IN VAR
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD

FIGURE A.1

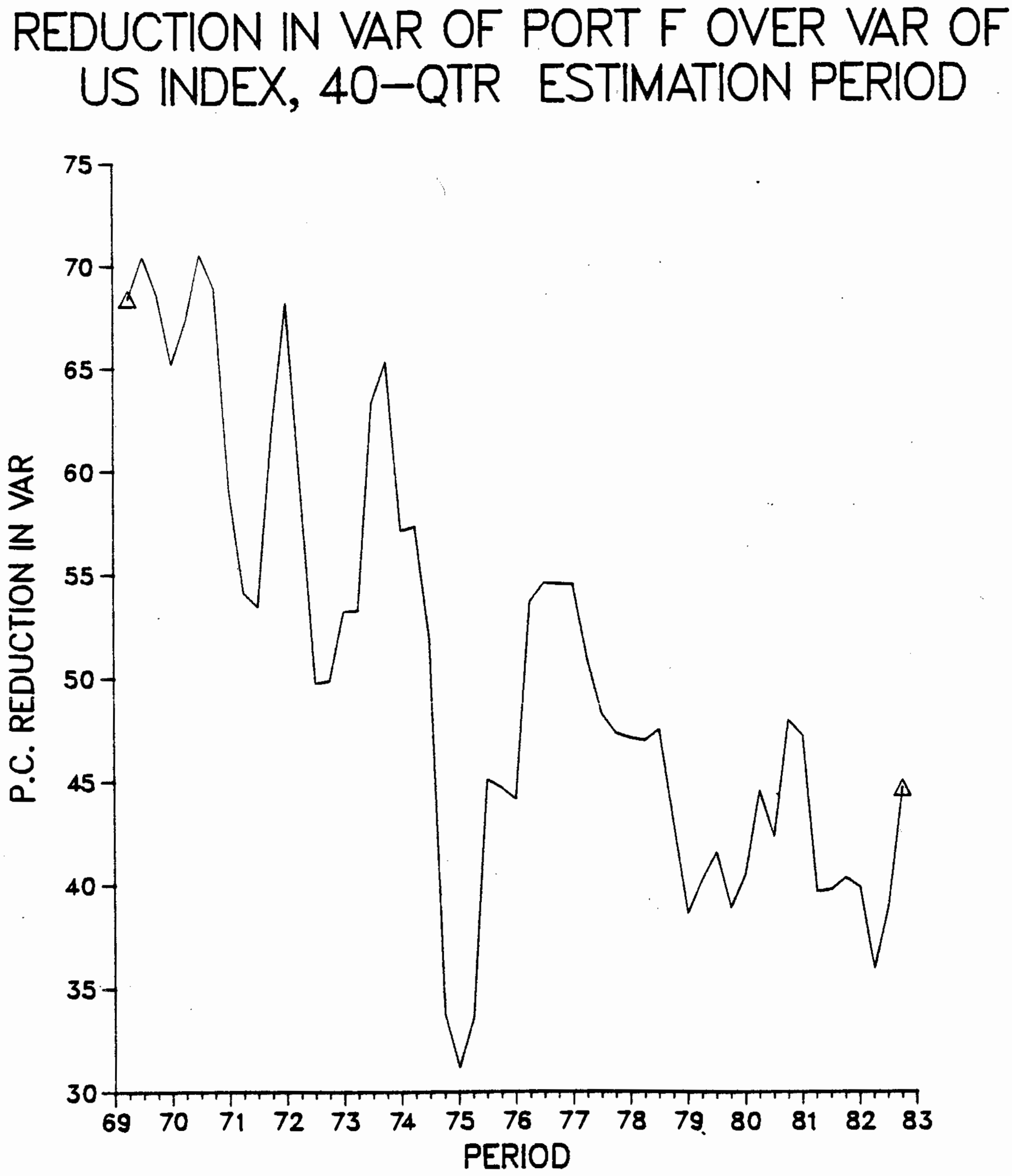

REDUCTION IN VAR OF PORT F OVER VAR OF
US INDEX, 40-QTR ESTIMATION PERIOD
P.C. REDUCTION IN VAR
75
70
65
60
55
50
45
40
35
30
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD

FIGURE A.2

EXCESS RET ON PORT E OVER RET ON US INDEX,
28–QTR ESTIMATION PERIOD

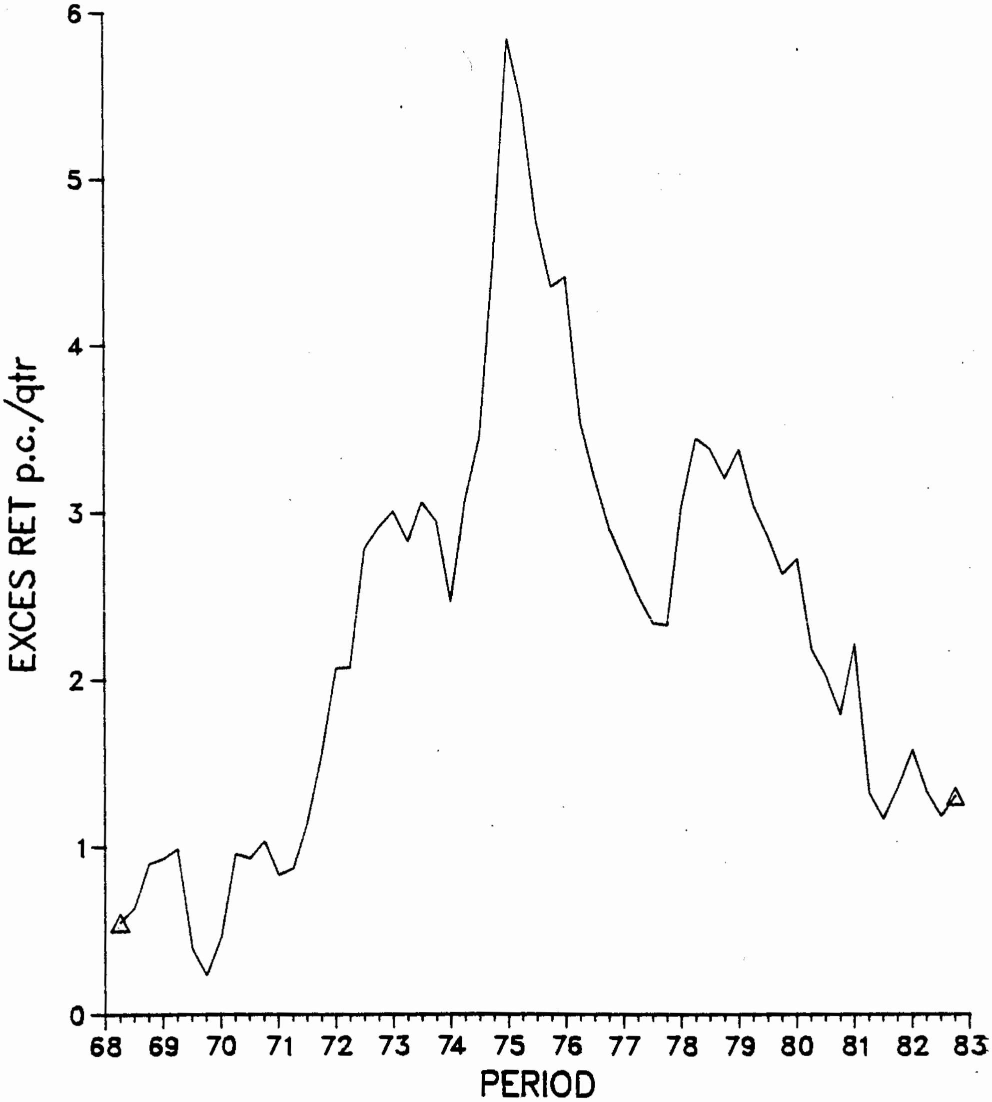


FIGURE A.3

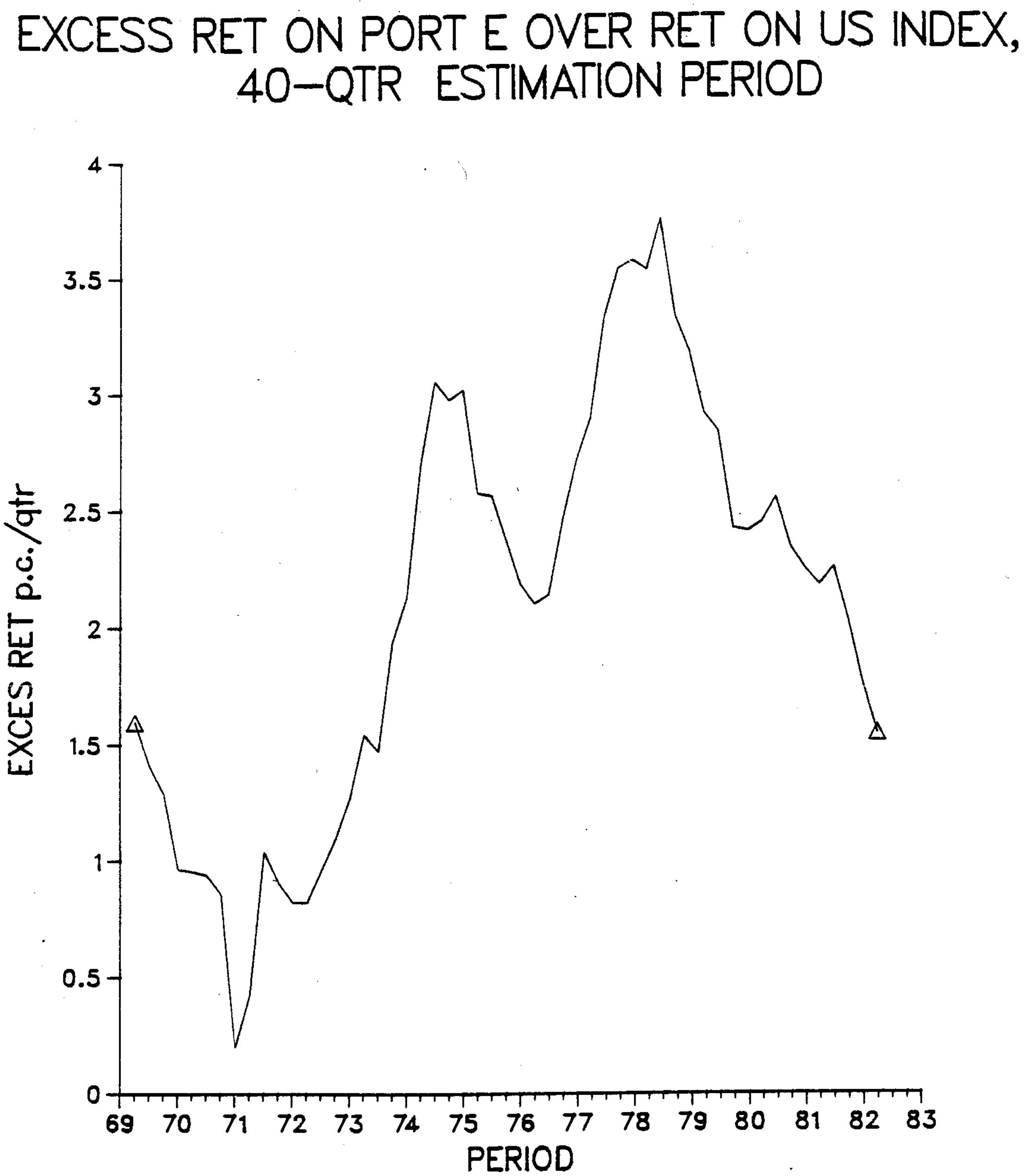

EXCESS RET ON PORT E OVER RET ON US INDEX,
40—QTR ESTIMATION PERIOD
EXCES RET p.c./qtr
4
3.5
3
2.5
2
1.5
1
0.5
0
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD

FIGURE A.4

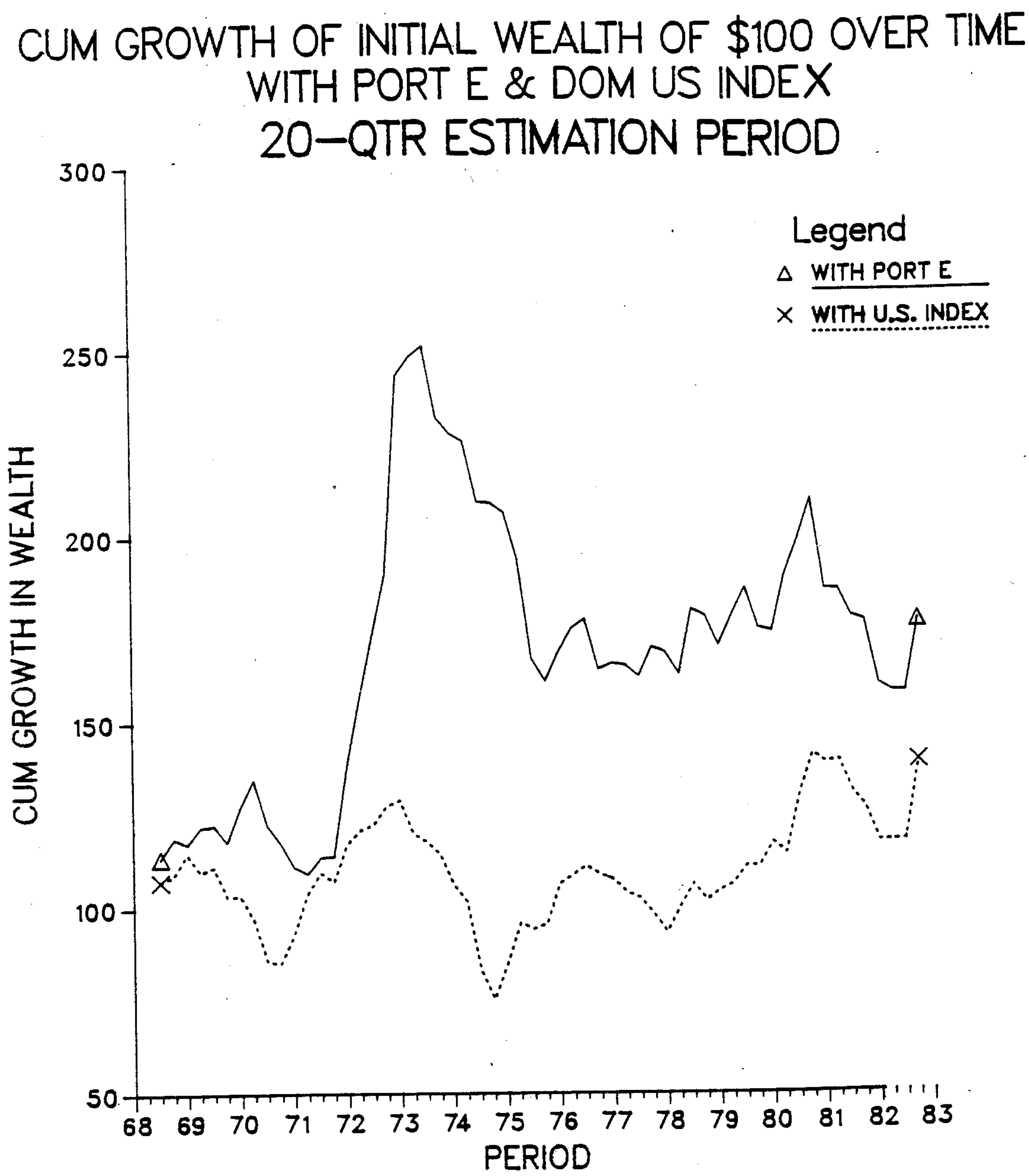

CUM GROWTH OF INITIAL WEALTH OF $100 OVER TIME
WITH PORT E & DOM US INDEX
20–QTR ESTIMATION PERIOD
Legend
WITH PORT E
WITH U.S. INDEX
CUM GROWTH IN WEALTH
300
250
200
150
100
50
68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD

FIGURE A.5

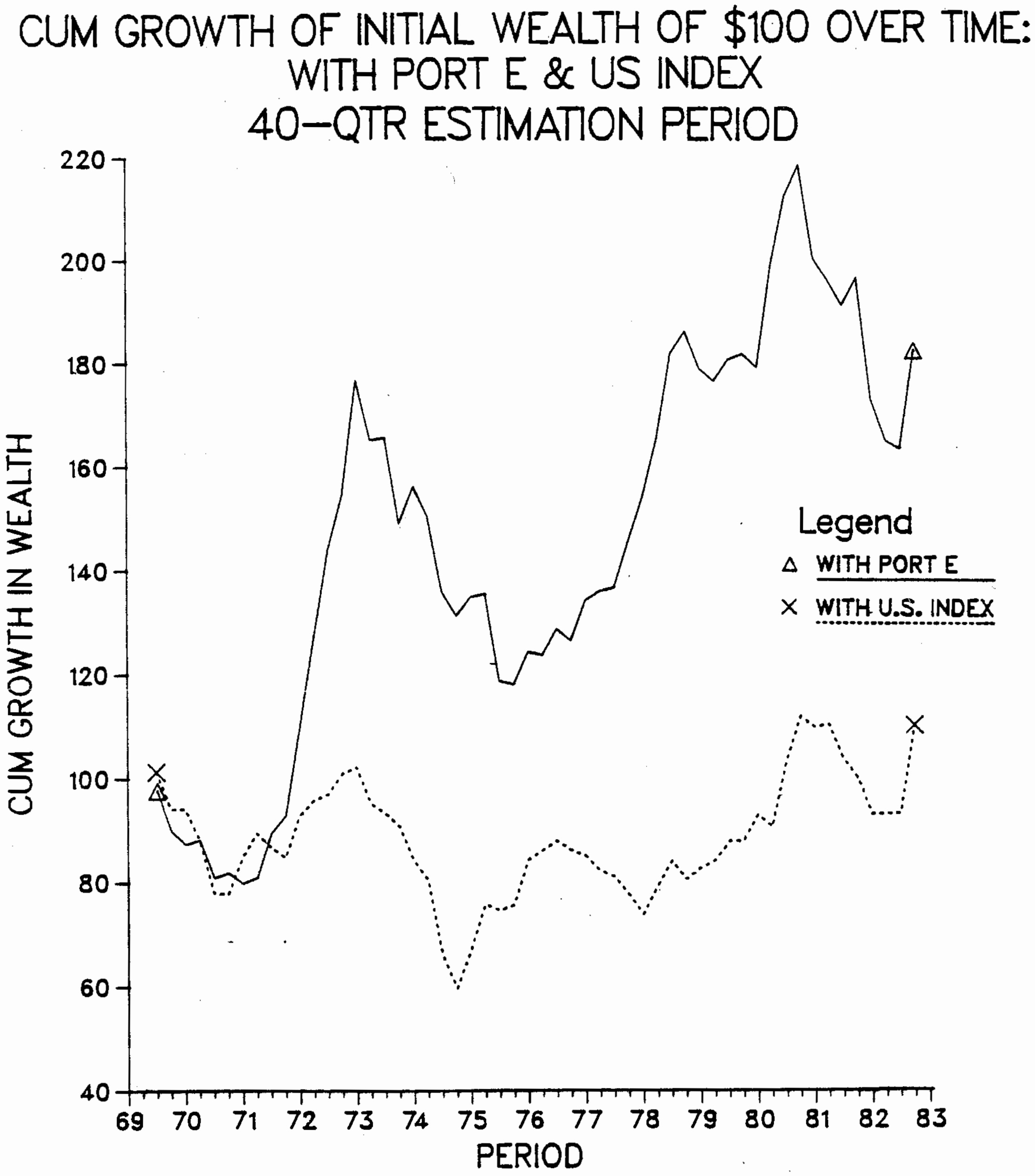
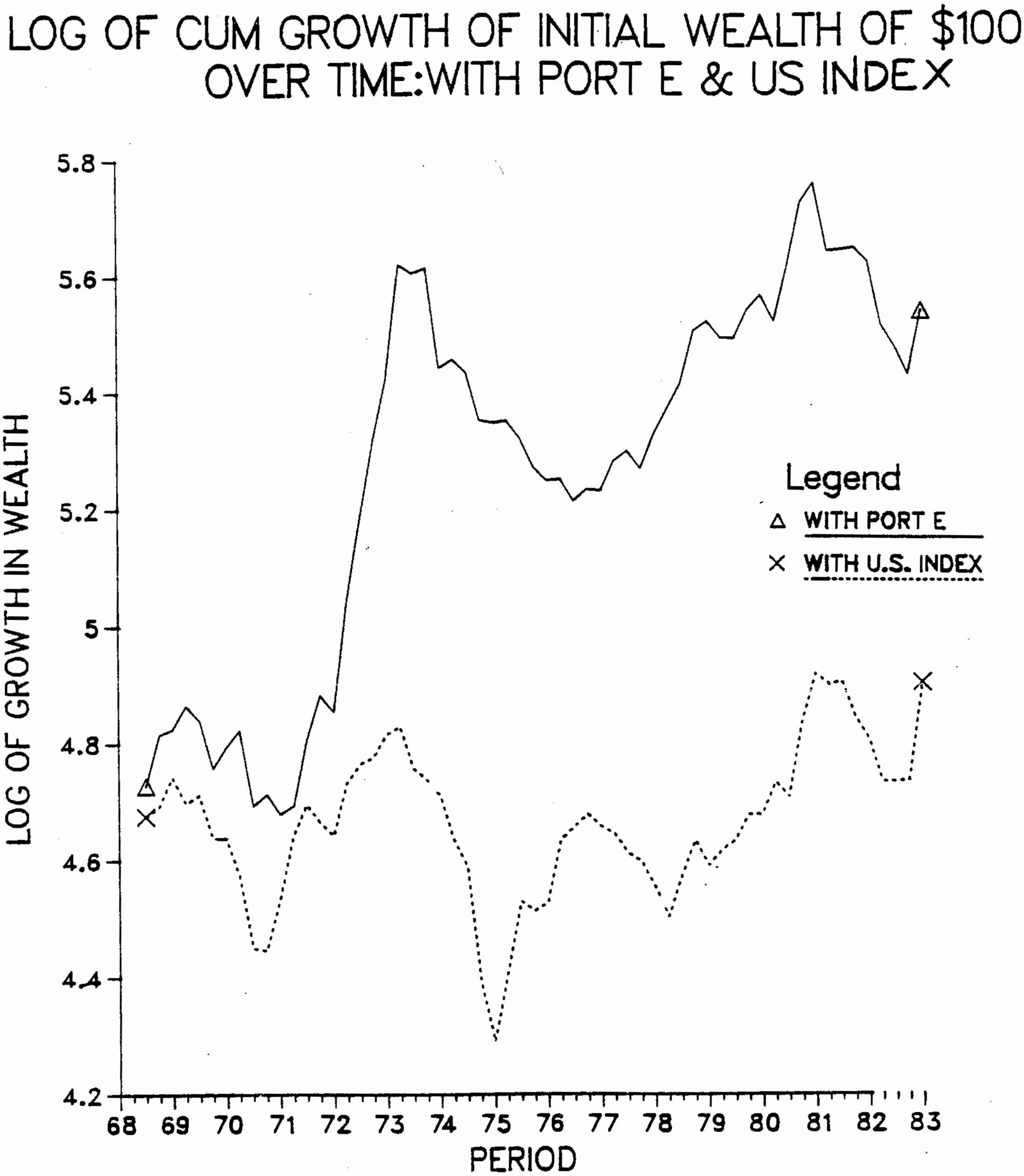
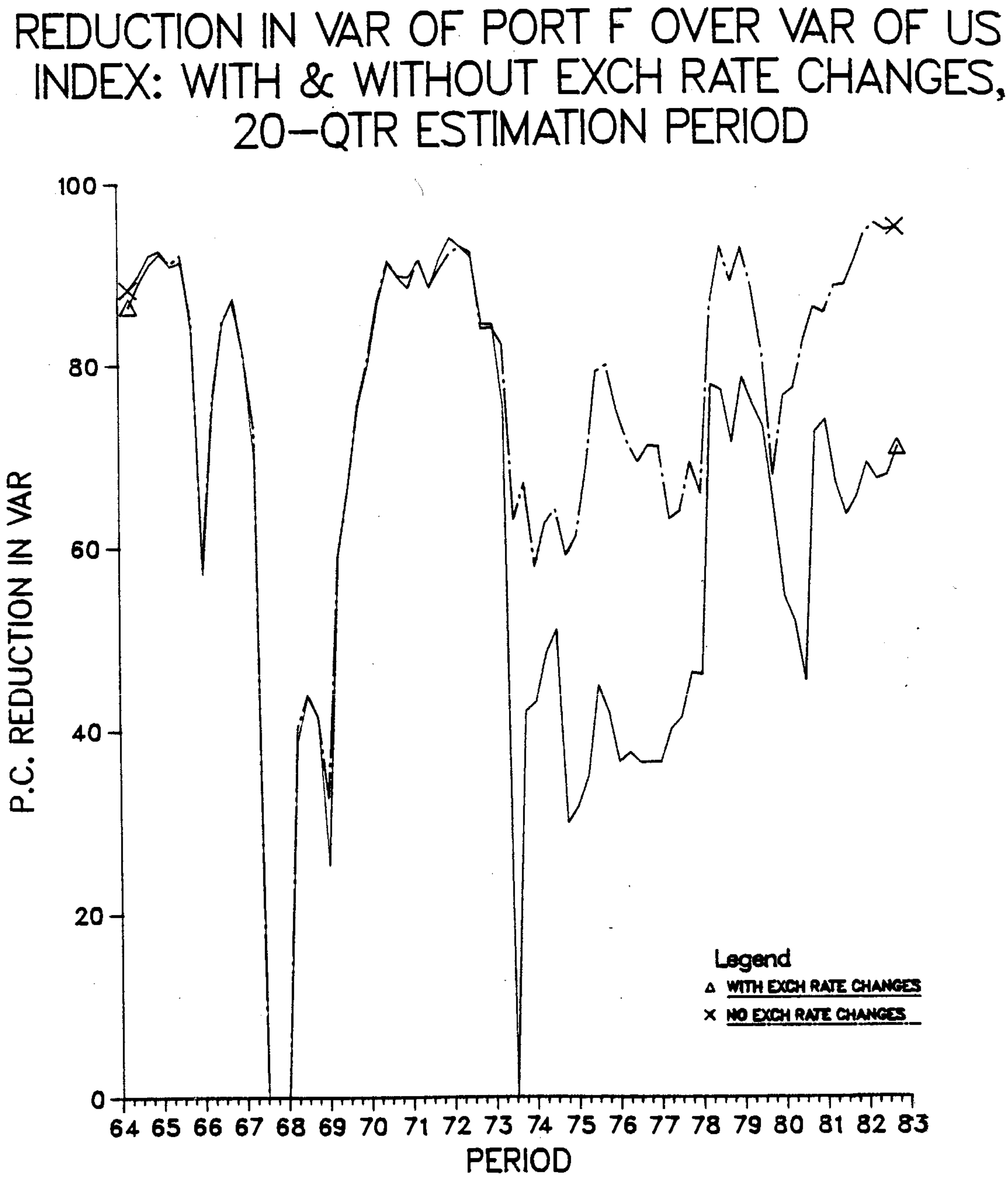

CUM GROWTH OF INITIAL WEALTH OF $100 OVER TIME:
WITH PORT E & US INDEX
40—QTR ESTIMATION PERIOD
220
200
180
160
140
120
100
80
60
40
CUM GROWTH IN WEALTH
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD
Legend
WITH PORT E
WITH U.S. INDEX

FIGURE A.6



LOG OF CUM GROWTH OF INITIAL WEALTH OF $100
OVER TIME:WITH PORT E & US INDEX
LOG OF GROWTH IN WEALTH
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
PERIOD
Legend
WITH PORT E
WITH U.S. INDEX

FIGURE A.7



REDUCTION IN VAR OF PORT F OVER VAR OF US INDEX: WITH & WITHOUT EXCH RATE CHANGES, 20-QTR ESTIMATION PERIOD
100
80
60
40
20
0
P.C. REDUCTION IN VAR
64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83
PERIOD
Legend
WITH EXCH RATE CHANGES
NO EXCH RATE CHANGES

FIGURE A.8

Table A.1

Pairwise Covariances Between Capital Gains/Losses of Country i and j, C(cgi,cgj), for 1980-1, Ex ante Data, 28-Qtr Estimation Period

LEGEND: A=Australia, B=Belgium, C=Canada, D=Denmark, F=France, G=Germany, I=Italy, IR=Ireland, J=Japan, N=Netherlands, SA=South Africa, SW=Sweden, SZ=Switzerland, UK=UnitedKingdom, US=United States AU=Austria, FN=Finland, NW=Norway.

	A	B	C	D	F	G	I	IR	J	N	SA	SW	SZ	UK	(US)	(AU)	(FN)	(NW)
A	0.0097																	
B	0.0037	0.0043																
C	0.0049	0.0037	0.0066															
D	0.0044	0.0029	0.0025	0.0058														
F	0.0055	0.0041	0.0053	0.0026	0.0105													
G	0.0031	0.0018	0.0013	0.0022	0.0026	0.0029												
I	0.0042	0.0037	0.0032	0.0020	0.0052	0.0008	0.0099											
IR	0.0058	0.0050	0.0043	0.0055	0.0039	0.0042	0.0028	0.0158										
J	0.0032	0.0024	0.0024	0.0030	0.0019	0.0019	0.0016	0.0047	0.0034									
N	0.0038	0.0034	0.0029	0.0037	0.0038	0.0034	0.0022	0.0055	0.0034	0.0058								
SA	-0.0022	0.0004	0.0002	-0.0049	-0.0010	-0.0025	0.0037	-0.0037	-0.0021	-0.0015	0.0262							
SW	0.0032	0.0020	0.0017	0.0022	0.0019	0.0014	0.0013	0.0019	0.0013	0.0026	0.0005	0.0043						
SZ	0.0039	0.0025	0.0034	0.0028	0.0025	0.0020	0.0017	0.0052	0.0024	0.0027	-0.0031	0.0012	0.0042					
UK	0.0080	0.0061	0.0062	0.0068	0.0076	0.0053	0.0030	0.0145	0.0046	0.0067	-0.0085	0.0025	0.0069	0.0202				
US	0.0046	0.0029	0.0038	0.0033	0.0040	0.0021	0.0022	0.0045	0.0027	0.0033	-0.0038	0.0016	0.0030	0.0068	0.0043			
AU	0.0007	0.0009	0.0004	0.0010	0.0007	0.0004	0.0014	0.0002	0.0005	0.0009	0.0017	0.0004	0.0001	0.0003	0.0004	0.0010		
FN	0.0002	0.0020	0.0024	0.0012	0.0020	0.0000	0.0019	0.0003	0.0010	0.0013	0.0003	0.0009	0.0009	-0.0003	0.0008	0.0007	0.0055	
NW	0.0043	0.0045	0.0053	0.0029	0.0049	-0.0008	0.0083	-0.0000	0.0005	0.0013	0.0074	0.0020	0.0014	0.0012	0.0026	0.0026	0.0037	0.0164

Table A.2

Pairwise Covariances Between Exchange Gains/Losses of Country i and j, C(egi,egj), for 1980-1, Ex ante Data, 28-Qtr Estimation Period

	A	B	C	D	F	G	I	IR	J	N	SA	SW	SZ	UK	AU	FN	NW
A	0.0019																
B	0.0008	0.0030															
C	0.0001	-0.0002	0.0004														
D	0.0009	0.0026	-0.0002	0.0025													
F	0.0008	0.0021	-0.0003	0.0020	0.0025												
G	0.0010	0.0031	-0.0002	0.0028	0.0024	0.0035											
I	0.0005	0.0009	-0.0004	0.0008	0.0013	0.0009	0.0022										
IR	0.0005	0.0016	-0.0002	0.0013	0.0013	0.0016	0.0008	0.0020									
J	0.0012	0.0012	-0.0003	0.0012	0.0010	0.0013	0.0004	0.0008	0.0025								
N	0.0008	0.0028	-0.0002	0.0025	0.0020	0.0030	0.0011	0.0014	0.0010	0.0027							
SA	0.0010	0.0017	0.0000	0.0016	0.0014	0.0018	0.0007	0.0011	0.0007	0.0016	0.0022						
SW	0.0005	0.0023	-0.0001	0.0022	0.0018	0.0025	0.0008	0.0011	0.0007	0.0022	0.0014	0.0025					
SZ	0.0012	0.0028	-0.0003	0.0026	0.0023	0.0031	0.0011	0.0018	0.0020	0.0025	0.0015	0.0022	0.0047				
UK	0.0005	0.0015	-0.0002	0.0011	0.0013	0.0015	0.0008	0.0019	0.0006	0.0013	0.0011	0.0011	0.0016	0.0020			
AU	0.0010	0.0029	-0.0002	0.0026	0.0022	0.0032	0.0010	0.0014	0.0012	0.0028	0.0017	0.0023	0.0029	0.0013	0.0030		
FN	0.0007	0.0018	-0.0001	0.0017	0.0014	0.0019	0.0005	0.0011	0.0005	0.0016	0.0013	0.0017	0.001[illegible]		0.0018	0.0017	
NW	0.0009	0.0024	-0.0001	0.0022	0.0018	0.0026	0.0006	0.0014	0.0010	0.0022	0.0018	0.0022	0.0[illegible]	0.0013	0.0024	0.0018	0.0025

LEGEND: A=Australia, B=Belgium, C=Canada, D=Denmark, F=France, G=Germany, I=Italy, IR=Ireland, J=Japan, N=Netherlands, S=South Africa, SW=Sweden, SZ=Switzerland, UK=United Kingdom, AU=Austria, FN=Finland, NW=Norway

Table A.3

Pairwise Correlations Between Capital Gains/Losses of Country i and j, r(cgi,cgj), for 1980-1, Ex ante Data, 28-Qtr Estimation Period

	A	B	C	D	F	G	I	IR	J	N	SA	SW	SZ	UK	US	AU	FN	NW
A	1.00																	
B	0.58	1.00																
C	0.61	0.70	1.00															
D	0.59	0.59	0.40	1.00														
F	0.54	0.61	0.63	0.33	1.00													
G	0.57	0.51	0.30	0.54	0.48	1.00												
I	0.43	0.56	0.39	0.26	0.50	0.16	1.00											
IR	0.47	0.61	0.41	0.57	0.30	0.61	0.22	1.00										
J	0.56	0.63	0.50	0.67	0.31	0.60	0.27	0.65	1.00									
N	0.51	0.69	0.47	0.65	0.49	0.83	0.29	0.58	0.76	1.00								
SA	-0.14	0.04	0.01	-0.40	-0.06	-0.29	0.23	-0.18	-0.22	-0.12	1.00							
SW	0.50	0.46	0.32	0.45	0.28	0.39	0.19	0.23	0.34	0.53	0.04	1.00						
SZ	0.62	0.60	0.65	0.57	0.38	0.56	0.26	0.63	0.63	0.56	-0.29	0.28	1.00					
UK	0.57	0.66	0.54	0.63	0.52	0.68	0.21	0.81	0.56	0.62	-0.37	0.27	0.75	1.00				
US	0.71	0.68	0.71	0.66	0.59	0.58	0.33	0.55	0.69	0.66	-0.36	0.37	0.71	0.73	1.00			
AU	0.23	0.42	0.14	0.41	0.23	0.23	0.43	0.05	0.29	0.38	0.33	0.21	0.05	0.08	0.21	1.00		
FN	0.03	0.41	0.40	0.22	0.26	0.00	0.25	0.03	0.22	0.23	0.02	0.18	0.20	-0.03	0.16	0.28	1.00	
NW	0.34	0.53	0.50	0.30	0.37	-0.11	0.65	-0.00	0.07	0.13	0.36	0.24	0.16	0.06	0.31	0.64	0.39	1.00

LEGEND: A=Australia, B=Belgium, C=Canada, D=Denmark, F=France, G=Germany, I=Italy, IR=Ireland, J=Japan, N=Netherlands, SA=South Africa, SW=Sweden, SZ=Switzerland, UK=United Kingdom, US=United States AU=Austria, FN=Finland, NW=Norway

Table A.4

Pairwise Correlations Between Exchange Gains/Losses of Country i and j, r(egi,egj), for 1980-1, Ex ante Data, 28-Qtr Estimation Period

	A	B	C	D	F	G	I	IR	J	N	SA	SW	SZ	UK	AU	FN	NW
A	1.00																
B	0.34	1.00															
C	0.10	-0.20	1.00														
D	0.41	0.94	-0.16	1.00													
F	0.35	0.79	-0.30	0.78	1.00												
G	0.41	0.97	-0.13	0.93	0.80	1.00											
I	0.23	0.37	-0.48	0.33	0.55	0.34	1.00										
IR	0.26	0.64	-0.20	0.57	0.60	0.61	0.38	1.00									
J	0.55	0.43	-0.33	0.49	0.41	0.44	0.17	0.34	1.00								
N	0.35	0.97	-0.22	0.93	0.77	0.96	0.44	0.59	0.40	1.00							
SA	0.51	0.65	0.04	0.68	0.62	0.65	0.30	0.54	0.29	0.65	1.00						
SW	0.23	0.85	-0.12	0.89	0.74	0.84	0.35	0.49	0.27	0.84	0.62	1.00					
SZ	0.39	0.76	-0.22	0.75	0.68	0.77	0.35	0.58	0.60	0.69	0.47	0.63	1.00				
UK	0.25	0.61	-0.21	0.50	0.57	0.57	0.38	0.96	0.28	0.54	0.53	0.48	0.53	1.00			
AU	0.43	0.97	-0.16	0.94	0.79	0.98	0.41	0.59	0.42	0.97	0.68	0.86	0.77	0.54	1.00		
FN	0.40	0.80	-0.07	0.82	0.67	0.80	0.28	0.60	0.22	0.76	0.69	0.85	0.66	0.58	0.83	1.00	
NW	0.41	0.88	-0.08	0.90	0.74	0.87	0.28	0.63	0.38	0.85	0.77	0.87	0.70	0.59	0.88	0.88	1.00

LEGEND: A=Australia, B=Belgium, C=Canada, D=Denmark, F=France, G=Germany, I=Italy, J=Japan, IR=Ireland, N=Netherlands, SA=South Africa, SW=Sweden, SZ=Switzerland, UK=United Kingdom, AU=Austria, FN=Finland, NW=Norway

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