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THEORY OF INTERNATIONALLY DIVERSIFIED PRODUCTION UNDER UNCERTAINTY: THE EFFECTS OF EXCHANGE RATE FLUCTUATIONS ON GROWTH OF DIRECT FOREIGN INVESTMENT, RETURN, STABILITY, AND RISK

by

Yooman Kim

M.A., Simon Fraser University, 1979

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
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ABSTRACT

The main purpose of this thesis is to construct a theoretical model in which some of the factors traditionally identified as the major determinants of direct foreign investment can be analyzed rigorously. From this model, we extract explicitly its theoretical implications and subject them to empirical tests. Additionally, its purpose is to develop a model which is capable of incorporating explicitly stochastic exchange rate fluctuations. For this purpose, we introduce exchange rate fluctuations into a traditional model of a multi-plant firm under uncertainty and analyze the effects stochastic exchange rate fluctuations can bring to bear on the equilibrium return-risk relationship in direct foreign investment.

For tools of theoretical analyses in the first part of this thesis, we draw upon the works of Professor Herbert Grubel. We then proceed to construct the model of internationally diversified production by introducing uncertainty in the production function of the traditional multi-plant firm and maximizing the expectation of its profit.

It is demonstrated that growth of direct foreign investment, for the most part, can be explained ultimately by the return-risk considerations, while at the same time changes in the return-risk relationship in turn can be explained primarily by exchange rate fluctuations. It is shown analytically and substantiated empirically that exchange rate fluctuations play the quintessential role in explaining foreign return performance, stability of return, and risks associated with direct foreign investment.

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INTRODUCTION

THEORY OF INTERNATIONALLY DIVERSIFIED PRODUCTION UNDER UNCERTAINTY

The main purpose of this thesis is to rigorously analyze the traditionally identified determinants of direct foreign investment within the context of a theoretical model, and to examine empirically the characteristics of foreign investment in terms of expected rate of return, "stability" of returns, and "risks" associated with direct foreign investment under uncertainty. Additionally, its purpose is to construct a stochastic model of internationally diversified production via direct foreign investment, which is capable of incorporating explicitly stochastic exchange rate fluctuations. For this purpose, we introduce exchange rate fluctuations into the traditional model of a multi-plant firm, in which we entertain the notion of undiversifiable, systematic "exchange rate risks" and track the effects exchange rate fluctuations can bring to bear on the equilibrium return-risk relationship in the context of direct foreign investment. Upon completion of model construction, the implications regarding exchange rate effects on growth of direct foreign investment, return performance, stability of return, and risks connected to fluctuating exchange rates are then extracted explicitly, analyzed rigorously, and subjected extensively to empirical tests.

For tools of theoretical analyses in the first part of this thesis, we draw upon the works of Professor Grubel, extensively from his theory of internationally diversified portfolio. In particular, we extrapolate the investment-decision model of rate of return maximization, with minor modifications, to the extended analyses for direct foreign investment.

for the purposes of analyzing return performance of foreign investment, we follow the portfolio approach to construct a stochastic version of the traditional multi-plant model for the case of internationally diversified production under uncertainty. For tools of theoretical investigations, however, we extend the use of the traditional mean-variance framework developed by Markowitz, Mossin, Sharpe, and Tobin for characterizing investment performances, and employ classical hypothesis-tests and regression analyses for capturing exchange rate effects and time-dependent shifts of estimated parameters.

It is concluded that growth of direct foreign investment, for the most part, can be explained ultimately by return-risk considerations. At the same time, changes in the equilibrium return-risk relationship are explained, primarily, by exchange rate fluctuations alone. It is demonstrated theoretically and substantiated empirically as well that exchange rate fluctuations play an impregnable, quintessential role for explaining virtually every aspect of foreign investment performance, reaching far more deeply than initially supposed. It is shown that exchange rate fluctuations can explain, both inter-temporally and inter-spatially, more than half of the total variations in the level of foreign return, stability, and systematic risk over a wide cross-section of portfolio performance. Consequently, a model of international investment, formulated without explicit incorporation of the exchange rate fluctuations, is shown to be misspecified, <u>a priori</u>, and has embedded a fundamental source of ambiguity which is bound to manifest itself in the form of contradictory implications theoretically as well as in nonsensical results empirically.

This thesis is organized into, broadly speaking, two parts. Part I of this thesis develops a non-stochastic model of a firm that maximizes rate of return as its principal objective for providing direct foreign investment abroad. Part II takes a small step forward to construct a stochastic model of a multi-plant firm that invests in its domestic as well as foreign production facilities under uncertainty.

Chapter I lays down a theoretical foundation to set the stage in which traditionally identified determinants of direct foreign investment are discussed for an international firm with return maximization as its guiding principle. Following closely the development of Interest Parity Theory, we will also develop an "Efficiency Parity Theory" as its counterpart in direct foreign investment. Based upon these analyses, we derive, using both mathematical and diagrammatical approaches, a supply schedule of direct foreign investment abroad.

Chapter II presents some data on the growth pattern of U.S. direct foreign investment and foreign return performance for the past 15 years. Direct foreign investments are distinguished between manufacturing and service industries classification. Based on these data, regression analyses are carried out in order to determine the nature of empirical relationship between the rate of return available from investing abroad and the growth pattern of direct foreign investment, distinguished in terms of time, industry classification, and countries.

Chapter III completes the first phase of our model construction by introducing demand for direct foreign investment by host countries. From this, we derive the demand schedule for direct foreign investment by use of both mathematics and diagrams. Consequently, bringing together both supply and demand conditions into the discussion enables us to derive comparative static properties of equilibrium foreign investment. In particular, we have analyzed the comparative static effects on the equilibrium level of foreign investment inflow into host countries when there occur changes in depreciation accompanying technological obsolescence and changes in the feedback-effect that the foreign investment engenders upon the indigenous output.

Chapter IV pauses for a digression to reexamine the meaning of instability of returns and risks associated with foreign investment, before proceeding onto the second phase of our model construction. The notion of the instability of returns is differentiated conceptually from the traditional notion of risks associated with uncertain return performances. For this purpose, we define the quantitative instability surrogate in terms of "mean-preserving variances" representing the "pure instability of returns", rather than in terms of the simple gross variance measure or some other variants of a second moment that are usually employed in the traditional mean-variance models. Direct foreign investment also is distinguished in terms of those taking place in developing countries vis-a-vis those in developed countries. The two approaches of quantifying instability of return performances are then compared analytically and subjected to classical dual hypothesis-tests. From that discussion, it is revealed that there exists statistical white noise embedded in the observed return figures, created by the scale phenomenon associated with comparing foreign investment performance in different samples that are obtained from various time periods and various locations of investment. Resulting from this, the traditional risk surrogate, formulated in terms of the simple gross variance or some variant thereof, gives grossly misleading, if not outright nonsensical, results to be of much practical importance in decision making process for direct foreign investment. Therefore, the notion of risk connected to foreign investment is reformulated in the second part of this thesis within the context of a stochastic model in which exchange rate fluctuations have been explicitly structured from the outset.

For the second part of this thesis, chapter V opens up a line of investigation into the effects of uncertainty on equilibrium production conditions for a firm that possesses a portfolio of internationally diversified production facilities. For this purpose, we develop a stochastic version of the traditional multi-plant firm with its production facilities located at home and abroad. Before introducing exchange rate fluctuations into the model, however, we pause briefly to find a way in which the risk-premium required by the assumed risk-averse investor can be structured into the stochastic model of internationally diversified production under uncertainty. This procedure will pave the way, subsequently, to incorporate exchange rate fluctuations with relative ease and speed.

Chapter VI incorporates stochastic exchange rate fluctuations into the model developed in the previous chapter. From this extended model, we derive the Investment Market Line (IML) for characterizing the equilibrium return-risk relationship under stochastic exchange rate fluctuations, as a counterpart to the traditional Security Market Line (SML). The effects brought to bear on the Market Price of Risk (MPR) and the undiversifiable systematic risks due to the presence of exchange rate fluctuations are then analyzed separately. For these purposes, we define "systematic exchange rate risk" to mean the degree of covariability between return performances and exchange rate fluctuations. The quantitative measure of the exchange rate risk is represented by the slope coefficient of the characteristic line, which is obtained by running the first-pass regression of returns with respect to the corresponding exchange rate fluctuations. Consequently, it is shown that the true equilibrium relationship in direct foreign investment cannot be specified strictly in terms of a simple linear relationship of the traditional return-risk trade-off, because of exchange rate fluctuations, without simultaneously implanting the root cause of many biases in investment-decision making process. Finally, the various arguments developed in this chapter are subjected to empirical investigations by first extracting testable hypotheses of the IML model and then testing them in a multiple regression framework. From the empirical analysis, it is concluded that the role of exchange rate fluctuations is a sine qua non for explaining equilibrium return-risk relationship in foreign investments, far more precise and potent than putative considerations of the traditional SML model.

Chapter VII turns to investigate empirically changes in levels of mean returns and also variances of mean returns which follow from exchange rate fluctuations. For this purpose, we proceed to literally criss-cross over the observed data in a systematic fashion, by means of running first-pass regressions vertically, i.e., inter-temporally, and then running second-pass regressions horizontally, i.e., cross-sectionally. Consequently, it is shown that in most portfolios of direct foreign investments we considered, exchange rate fluctuations alone could explain, both inter-temporally and cross-sectionally, substantially more than half of the total variation in mean return levels as well as in the variances of mean returns. Next, we dig into each type of the regressions by performing subregressions on relevant data, each subregression corresponding to a particular subperiod of the total period for which the initial first-pass regressions were carried out. Consequently, this procedure flushes out the time-profile of the respective equilibrium relationship between exchange rate fluctuations and return performances, and also between exchange rate fluctuations and variances of returns. Finally, any time-dependent shifts of the relevant parameters thus-estimated are then exposed and put through an explicit time-independence test for further empirical verification.

Chapter VIII completes the second phase of our model construction and closes this thesis. In this chapter, we start out by estimating the classical characteristic line, i.e., with respect to market rate, in order to generate the systematic market risk measures associated with foreign investment. Portfolios are then formed, containing foreign investment and domestic investment in manufacturing industries. It is shown that subsequent to the portfolio formation, there emerge substantial welfare gains in the form of reduced total risk following diversification of the foreign investment. The characteristic lines of portfolios are then estimated according to subperiods, i.e., a first-pass regression is performed for each subperiod for the purpose of exposing a time-profile of corresponding market risks. Time-series on the market betas obtained from the above regressions are subjected to time-independence tests. It is shown that the estimated market betas are an increasing function of time, hence implying that the portfolios of foreign investments have decidedly taken on the characteristics of increasing aggressiveness over the time-span considered.

Next, the relationships between systematic market risk and exchange risk are analyzed empirically in order to determine whether there exists a consistent relationship between the two types of risks. It is demonstrated that the type of relationship suggested from theoretical considerations could also be established empirically, based on the examination of their inter-temporal and cross-sectional relationships.

Finally, all of the various components of the model, developed heretofore in the second part of the thesis, are brought together to represent empirically an overall picture of the equilibrium relationship that exists in direct foreign investment under stochastic exchange rate fluctuations. For this purpose, we perform second-pass regressions by employing the traditional SML model as well as our IML model, according to subperiods. From this, we distill successively the equilibrium relationship existing in each subperiod among the corresponding return, risk-free rate of return, level of exchange rate fluctuation, systematic market risk, and systematic exchange risk over a cross-section of portfolios. By following the iterative procedure, we open up the time-profile of the equilibrium relationship in order to reveal any time-dependent shifts of the estimated parameters between the periods. After a comprehensive review of the empirical findings, we also concur with those of other studies and conclude that estimated equilibrium relationships have indeed experienced significant shifts during the past fifteen years. At the same time, however, this thesis draws the conclusion, a fortiori, that the exchange rate effect has not only pervaded through virtually all aspects of the theoretical as well as all strata of the empirical relationship existing in direct foreign investment, but also it, above all else, emerges as the primary agent, quintessential for providing the theoretical underpinnings as well as the empirical vailidation of such relationships. Consequently, we conclude that the catalyst for inducing variations in the foreign return performances, stability of returns, risks, as well as the equilibrium return-risk relationship existing in the foreign investment, for the most part, is found in the role played by stochastic exchange rate fluctuations.

CHAPTER I A THEORETICAL APPROACH TO DIRECT FOREIGN INVESTMENT ANALYSIS

I-1. A Model Specification for the Supply of Direct Foreign Investment

While we are impressed with the complexity and the multitude of various motives and simultaneous objectives upon which an international firm may base its decision to invest abroad[1], it seems reasonable to assume, at the same time, traditional profit maximization as a first approximation of its guiding principle. Thus, the firm maximizes expected present value of total profits from all investment projects it undertakes over a multi-period investment horizon. In other words, the firm maximizes:

$$\sum_i \sum_t PV^e_{it} = \sum_i \sum_t K_i(m_{it}-r_{it}-d_{it}-a_{it}w_{it})/(1+r_{it})^t \qquad (I.1)$$

where

PV^e_{it} = the expected present value of ith project in period t.

K_i = the initial amount allocated to ith project.

m_{it} = the value of "rate of internal efficiency" of an investment project.

r_{it} = interest rate.

d_{it} = rate of economic depreciation.

a_{it} = technical coefficient for labor-intensity of production.

w_{it} = real wage rate.

Under the present value criterion, the firm is presumed to compute a present value for each possible investment project it undertakes. In order to maximize its earnings, the firm then should invest in all investment

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[1] See, for example, Caves (1971) and Helleiner (1973).

projects, whether domestic or foreign, in which PV_i^e is positive because the positive value provides an incentive to extend the exploitation of firm-specific advantages[2] as long as extraction of additional rents from the advantages results in a net increment to total PV^e at the margin. The firm thus undertakes all investment projects with positive value of the earnings according to decreasing order of their PV_i^e ranking, starting from the investment project with the highest value of PV_i^e.

Traditionally, it has been considered that the most important sources for the supply of direct foreign investment emanate from international corporations of the developed countries who are constantly searching for opportunities for investment in their global pursuit of higher earnings. To keep our exposition simple, therefore, we will assume in the following analyses that foreign investment is funded entirely by an international firm through its capacity to generate internally the total amount of the necessary capital from its retained earnings or issuing stocks and bonds, or alternatively, financed by externally-raised capital from international capital markets. It is inessential, however, to the main analysis of our model whether the foreign firm raises the necessary capital internally within the company or externally in the world capital market. We will, therefore, take the financial cost of capital from either method of financing the investment to be the rate of interest, which is given exogenously in equation (I.2) below.

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[2] See Caves (1971), Johnson (1970), and Kindleberger (1969).

It should be recognized, however, that foreign investment typically transmits to host countries not only the physical capital but also other factors of production such as managerial skill and technical know-how in a non-separable "package", in the words of Johnson (1970), and that each of the other factors is frequently a joint input to production of outputs in both the host country and the foreign firm's home country. Thus, we cannot realistically hope to obtain separated productivity measures for each factor of the investment package, nor can we hope to have the firm's earnings allocated to the individual factors of production. For these reasons, we will define instead the expected "rate of internal efficiency" of an investment project to mean the rate of return on the total investment package, including any profits in addition to returns to capital and the other factors of production in the investment package. The expected rate of internal efficiency on the ith investment project in period t is denoted by m^*_{it} in equation (I.2) below.

For ease of exposition, let us consider the case in which a U.S. firm has K dollars available for a lump-sum investment in an additional project, which is to be chosen from investment opportunities available in either the U.S. or South Korea.[3] In other words, the firm invests all of the K dollars either in its home country (U.S.) or abroad for a direct foreign investment in the host country (South Korea), depending on the outcome of the following PV calculations:

$$K \sum_t [(m_t - r_t - d_t - aw_t)/(1+r_t)^t] \gtreqless (K/S) \sum_t [F_t (m^*_t - r_t - d^*_t - a^* w^*_t)/(1+r_t)^t], \qquad (I.2)$$

---

[3] See Grubel (1977), Page 248.

where

K = the amount available for an additional investment.

S = the initial spot exchange rate, defined in units of the investor's currency (U.S. dollars) in order to obtain one unit of the host country's currency (South Korean wons).

F_t = the expected forward (future-spot) rate of exchange in period t.

w_t = proxy variable for real efficiency wage rate, i.e., adjusted for labor productivity.

The superscript * denotes the expected value of the corresponding variable in the host country for the direct foreign investment.

The above expression can be simplified by noting that the discount factor $(1+r_t)^t$ is the same on both sides of the expression so that it can be cancelled out. Following the well-known random walk hypothesis, it is assumed that net earnings are independent and identically distributed in each subperiod of the investment's entire productive life[4]. Without loss of generality in subsequent equations, therefore, we can drop the time subscript and the summation sign from equation (I.2), and rewrite it henceforth as follows:

$$K(1+m-r-d-aw) \lesseqgtr (K/S)(1+m^*-r-d^*-a^*w^*)\cdot F \qquad (I.3)$$

While it is recognized that the one period approximation of the multi-period analysis required in the Expression (I.3) may be an oversimplification, we should also recognize that a multiperiod analysis involving the comparison

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[4] Markowitz (1959) has shown that maximizing the single-period expected utility gives a procedure which will maximize the terminal portfolio value in addition to maximizing the multi-period expected utility. See Chapter 6.

of unobservable inter-temporal expected utility function cannot realistically be made operational. Because of this, we will develop our arguments below with the use of the simplified version as stated in the Expression (I.3).

The left-hand-side of the Expression (I.3) gives the present value of the domestic investment in the U.S., and the right-hand-side of the expression gives the expected present value of the direct foreign investment in South Korea at the end of an appropriately adjusted investment period. The right-hand-side of the Expression (I.3) converts first the K dollars for the direct investment into South Korean wons at the initial spot rate of exchange, i.e., (\$K/S). Therefore, the term $(\$K/S)(1+m^*-r-d^*-a^*w^*)$ represents the final value at the end of the investment period in units of the Korean wons, which includes the value of initial investment as well as net earnings. This sum is then multiplied by the expected forward rate of exchange to ascertain the dollar value of the direct foreign investment at the end of the investment period, i.e., $(\$K/S)(1+m^*-r-d^*-a^*w^*)\cdot F$. Forward sale of the firm's foreign investment earnings for dollars thus assures the comparability of investment returns for the U.S. investor, and in effect it eliminates all risks from changes in the foreign exchange rate for the entire period of the direct foreign investment in South Korea[4]. Therefore, if the right-hand-side of the Expression (I.3) is greater than the left-hand-side, the firm is assumed to make the direct foreign investment in South Korea, and similarly, if the left-hand-side is larger than the right-hand-side, the firm invests in the U.S. instead.

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[4] This assumption, however, is relaxed in the second part of this thesis where we analyze explicitly the categorical effects of stochastic exchange rate fluctuations on foreign return performances and their variances.

The theory is that the flows of the direct foreign investment in general will continue to adjust until the Expression (I.3) is an equality. But at such time, the firm will be indifferent to the choice of a particular location for a further investment so that other considerations, such as policy incentives provided by host countries, expectation of devaluation, or degree of the firm's risk-aversion associated with operating abroad for uncertain profits, for example, will influence the firm's decision over the investment location.

The above explanation of the investor's behavior suggests that the instability of foreign exchange market conditions poses a potential blockage for the firm in committing the investment abroad since direct foreign investment-related activities involve the risk resulting from changes in foreign exchange rate. Currency revaluation can lead to large losses or gains under unstable foreign exchange market conditions, creating incentives for the firm to offset them systematically. Therefore, the firm will be assumed to hedge at all times regardless of forward exchange rates by continuously covering forward all long term assets and liabilities in the forward exchange market against the risk of exchange rate changes. Consequently, the capital value of its foreign assets, such as accounts receivable, plant and equipment, and inventories, is assumed to be protected against the risk of stochastic changes arising from exchange rate fluctuations in the future.

I-2. Efficiency Parity Theory of Direct Foreign Investment

Using Expression (I.3) as a starting point, we can now readily develop an "efficiency arbitrage theory" of direct foreign investment by closely following its counterpart from the theory of interest arbitrage, whose modern innovation is due to Professor Grubel in developing a new approach to the subject matter[1]. For this purpose, let us define the efficiency arbitrage margin (EAM) of direct foreign investment to be the advantage margin of the investment abroad over domestic investment in Expression (I.3), restated below:

$$\$K(1+m-r-d-aw) < (\$K/S)(1+m^*-r-d^*-a^*w^*)F. \tag{I.3}$$

A useful way of looking at the equilibriating process in Expression (I.3) is then to regard it as exploiting the EAM available from the investment opportunity abroad. Specifically, we can write the EAM from a simple manipulation[2] of the above Expression (I.3) as follows:

$$EAM = (m^*-m)/D + (d-d^*)/D + a(w-w^*)/D + (F-S)/F, \tag{I.4}$$

where

$D = (1+m-r-d-aw) > 0.$

$a = a^*$

$d(EAM)/d(m^*,d,w,F) > 0.$

$d(EAM)/d(m,d^*,w^*,S) < 0.$

---

[1] See Grubel (1966).

[2] From Expression (I.3), we have $S/F < (1+m^*-r-d^*-a^*w^*)/D$. Subtracting one from both sides of the above expression, and then rearranging the terms, we obtain the expression for EAM.

This can be positive or negative, depending on whether the net advantage from the investment in the Expression (I.4) lies in South Korea or in the U.S., respectively. For example, when EAM is positive, U.S. firms invest in South Korea, which, ceteris paribus, exerts downward pressure continuously on the rate of return realized from the investment in South Korea until all incentives for further investment arbitrage are eliminated. When the efficiency arbitrage margin is zero in equation (I.4), the firm that makes its decision solely based upon the expected present value of the investment is indifferent to its choice over investing in South Korea or the U.S. As mentioned before, other factors will then enter into the decision process to exert influence over the choice between the two countries. Therefore, a positive EAM means that it is more profitable, in terms of the expected PV, to invest in South Korea, and a negative EAM means that domestic investment in the U.S. instead is more profitable than direct foreign investment for the U.S. investor.

The division by D in the first three terms of equation (I.4') follows from algebraic necessity for deriving the efficiency arbitrage margin from Expression (I.3). The value of the denominator D is nothing but the total rate of return on domestic investment which includes the initial capital plus the rate of any net earnings. When the domestic profit is assumed to be zero, it is unity so that neither magnitudes nor signs of the first three terms are affected by its division. However, its value is zero when the loss of earnings from the investment project is large enough to completely wipe out the initial investment of capital, as in a case of bankruptcy[3].

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[3] In this case, Expression (I.3) is undefined. Therefore, we will rule out this possibility in the case of domestic investment.

The labor-intensity coefficient associated with the given level of invested capital in the equation (I.4) is assumed to be the same in the U.S. and South Korea, thus obviating one source of comparative advantage found in the classical Ricardian model as a possible motive for explaining direct foreign investment behavior. In other words, the production functions in our model are subject to the identical production technique assumed in the Heckscher-Ohlin model, which points to differences in relative factor costs imparted by dissimilarities in relative factor endowments as the key motive for explaining direct foreign investment in South Korea.

Inspection of equation (I.4) reveals that the efficiency arbitrage margin may be positive or negative, depending on the signs and the relative magnitudes of all four terms in the equation. The first term gives the difference in the rates of internal efficiency from the investments in the two countries, expressed as a percentage of the final return on the investment in the U.S. It is positive when the expected rate of internal efficiency from investing in South Korea is higher than those from the U.S. The second term represents the difference in the rates at which economic obsolescence of the invested capital assets occurs in the two countries. It is positive if the technological improvements due to more extensive research and development efforts, for example, proceed at a faster rate in the U.S. The third term of the equation (I.4) reflects the difference in the real efficiency wage rates in the two countries. It is positive as the wage rate differential exceeds the labor productivity differential between the U.S. and South Korea. Therefore, the comparative labor cost advantage of production lies with direct foreign investment rather than domestic investment in the U.S. when the third term is positive, and vice versa when it is negative. The fourth term gives the difference between the expected forward rate of exchange and the spot rate, hence representing capital gain or loss from the required foreign exchange transaction, expressed as a percentage of the expected forward rate at the time of repatriation of foreign investment earnings. It is positive or negative depending on whether the foreign currency, i.e., Korean won, is expected to be revalued upward or downward in comparison to the U.S. dollar. Since all four terms are expressed in percentages, they can be added or subtracted from one another, and the sum of the terms represents the arbitrage margin of an investment's internal efficiency, i.e., EAM in terms of percentage rate of net return, which is made amenable now to comparing with other types of percentage rates of return, such as the covered arbitrage margin (CAM) from the interest parity theory.

In order to focus our attention, first, on the "real aspect" of production, as opposed to the "financial aspect" of direct foreign investment arising from required foreign exchange dealings, we will assume for the moment that the foreign exchange market is perfectly stable such that the spot rate and the expected forward rate are equal. This implies that the fourth term in equation (I.4) vanishes completely, affecting in no way the firm's decision to invest abroad. This assumption will be relaxed shortly, however, when we consider the foreign exchange aspect separately.

One obvious implication that follows immediately from this assumption is that U.S. investors will make investments in Korea if any one of the terms in the equation is positive, holding all other terms zero. For example, the U.S. will supply direct foreign investment to Korea, as long as the supposed superiority of technological improvements persists in the U.S. This is because the faster pace of its technological progress causes a correspondingly faster rate of economic obsolescence[4] of the capital assets that are currently invested in the U.S., thus making the second term of equation (I.4) take a positive value. Direct foreign investment, therefore, may occur even if there were no comparative advantages arising from greater efficiency of investment or lower labor cost of production associated with the direct foreign investment. Thus, if the disparity in technological improvement between the two countries is sufficiently large, a U.S. firm may be forced to invest abroad, in spite of the existence of the comparative advantage available from the greater efficiency of investment and/or lower labor cost of production in its home country. In other words, the second term is so large in magnitude that it dominates the comparative advantages arising from all of the other terms, resulting in a positive EAM, hence outflow of direct investment abroad. This implication of the model follows directly from the equation (I.4). This analysis brings forth the immediate problems of practical importance posed by economic obsolescence accompanying technological improvement at a rapid pace in the U.S. These problems are of concerns to high-technology industry, in particular,

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[4] See Brash (1976).

where technological improvement advances rapidly, and the resulting supersession of the capital assets ensues almost immediately without lags.

Of particular importance to South Korean policy makers are those instances when in spite of generally lower levels of wage rates, direct foreign investment ceases to flow into the country due to dismally small productivity of its native workers, which makes the observed low wage rate rather high in effect in terms of the real efficiency wage rate, i.e., adjusted for labor productivity[5]. This may result in a negative value for the efficiency wages differential in the third term of the above equation (I.4). In such cases, it is clear that South Korean government or the foreign firms undertake extensive labor-training programs in order for any positive amount of direct foreign investment to take place in South Korea. When such programs for increasing productivity of local labor are initiated by foreign firms investing in South Korea, the presence of the risk of not recovering expenditures incurred or the risk of not capturing the incremental labor productivity may force many foreign firms to refrain from such activities and hence reduce supply of direct foreign investment which could flow to South Korea. This account of the labor market condition in the above explanation is, without doubt, an overly simplified version, but it nevertheless depicts a realistic picture of foreign firm's behavior in international labor market. Acting upon the above considerations, international firms may then decide not to invest in South Korea even when they can exploit higher rate of internal efficiency and/or lower depreciation costs associated with the direct foreign investment. This result will hold

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[5] See Belassa (1971). For an empirical study, see Riedel (1975).

valid so long as these advantages are not large enough to more than offset the comparative disadvantage arising from the generally low labor productivity conditions abroad.

We will now relax the perfect stability assumption made for foreign exchange rates and consider the situation in which the efficiency arbitrage margin for direct foreign investment is initially zero such that the international investor is initially indifferent with regard to production location. In this situation, exchange rate fluctuations will set off forces to disturb the initial equilibrium, thus resulting in increased inflow of direct foreign investment into South Korea or increased domestic investment in the U.S., respectively, depending on whether the EAM is positive or negative in the above equation (I.4). Therefore, when the magnitude of the fourth term, representing the effect of exchange rate fluctuations on the EAM, is very large, it is also capable of swamping all of the other terms[1]. However, the manner in which exchange rate fluctuations affect equilibrium foreign investment is far more complex than initially supposed, requiring detailed analyses of the exchange rate effect. It will be shown later that this is because we must distinguish, on the one hand, the type of exchange rate fluctuations: whether they are exchange-averse, exchange-neutral, or exchange-preferred, as well as the manner in which

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[1] This possibility may be of limited use, however, in the case of exchange rate fluctuations solely due to inflation. Thus, if the foreign price level doubles, the value foreign earnings and assets also double in the foreign currency. Consequently, exchange rate depreciation due to these influences does not affect long-run investment decisions directly, though variance of earnings may be affected. The author is grateful to Professor Grubel for this and other helpful comments on an earlier draft.

each type of exchange rate fluctuation affects the level of direct foreign investment, returns, and risks associated with the foreign investment. Depending on these considerations, it is shown to matter a great deal with regard to the eventual effects exchange rate fluctuations can cause on foreign earnings, risk-premium, market price of risk, and undiversifiable systematic risks. These considerations, however, will take us far beyond the scope of our objectives intended for this introductory chapter, for these terms need to be cast within a framework of a stochastic model. For this reason, we will confine our analyses strictly within the present model of return maximization for part I of this thesis and defer detailed analyses of various exchange rate effects until part II.

I-3. Geometric Representation of the Supply of Direct Foreign Investment

Using equation (I.4) as a starting point, we can now readily develop the supply schedule of direct foreign investment[1]. For this purpose, we will define the "parity rate of return", denoted by the symbol μ_0, to represent the expected rate of return on capital assets invested abroad, that is, $\mu_0 = m^* - aw^*$, which gives the zero efficiency arbitrage margin at the exogenously given values for the other variables in the equation (I.4). In other words, the parity rate of return on the capital invested abroad is defined by setting the EAM from equation (I.4) equal to zero. Therefore, we can write the parity rate as follows:

$$\mu_0 = \mu + (d^* - d) + (S - F)D/F, \qquad (I.5)$$

where

$\mu = m - aw.$

The parity rate is represented by the point where the 'SS' schedule intersects the vertical axis of Figure (I.1) below, in which the horizontal axis is the amount of capital assets invested per unit period of time, and the vertical axis is expected rate of return on the invested capital assets. This point on the vertical axis indicates that at the parity rate of return, international investors are indifferent to the choice between domestic investment and direct foreign investment.

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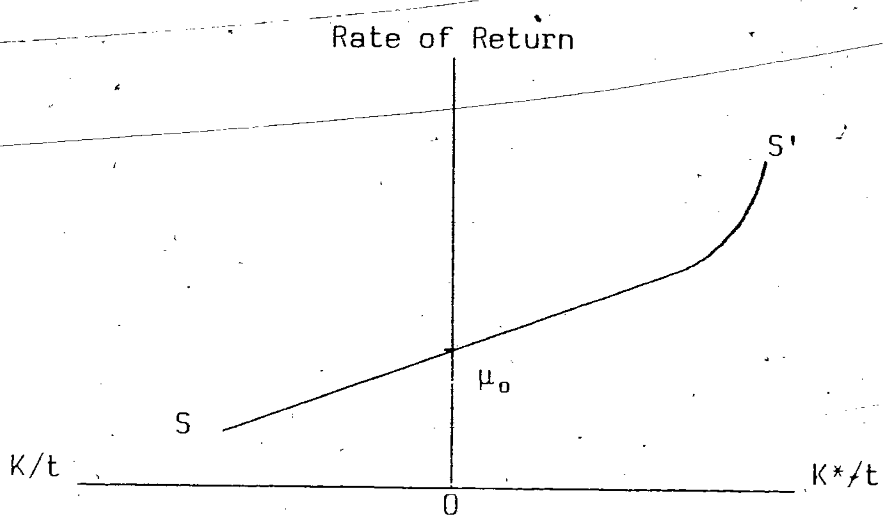
[1] See also Grubel (1977), Page 251.

FIGURE (I.1)

Supply of Direct Foreign Investment Abroad



The SS' schedule in the Figure (I.1) represents the functional relationship between expected rate of return on investment and amount of investment under the assumption that all other exogenously given variables are held constant. The positive slope of the SS' schedule indicates that when the expected rate of return is above the parity rate of return, i.e., $\mu^* > \mu_0$, U.S. entreprenuers invest abroad, and when the expected rate is below the parity rate, i.e., $\mu^* < \mu_0$, they provide domestic investment in the U.S. This interpretation follows directly from equation (I.4). It can be understood most readily by considering the fact that starting from the parity rate μ_0, if the foreign rate of return rises above the parity rate, the efficiency arbitrage margin is positive so that a positive incentive is created for making direct foreign investment abroad, and consequently, capital assets flow out of the U.S. By following strictly analogous reasoning, it follows conversely that for those expected rates of return available from direct foreign investment below the parity rate, there are negative incentives for making the foreign investment, i.e., EAM < 0, and investment takes place in the U.S. instead. Therefore, the left-hand-side of the SS' curve represents negative excess supply of direct foreign investment due to the comparative advantage of investing in the U.S. in comparison to providing direct foreign investment abroad.

The slope of the SS' schedule can also be derived with a simple mathematical procedure. It is clear that the EAM from the equation (I.4) can be rewritten as follows:

$$EAM = (\mu^* - \mu) + (d - d^*) + (F - S)D/F. \tag{I.6}$$

Therefore, the investment criterion based on equation (I.4) implies that the supply of direct foreign investment can be expressed in terms of EAM. That is,

$$K^* = G[(\mu^* - \mu) + (d - d^*) + (F - S)D/F], \tag{I.7}$$

where

$dG/d[\cdot] > 0.$

$d[\cdot]/d(\mu^*, d, F) > 0.$

$d[\cdot]/d(\mu, d^*, S) < 0.$

Totally differentiating the above equation (I.7), while holding constant all variables other than μ^* and K^*, gives us

$$d\mu^*/dK^* = 1/G'[\cdot] > 0. \tag{I.8}$$

This equation gives the movement along a given SS' schedule as the two variables μ^* and K^* are allowed to change simultaneously, but not the shift of the SS' schedule from its initial position. Since we already know that the sign of $dG/d[\cdot]$ is positive, it is clear that the sign of $d\mu^*/dK^*$ must be also positive. In other words, the SS' schedule shown in Figure (I.1), which represents supply of direct foreign investment from the above equation (I.7), has a positive slope.

The shape of SS' schedule reflects supply elasticity of direct foreign investment with respect to changes in the expected rate of return, representing the willingness of investors to increase the share of direct foreign investment in their portfolio as well as the willingness of new investors to open production facilities abroad. However, as the expected rate of return available from the foreign investment rises from the parity rate towards higher rates, it leads to a diminishing rate of increase in the direct foreign investment. This follows from noting that the increasingly higher levels of the foreign investment lead to diminishing benefits of portfolio diversification, marginal inconvenience[2] of foreign production activities, or perhaps, to increasing fear of expropriation of capital assets held abroad by hostile foreign governments[3]. Thus, increasingly larger rate of return must become available in order to persuade the investors to provide additional supply of direct foreign investment. In other words, the supply elasticity of direct foreign investment with respect to changes in the expected rate of return diminishes with increasing levels of capital assets held abroad.

The SS' schedule of direct foreign investment shifts vertically in parallel upward or downward, according to equation (I.5). This causes the rate of return to increase or decrease, respectively, at all given levels of investment. Consequently, the parity rate also increases or decreases when exogenously given variables change.

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[2] This assumes absence of a positive scale-economy.

[3] This is discussed at great length in the second part of this thesis.

Alternatively, this can be seen as shifting horizontally in parallel to the left or to the right, according to equation (I.7). Consequently, this causes the supply of direct foreign investment to decrease or to increase, respectively, at all given levels of the rate of return. For a concrete example, suppose that the forward rate of exchange falls. From the equation (I.5), it can be seen that this results in raising the parity rate of return μ_o, hence shifting at the same time the entire SS' schedule upward at all given levels of the capital invested. This follows since the investors will find their domestic investment in the U.S. to be more attractive due to the decrease in the forward exchange rate. Alternatively, we can see from equation (I.7) that the expected fall of the forward exchange rate will result in shifting the SS' curve to the left, reducing the supply of direct foreign investment at all given levels of expected rate of return, as the third term in the equation (I.7) decreases with the fall of the forward exchange rate.

The above explanation for the shifts of SS' schedule can be captured in explicit expression. For example, differentiating the equation (I.5) with respect to the forward exchange rate variable, holding constant all other variables in the equation, we obtain:

$$d\mu^* = -(SD/F^2)dF > 0, \qquad (I.9)$$

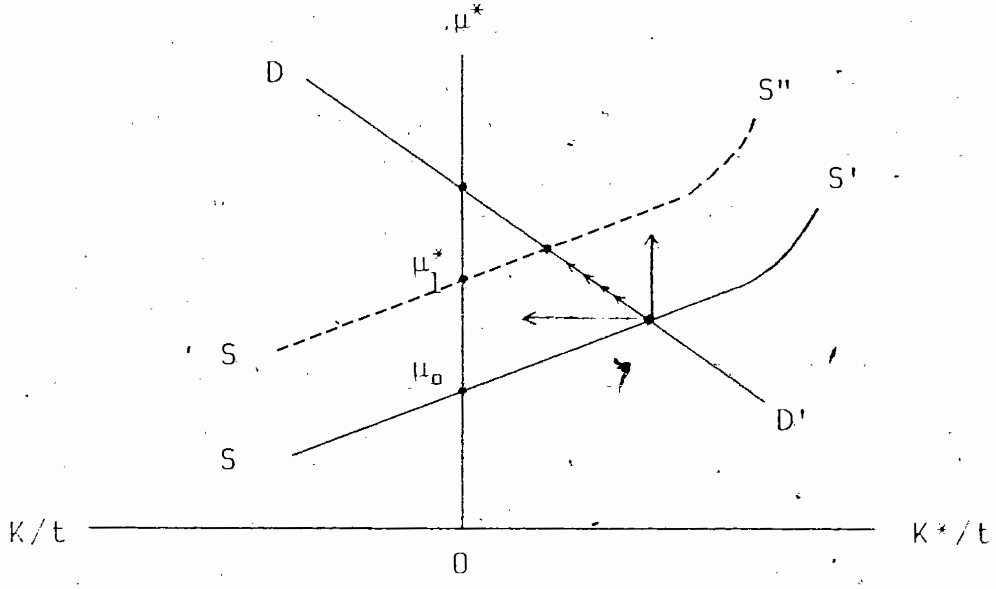
In other words, as the forward exchange rate falls, the parity rate must increase, i.e., the SS' schedule shifts vertically upward, reducing the levels of direct foreign investment supplied at all given levels of expected rate of return. Alternatively, differentiating the equation (I.7) with respect to the forward exchange rate also, holding constant all other variables in the equation, we obtain:

$$dK^* = (G'SD/F^2)dF > 0. \qquad (I.10)$$

This expression states that as the forward exchange rate falls, the levels of direct foreign investment supplied also must fall at all given levels of expected rate of return, therefore shifting the supply schedule to the left. These shifts are depicted in Figure (I.2) where the initial position of the supply schedule is represented by SS', and its final position following the exogenous change is represened by SS" curve. For analyzing the effects on the equilibrium values of (μ^*, K^*), however, a demand schedule for direct foreign investment must be introduced. This will then enable us to incorporate into our analysis both supply and demand conditions and to track how equilibrium values are affected. This task will be taken up in chapter III after we provide some empirical data on the growth pattern of U.S. direct foreign investment abroad and rates of return realized from the foreign investment.

FIGURE (I.2)

Shift of Supply Schedule



CHAPTER II EMPIRICAL RELATIONSHIP BETWEEN RATE OF RETURN AND SUPPLY OF U.S. DIRECT FOREIGN INVESTMENT ABROAD

II-1. Empirical Results from Regression Analysis on Growth of U.S. Direct Foreign Investment Abroad and Foreign Earnings, 1968-1982

The data presented in the following tables cover the time-period between 1968 through 1982, for which relatively reliable time-series are available for direct comparison of annual rates of return realized and the growth rates of U.S. direct foreign investment. The rate of return is measured as income after tax divided by the mean of current and preceding year-end book values of U.S. direct foreign investment position[1]. The growth rate of direct foreign investment is calculated as the difference between current and preceding year-end book values divided by preceding year-end book value. The figures reported under the subgrouping for manufacturing industries are calculated directly from the data provided by the Survey of Current Business. For the service industries subgrouping, however, the reported figures are derived by defining it as the residual industry after we subtract manufacturing, petroleum, mining, and smelting industries from total industries reported in the Survey of Current Business. To the fullest extent possible, inconsistencies in definitions used for obtaining the reported data have been adjusted and reconciled in order to facilitate the comparison between the rate of return and the growth of U.S. direct

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[1] This formula follows the convention adopted by the Survey of Current Business.

foreign investment over time (see Table II.1), as well as across the foreign countries in which U.S. investments have taken place during this time-period (see Table II.2). The particular period of time (1968-1982) has been chosen in anticipation of further empirical investigations into the interrelationships among the rate of return, its stability, and risks associated with the U.S. direct foreign investment, which are considered in later chapters.

For the purposes of the present investigation into the hypothesis that direct foreign investment has a positive functional relationship to rate of return, growth rates of U.S. direct foreign investment are compared with rates of return realized from investment abroad. Because of complications and unreliability of quantity comparisons of investigation of this nature, we have chosen to work with percentage rate figures. In other words, we propose to test whether increases in rate of return exert a positive impact on the rate of growth of direct foreign investment.

The relevant data are provided in Table (II.1). These data are then plotted in scatter diagrams on a natural scale, for both manufacturing and service industries. The scatter diagrams show definite indications of a positive relationship between the two variables. As a first approximation, simple linear regressions were run to fit the data, reflecting the hypothesis that over time, there exists a linear relationship between the rate of return and the growth rate of direct foreign investment in each industry subgroup. Denoting the symbol g_{mt} for growth rate and μ^{*}_{mt} for rate of return on U.S. direct foreign investment in manufacturing industries in period t, the regression equation of the following simple linear form was estimated:

$$g_{mt} = -\underset{(3.4303)}{6.8877} + \underset{(.2772)}{1.3803}\,\mu^{*}_{mt} + \underset{(3.0443)}{e_{mt}}, \qquad \text{(II.1)}$$

where $g_{mt} = d \ln DFI_{mt}$.

Thus, the marginal propensity to invest abroad, defined to be the change in growth rate of direct foreign investment in response to a marginal change in rate of return in foreign manufacturing, is positive and greater than unity. In other words, a one percent increase in the foreign rate of return would lead, on the average, to more than a one percent increase in the growth rate of direct foreign investment supplied. The values reported in the parentheses below the regression equation refer to the corresponding errors of estimates.

It should be noted that our hypothesis under present investigation concerns testing the existence of a positive functional relationship, the causation running from the rate of return representing the independent variable to the growth rate representing the dependent variable, rather than the existence of merely a positive association between the two variables. That this, indeed, should be the case can be understood from simply noting that its converse case cannot be true under normal circumstances, except when incremental investment engenders such an enormous positive external effect on earnings realized not only from the new capital but also from existing capital so as to lead to an overall increase in the return on all invested capital assets[2]. But in normal situations, we know from the way in which rate of return is calculated that a higher growth rate reduces automatically the calculated rate of return by making the capital base larger in the denominator of the rate of return formula. This is what the results in (II.1) indicates.

Similarly, denoting g_{st} and μ^*_{st} to mean the growth rate and rate of return, respectively, on U.S. direct foreign investment in service industries in period t, regression equation of a simple linear form was estimated for the service industries also:

$$g_{st} = \underset{(8.8008)}{-\,15.0892} + \underset{(.6317)}{1.9554}\,\mu^*_{st} + \underset{(6.2886)}{e_{st}}, \qquad \text{(II.2)}$$

where

$g_{st} = d \ln DFI_{st}$.

The marginal propensity to invest abroad with respect to an increase in rate of return is positive for the service industries also, and it is greater than unity. In other words, a one percent increase in the rate of return earned from the foreign investment in service industries would induce, on the average, more than a one percent growth of the direct foreign investment. The empirical results obtained here indicate that direct foreign investment activities in service

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[2] This occurence may still be possible in some cases of individual foreign investments, but not likely for the aggregate investment.

industries tend to be more sensitive to changes in rate of return than those in manufacturing industries. At the same time, the estimated regression coefficients are less accurate in terms of calculated errors of estimates. For either subgrouping of the foreign investment, however, the regression results show that supply of direct foreign investment responds, in an accelerating fashion over time, to changes in the rate of return.

The regression coefficients from either industry classification are statistically significant at more than the 95% level of confidence. The correlation coefficients between the rate of return and the growth rate of direct foreign investment are .8100 and .6514 for manufacturing industries and service industries, respectively. The correlation coefficients could have been increased by fine-tuning the observed data set, for example, by throwing out extreme values from the calculation since extreme values affect the calculated coefficients of correlation inordinately. To save degrees of freedom in the sample observations, however, we left them in the data set to be included in running the above regression. Other relevant results from the regression are also reported in Table (II.2).

TABLE (II.1)

Rate of Return and Growth of U.S. Direct Foreign Investment, 1968-1982

Year	MANUFACTURING		SERVICES		ALL INDUSTRIES	
	Growth	Return	Growth	Return	Growth	Return
1968	10.3	10.1	6.8	9.5	9.5	11.1
1969	12.6	11.6	11.9	10.4	10.0	11.8
1970	9.6	10.6	13.1	10.9	10.8	11.4
1971	10.7	10.7	8.4	11.1	9.6	11.6
1972	11.5	13.0	8.7	13.1	8.6	12.7
1973	15.8	15.9	22.1	15.3	12.7	17.3
1974	15.3	14.0	20.7	15.5	8.7	18.1
1975	9.2	11.2	13.6	15.4	12.7	14.2
1976	9.4	12.3	11.8	15.2	10.3	14.6
1977	1.4	10.8	14.0	14.6	6.7	13.9
1978	12.3	15.1	16.8	16.8	11.5	16.5
1979	13.4	17.6	19.8	16.7	15.4	21.8
1980	12.8	13.1	13.6	17.1	14.6	18.4
1981	3.6	9.0	4.8	13.8	5.1	14.7
1982^P	-1.8	5.7	-10.8	10.0	-2.2	10.2

Note: P stands for provisional data used for 1982.

Source: Survey of Current Business.

FIGURE (II.1)

Rate of Return and Growth of U.S. DFI in Manufacturing Industries

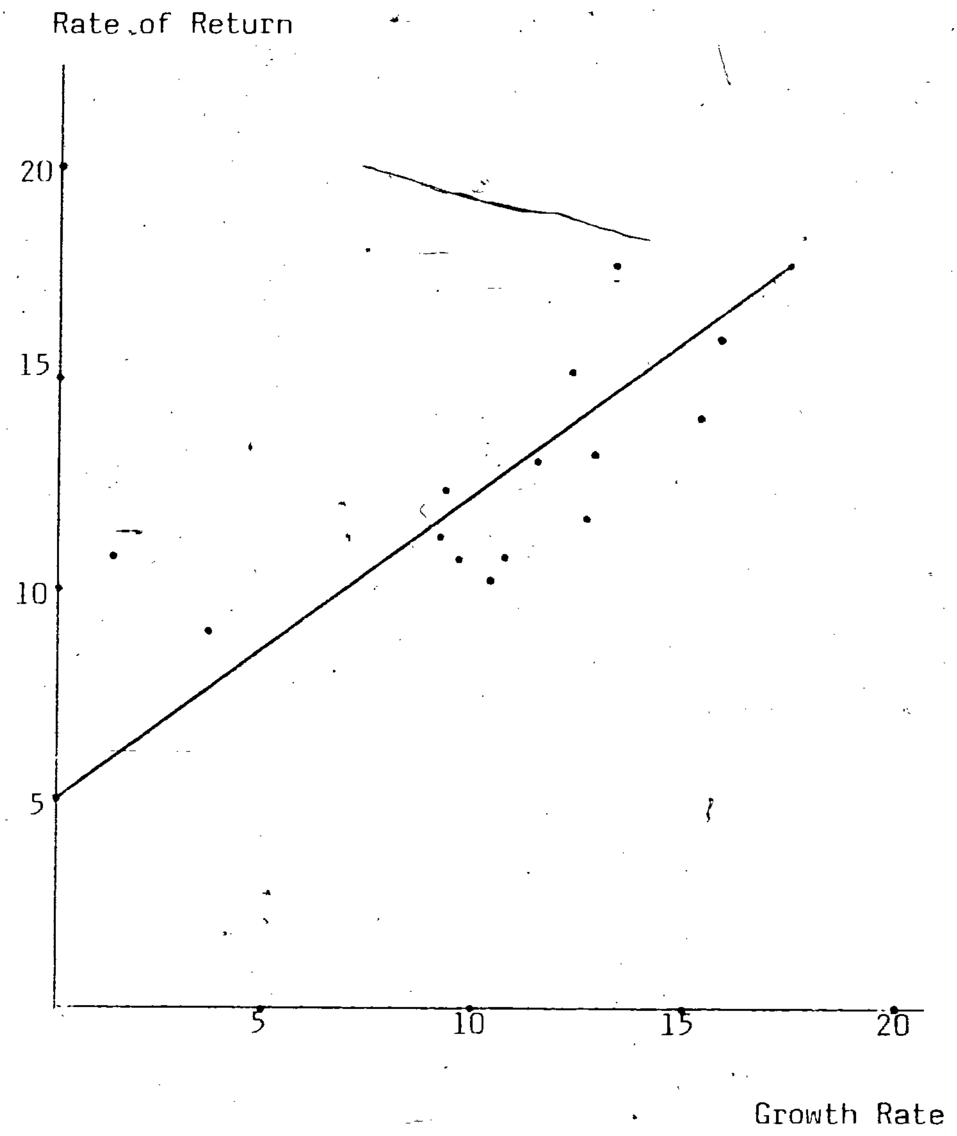

FIGURE (II.2)

Rate of Return and Growth of U.S. DFI in Service Industries

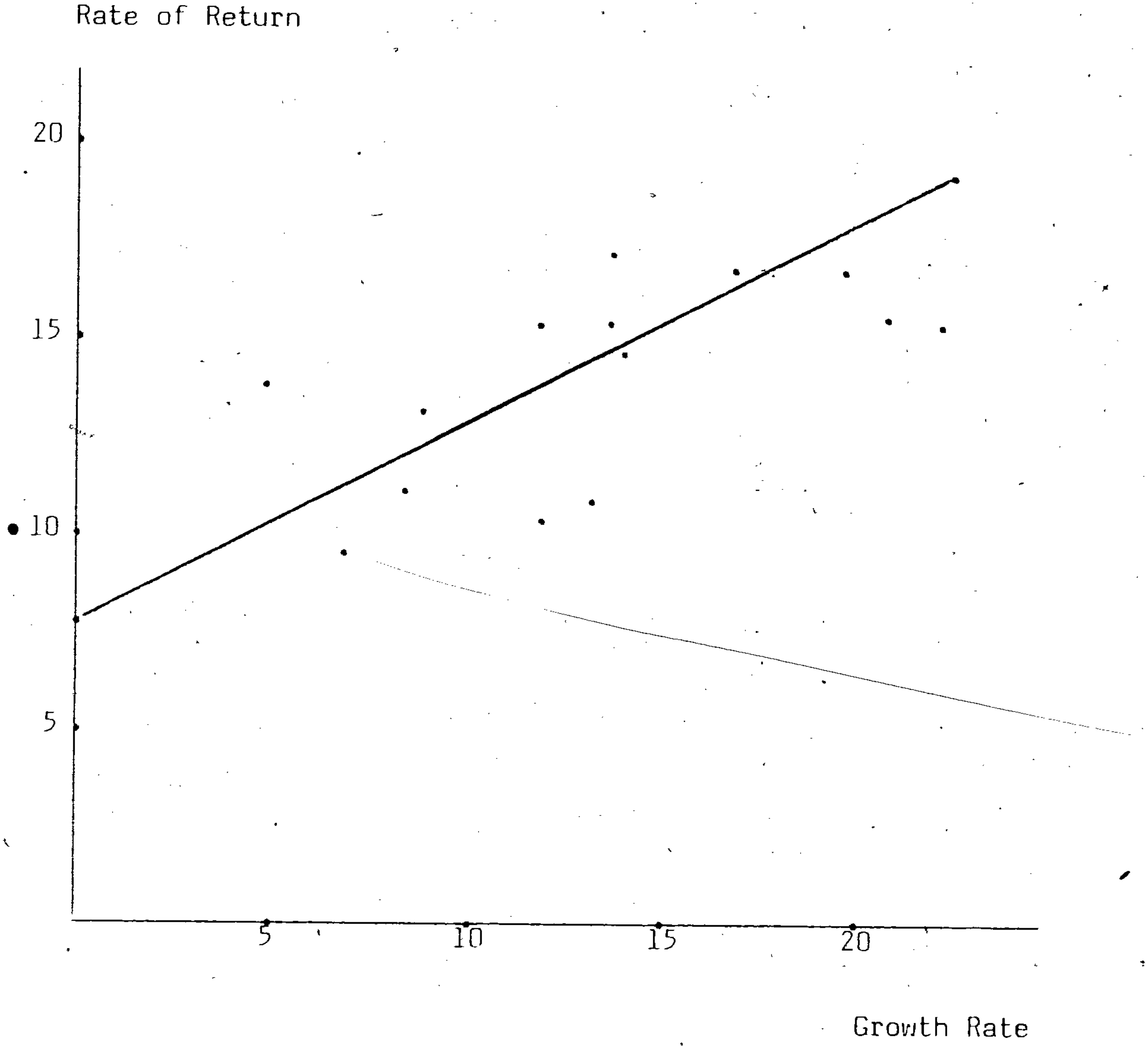

TABLE (II.2)

Regression Results: U.S. Direct Foreign Investment by Industry

	Manufacturing	Services	All Industries
a	-6.8877	-15.0892	-1.7804
b	1.3803	1.9554	.7820
s_a	3.4303	8.8008	4.2359
s_b	.2772	.6317	.2843
s_e	3.0443	6.2886	3.5095
t_b	4.9798*	3.0956*	2.7503*
F	24.7984	9.5825	7.5641
r	.8100	.6514	.6065

Note: * denotes statistical significance at 1% level of Type I error.

II-2. Empirical Results from International Comparison of Earnings and Growth Rates of U.S. Direct Foreign Investment Abroad, 1968-1982

The next question we ask is whether, as in the time-series analysis of the preceding section, a positive functional relationship between the rate of return and the growth rate can also be established from inter-country comparisons of the two variables during the time-period from 1968 to 1982. For this purpose, we selected 28 foreign countries, consisted of 16 developed countries and 12 developing countries, in which U.S. direct foreign investment took place. For each country, the relevant data were collected for the past 15 years, and in each year during the entire period, annual rate of return and annual growth rates of U.S. direct foreign investment were calculated for manufacturing industries and for service industries. From the annual rates, we then obtained average rate of return and average growth rate from each country by discarding two values from each average rate, either because they were too extreme, or simply because they were not available. In cases when more than two observations of a variable were missing due to suppressed data of individual companies to avoid disclosure, we used simple moving average method to estimate the missing data, which were eventually included in the data set employed for obtaining the average rate of a variable. The definitions of the variables and the industry classification are defined as previously, except that for the present analysis, we must use the average rates from individual countries so that inter-country comparisons of the two variables, i.e., comparing the average rate of return and the growth rate of the U.S. direct foreign investment in various countries, are meaningful.

In our present inquiry into the hypothesis that direct foreign investment exhibits a positive functional relationship to rate of return inter-spatially, i.e., across countries, as well as inter-temporally, i.e., over time, average growth rates of the U.S. direct foreign investments taking place in individual foreign countries are to be compared with average rates of return earned from the investment. In other words, we propose to test whether or not direct foreign investment is supplied at a faster rate of growth to countries where higher returns are available.

The relevant data on the average growth rates and rates of return are presented in Table (II.3). These average rates are plotted in the scatter diagram, shown in Figure (II.3), on a natural scale for manufacturing industries. This scatter diagram also shows a definite indication of a positive relationship between the two variables. A simple linear regression equation, as a first approximation, was estimated to fit the data, reflecting our present hypothesis that there exists a linear relationship between the two variables inter-spatially for U.S. direct foreign investments abroad. Denoting the symbol g_{mj} for average growth rate and μ^*_{mj} for average rate of return on U.S. direct foreign investment in manufacturing industries of jth foreign country, the following regression equation of a simple linear form was estimated:

$$g_{mj} = \underset{(2,0312)}{-2.6791} + \underset{(.1477)}{1.0528}\, \mu^*_{mj} + \underset{(3.3251)}{e_{mj}} \qquad \text{(II.3)}$$

The marginal propensity to invest with respect to changes in the average rate of return is positive and greater than unity. Thus, a one percent increase in average rate of return available from a foreign country would lead, on the average, to attracting slightly more a one percent increase in the average growth rate of U.S. direct foreign investment supplied to that country's manufacturing sector. Unlike the inter-temporal marginal propensity to invest, obtained from the preceding analysis of time-series, however, the inter-spatial marginal propensity to invest reflects not only the changes in growth rate of overall foreign investments originating from the U.S., but also those changes in the growth rate of the U.S. foreign investment resulting from internationally mobile capital. The latter had already been invested abroad, moving from a foreign country to another in search of a higher return. Because of this, it is entirely possible that the level of direct foreign investment provided to a paticular foreign country accelerates without a net increase of the investment at all forthcoming directly from the U.S. However, disentangling the compound effects buried in the regression coefficient representing overall marginal propensity to invest, distinguished in terms of net investment originating from the U.S. and transferred investment moving from one foreign country to another, is not possible due to unavailability of the necessary data for tracking inter-country movements of capital assets between foreign subsidiaries of U.S. firms.

Extending the above analysis in a similar manner to investigate service industries, a simple linear regression was run in which g_{sj} and μ^*_{sj} denote, respectively, average growth rate and average rate of return available on U.S. direct foreign investment in jth country's service industries:

$$g_{sj} = \underset{(1.3361)}{-1.8147} + \underset{(.0960)}{1.0368}\,\mu^*_{sj} + \underset{(2.4906)}{e_{sj}} \qquad \text{(II.4)}$$

As before, the marginal propensity to invest is also positive and greater than unity, indicating that a one percent increase of average rate of return in a foreign country results in inducing more than a one percent increase of the growth rate of U.S. direct foreign investment supplied to that country's service industries.

The regression results from international comparisons of average rates of return and average growth rates of U.S. foreign investments are statistically significant at more than a 95% level of confidence. The correlation coefficients between the two variables in the present analysis are .8133 for manufacturing, and .9044 for service industries, respectively. In other words, more than a half of the total variance in the growth rates of the investment in either industry classification (specifically, 66% for the manufacturing industries and 82% for the service industries) can be explained by the changes in the corresponding rate of return alone. Other statistical results are summarised in Table (II.4). Judging from the consistency and quality of the statistical results with which the rate of return variable performs as an explanatory variable in the above regression equations, we can conclude that the variable works remarkably well in explaining observed changes in the dependent variable representing growth rates of U.S. direct foreign investments[3]. In later chapters, however, we will incorporate into our analysis more recently identified determinants of direct foreign investment, namely, the stability of earnings and risk associated with operating abroad for uncertain profits in a stochastic world. We will return to this topic in later chapters for detailed analyses, but first we will turn to provide an analysis of demand for direct foreign investment from abroad and proceed to derive some comparative static properties arising from the discussion of its equilibrium conditions.

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[3] See also Riedel (1975).

TABLE (II.3)

International Comparison: Growth and Return on U.S. DFI, 1968-1982

Countries	Manufacturing		Services		All Industries	
	Growth	Return	Growth	Return	Growth	Return
Argentina	5.9	10.3	10.3	12.4	7.4	12.2
Australia	6.7	10.5	14.8	13.3	9.5	13.2
Belgium	13.4	12.2	14.5	13.9	14.5	10.7
Brazil	13.7	11.5	14.2	11.6	13.9	11.4
Canada	6.2	9.9	9.1	9.7	6.4	11.1
Chile	4.2	5.3	3.0	3.4	4.8	7.5
Columbia	7.3	13.2	5.3	6.0	7.0	8.6
Denmark	12.9	11.7	14.8	14.4	13.0	7.3
France	10.2	10.9	11.4	12.5	11.2	9.7
Germany	11.2	18.6	14.2	13.3	10.8	14.0
India	6.9	10.8	0.4	7.6	3.6	9.3
Indonesia	18.8	17.2	23.7	28.1	35.5	65.5
Ireland	29.8	26.6	19.8	18.5	28.0	22.0
Italy	12.4	16.0	13.6	13.2	10.2	9.7
Japan	15,3	18.3	19.4	17.9	15.1	14.8
Mexico	11.3	11.3	9.7	10.8	11.0	12.0
Netherlands	14.4	14.7	14.3	14.4	14.2	17.8
New Zealand	8.2	11.2	9.6	11.4	8.8	9.0
Norway	10.0	11.2	15.5	16.5	22.9	15.0
Panama	20.3	20.1	12.9	13.3	12.4	14.4
Peru	0.6	8.9	- 1.5	3.8	7.9	11.9
Philippines	6.5	11.3	6.6	10.1	5.2	10.0
South Africa	9.3	13.4	14.6	20.1	9.4	14.6
Spain	13.8	8.1	14.5	13.8	12.5	7.4
Sweden	10.5	11.1	5.2	9.8	8.1	6.7
Switzerland	11.7	17.6	14.4	17.2	13.3	18.5
U.K.	8.7	10.3	15.0	16.1	11.5	10.9
Venezuela	10.2	13.9	8.2	11.8	- 1.1	16.9

Note: Belgium includes Luxembourg. For Indonesia and Ireland, the reported average figures are based on the past ten years only.

Source: <u>Survey of Current Business</u>, August 1967 through August 1983.

FIGURE (II.3)

International Comparison of Growth and Rate of Return of U.S. DFI in Manufacturing Industries, 1968-1982

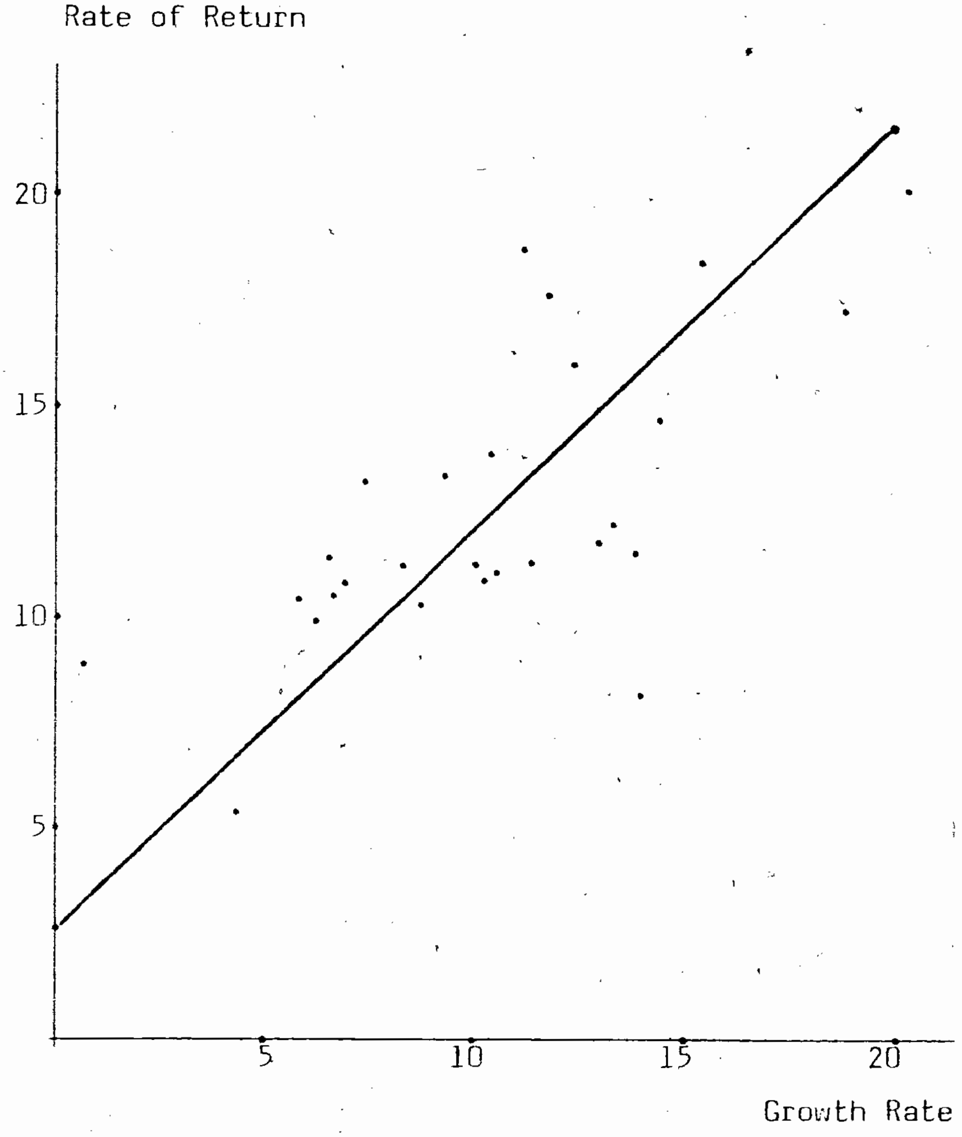

FIGURE (II.4)

International Comparison of Growth and Rate of Return of U.S. DFI in Service Industries, 1968-1982

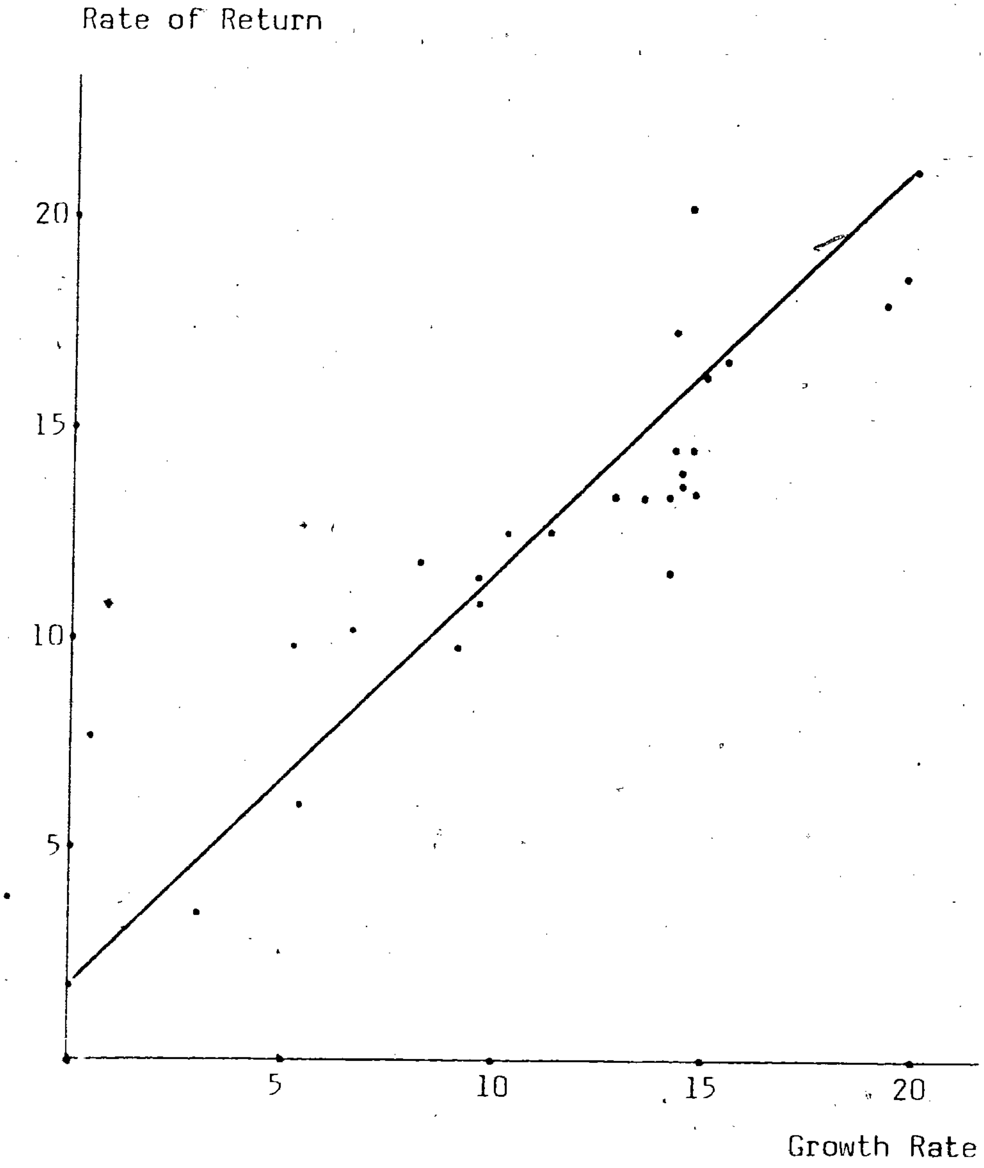

TABLE (II.4)

Regression Results: U.S. Direct Foreign Investment by Country

	Manufacturing	Services	All Industries
a	-2.6791	-1.8147	4.7810
b	1.0528	1.0368	.4926
s_a	2.0312	1.3361	1.5976
s_b	.1477	.0960	.0911
s_e	3.3251	2.4906	5.0899
t_b	7.1263*	10.8050*	5.4077*
F	50.7847	116.7484	29.2431
r	.8133	.9044	.7276

Note: * denotes statistical significance at 1% level of Type I error.

CHAPTER III. DEMAND FOR DIRECT FOREIGN INVESTMENT

III-1. A Model Specification of Demand for DFI

Using the same methodology with which we derived the supply of direct foreign investment in the first chapter, we can also obtain a demand schedule for direct foreign investment with the use of analogous reasoning. For deriving the supply schedule of direct foreign investment, the decision facing an international firm involved whether to invest the initial K dollars in the U.S. or South Korea. For deriving the demand schedule, on the other hand, it is assumed that government authorities of South Korea must decide whether to attract such direct foreign investment from abroad or to encourage indigenous firms to borrow necessary fund directly from international lending institutions in order to finance the local investment project. In other words, the South Korean authorities are assumed to borrow the K dollars necessary for the investment from international capital markets or induce direct foreign investment from abroad, depending on the calculated values of the following type:

$$(\$K/S)\cdot(MP_B - r) \lesseqgtr (\$K/S)\cdot(MP_{K*} - n*), \qquad \text{(III.1)}$$

where

MP_B = the marginal product of capital financed through international borrowing.

MP_{K*} = the marginal product of capital induced by the direct foreign investment.

r = the market rate of interest in the international capital market.

n^* = the cost of capital associated with the direct foreign investment.

South Korean authorities will decide to induce direct foreign investment in preference to the international borrowing if the net benefit from the increased capital formation via direct foreign investment is greater, at the margin, than the net benefit that can be extracted through its own investment of capital financed by international borrowing. Following this line of arguments, Cohen (1973) carried out a study that dealt with costs of foreign investment and its benefits on the South Korean economy. In it, he has argued that there was very little net gain from direct foreign investment in South Korea, and that South Korea would have been better off with loans borrowed from international capital market to finance its economic expansion. This was the case, according the Cohen's study, because while foreign firms investing in South Korea tended to be somewhat export-oriented, in comparison to their local counterparts, they used more imported materials and had a lower value added as a percentage of sales. Additionally, Cohen claims to have found no examples of foreign firms reinvesting their profits in other local industries. For these reasons, Cohen surmises that the net benefits to South Korea would have been less with direct foreign investment financing the investment rather than through the international loans borrowed by South Korea[1].

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[1] See Cohen (1973), p.196.

Furthermore, he concludes by citing arguments speculating that the principal reasons for encouraging direct foreign investment by the Korean government may have been political rather than economic[2].

These, of course, are hypotheses which have not been subjected to theoretical analyses, nor have they been substantiated empirically. Nevertheless, these arguments do open up a line of reasoning that will be helpful in understanding the demand pattern for direct foreign investment vis-a-vis foreign loans. Cohen's contentions are based on the implicit assumption that there are no external benefits engendered by DFI-related activities and/or that marketing the expanded output if indigenous firms does not involve extra expenses to South Korea. Falsity of these assumptions hardly warrants further discussions here, in light of the wide spectrum of various other convincing arguments that have been amassed in the literature dealing with direct foreign investments in developing countries, especially[3]. It suffices to note that to accept the line of argument predicated upon the assumptions implicit in Cohen's argument is to miss the very essence of the reasons why so many developing countries actively search for direct foreign investment. As Johnson (1970) put it, "the essence of direct foreign investment is a mechanism of the transmission to the 'host' country a 'package' of capital, managerial skill, and technical knowledge." Total benefits accruing to a host country can hardly be judged adequately, either in terms of market-orientation of the foreign investment or its initial contribution to the host country's capital

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[2] See Cohen, op. cit., p.196.

[3] See Balassa (1971) and Helleiner (1973).

formation. Consequently, the final benefits induced from foreign investment cannot be assumed, a priori, to be the same as those obtained from the equivalent amount of foreign loans.

One may nevertheless argue that since the marginal benefit of foreign loans relative to its marginal cost to a host country should be equal to the marginal benefit of direct foreign investment relative to its marginal cost, in order to achieve Paretian effiency, net benefits accrued on the two alternatives must be compared to each other at the margin. Thus, if net marginal benefits from direct foreign investment is larger in comparison to that available from foreign loans, then it could be argued that this provided sufficient evidence for existence of less than a socially optimal amount of direct foreign investment. This certainly opens up a legitimate line of argument.

For this purpose, we introduce the aggregate production function of the host country defined as follows:

$$Y = f(K^*,L^*) + g[(K,L),\ f(K^*,L^*)], \qquad \text{(III.2)}$$

where

$Q^* = f(K^*,L^*)$, the output produced by the foreign firms.

$Q = g[(K,L),\ f(K^*,L^*)]$, the output produced by the indigenous firms.

$Y = Q^* + Q$, the gross national product in real terms.

Analytically, the above equation states that the aggregate production function is additively separable, but the foreign input vector (K^*, L^*) affects both Q^* and Q. Thus, output produced by foreign firms depends on the input vector (K^*,L^*) only: $Q^* = f(K^*,L^*)$, while the output produced by indigenous firms is sensitive also to the level of the foreign firms' output in addition to its own input ~~vector~~: $Q = g[(K,L),\ Q^*(K^*,L^*)]$.

By solving the usual optimization problem in equation (III.2), we can obtain the Paretian optimality condition to achieve production efficiency:

$$(df/dK^*) = n^* \quad \text{if } (dg/dQ^*) = 0. \tag{III.3}$$

$$(df/dK^*) + (dg/dQ^*)\ (df/dK^*) = n^* \quad \text{if } (dg/dQ^*) \neq 0. \tag{III.4}$$

In other words, as additional units of foreign capital are employed, the resulting increment in aggregate output is given by the marginal product of the foreign capital (dY/dK^*), which corresponds to either equation (III.3) or (III.4), depending on whether or not $(dg/dQ^*) = 0$. But the marginal cost of foreign capital K^* to the host country is n^*. Therefore, if an additional K^* results in $\Delta Y > n^*$, then additional direct foreign investment is encouraged, and if $\Delta Y < n^*$, on the other hand, the host country will reduce inflow of direct foreign investment. The host country will continue to encourage foreign investment until $\Delta Y = n^*$ at the margin, as stated in the above equations.

This interpretation gives us the above equations as the equilibrium conditions for K*.

Equation (III.3) is consistent with the familiar optimum condition from the usual profit maximization: employ K* until the value of private marginal product equals n*. For the host country's indigenous firms, however, their profit maximizing decisions, made independent of the cross effect of their foreign counterpart's output level Q*, will not be efficient unless the foreign output-induced effect on their own production is zero, that is, unless (dg/dQ*) = 0. Specifically, in the presence of a positive external effect on indigenous output, market-determined K* will be less than socially optimal from the host country's point of view. This results in the social marginal product of foreign capital being higher than its private marginal product at the market-indicated cost of capital. In order to achieve the socially optimum amount of K*, therefore, the host country must provide sufficient incentives to encourage additional inflows of investment from abroad until its induced external effect is exhausted, i.e., (dg/dQ*) = 0, or until marginal foreign product of capital, i.e., df/dK*, is reduced sufficiently in the case of a positive external effect, i.e., dg/dQ* > 0, so that equation (III.4) holds as an equilibrium condition.

Another useful way to see this argument is to analyze explicitly the relations of private to social marginal costs of production[4].

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[4] See Bator (1958) for a rigorous examination of the neoclassical theory of external economies.

For Paretian optimality in production, we know that competitive market-mediation brings the private marginal transformation rate into equality with market-determined relative prices:

$$MRT_p = (dg/dK)/(df/dK^*) = (P^*/P), \qquad (III.5)$$

where

P^* = price of output produced by foreign firms.

P = price of output produced by indigenous firms.

The private marginal rate of transformation defines the private marginal cost of additional "foreign output" in terms of "indigenous output" foregone. Therefore, markets will be efficient if and only if this private marginal cost ratio reflects the true cost to society for transforming indigenous output, that is, output produced by indigenous firms, into an extra unit of output produced by foreign subsidiaries so that $MRT_p = MRT_s$, where the subscripts p and s denote private vs. social, respectively.

The social marginal rate of transformation MRT_s can be obtained from totally differentiating the two production functions and dividing one total differential into the other, we obtain the following:

$$MRT_s = \left|dQ/dQ^*\right|_s = (dg/dK)/(df/dK^*) - (dg/dQ^*). \qquad (III.6)^5$$

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[5] This expression assumes that marginal products of local labors are sufficiently low as to be negligible, for an easy comparison with the private cost of an additional foreign output. See footnote (6) for a full expression for the true cost of foreign output to society.

Thus, when direct foreign investment-produced output induces a positive external effect on indigenous firms of the host country, i.e., $(dg/dQ^*) > 0$, the true cost to society[6] of an additional output produced by foreign subsidiaries, in terms of indigenous output foregone, is smaller than the market-indicated private cost. It is smaller, in this case, by the amount of the positive feedback-effect on indigenous firms. Under these conditions, the market-determined level of direct foreign investment is clearly less than a socially optimal level. Therefore, further inflow of the foreign investment must be encouraged for achieving the socially optimal level. But it should be noticed that this is the same line of argument we had provided in conjunction with equation (III.4). In either case, however, we reach the same conclusion that there exist incentives for host countries to actively attract direct foreign investments on purely economic grounds as long as there persist positive levels of external benefits presumed in the above analyses[7].

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[6] $dQ = g_K dK + g_f f_{K^*} dK^* + g_L dL + g_f f_{L^*} dL^*.$

$dQ^* = f_{K^*} dK^* + f_{L^*} dL^*.$

Dividing the value of dQ by dQ* and noting that $dK = -dK^*$ and $dL = -dL^*$ along a given product transformation schedule, we obtain the full expression for the true cost to society of an additional foreign output:

$$\frac{dQ}{dQ^*} = \frac{(g_K - g_f f_{K^*})dK + (g_L - g_f f_L)dL}{f_{K^*}dK^* + f_{L^*}dL^*}.$$

By setting marginal products of labor equal to zero, we obtain (III.6):

$$\left|\frac{dQ}{dQ^*}\right|_s = \frac{dg/dK}{df/dK^*} - dg/dQ^*.$$

[7] Even in the case when the external benefit to a country is negative, the world's welfare gain resulting from the international production diversification may more than offset the negative external effect.

III-2. Threshold Rate of Return

In strict analogy to the derivation of the parity rate of return, discussed in conjunction with supply of direct foreign investment, we will now define the "threshold rate of return", denoted by n_o, to represent the expected rate of return, at which rate the host country is entirely indifferent as to whether an investment project is undertaken by foreign firms via direct foreign investment or by indigenous firms with funds borrowed from international capital markets. From a simple manipulation of the Expression (III.1), the threshold rate of return, in other words, is defined to be:

$$n_o = r + (MP_{K*} - MP_B) , \qquad \text{(III.7)}$$

where

$MP_{K*} = (dY/dK*)$

$MP_B = (dY/dK)$

The threshold rate is represented by the point where the DD' schedule intersects the vertical axis of the Figure (III.1).

The DD' schedule shown in the Figure (III.1) represents the equilibrium condition stated in equation (III.4). Thus, starting from the threshold rate n_o, if the cost of capital associated with direct foreign investment from abroad falls, employment of foreign capital, ceteris paribus, is raised so as to maintain the equilibrium condition of the equation (III.4).

It must be noted, however, that strictly speaking, demand for direct foreign investment cannot be represented by a simple marginal productivity schedule of foreign capital for the following two reasons: First, Δn^* will result in not only changes of the foreign capital K^* along its marginal productivity curve, but also shifts of marginal productivity curves of other factors of production. These shifts of other inputs in turn affect quantities used of the inputs, which feed back upon the original productivity schedule of the foreign capital, by shifting it as well. Second, the initial change in K^* affects marginal products of the inputs employed by indigenous producers as well, which also feed back on the original marginal productivity schedule of the foreign capital through the second term of the equation (III.4).

Thus, the right-hand-side of the DD' curve, i.e., below the threshold rate, is assumed to represent positive levels of direct foreign investment demanded per unit of time, in which incipient increments to the indigenous output $(dg/dQ^*)(df/dK^*)$ have already been accounted for. Conversely, it follows that in the left-hand-side of the DD' schedule, marginal products of capital financed through international loans borrowed by indigenous firms is higher in comparison to those of the capital invested through direct foreign investment by foreign subsidiaries. Consequently, local demand for foreign loans are encouraged while the direct foreign investment from abroad is discouraged. For these reasons, the left-hand-side of the DD' curve shown in Figure (III.1) is equivalent to negative excess demand for direct foreign investment, and simultaneously represents positive excess demand for international borrowing according to our model specified in the Expression (III.1).

The slope of the DD' schedule can be derived explicitly by totally differentiating equation (III.4) while holding constant all variables other than n* and K*:

$$\frac{dn^*}{dK^*} = \frac{d^2f}{dK^{*2}} + \frac{dg}{dQ^*}\,\frac{d^2f}{dK^{*2}} + \frac{d^2g}{dK^{*2}} < 0. \qquad \text{(III.8)}$$

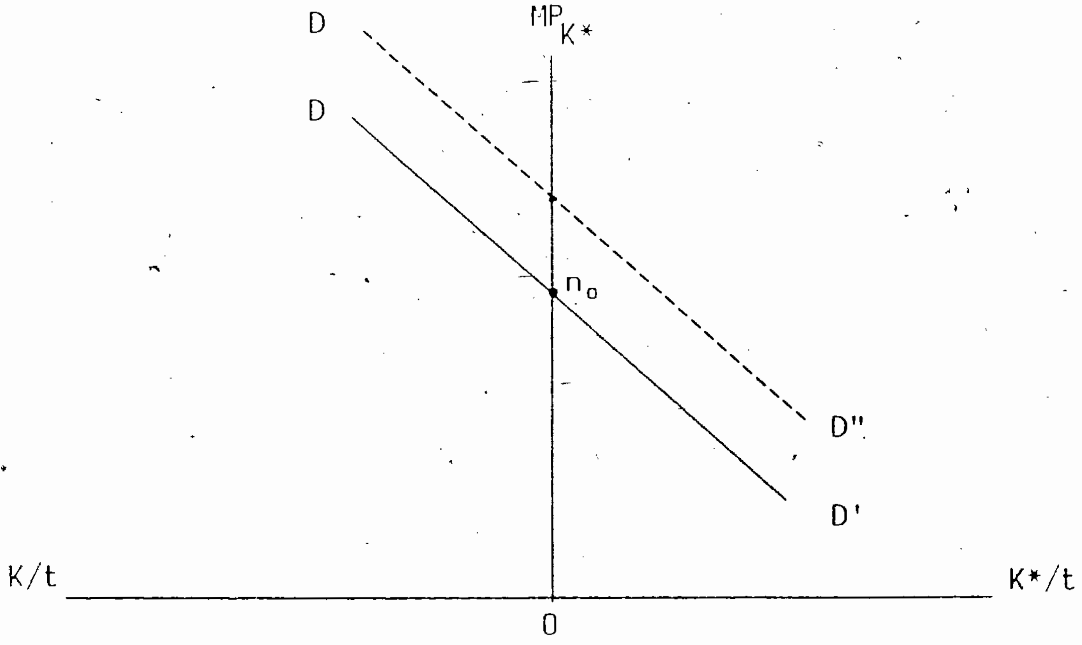
This expression indicates not a shift away from an initial position of the DD' schedule, but gives the changes in n* and K*, moving along the initial DD' curve. Since it is presumed that the term (dg/dQ*) is positive, and all second partials are negative for quasi-concave production functions, it is clear that the sign of the above equation must be negative. This shows that the DD' curve shown in Figure (III.1), which represents the demand for direct foreign investment, must be negatively sloped.

The DD' schedule shifts vertically upward or downward according to equation (III.7), thus increasing or decreasing the threshold rate n_0, respectively, in essentially same way as the parity rate μ_0 was affected according to equation (I.5) in the previous analysis.

Alternatively, we can interpret the DD' schedule as shifting horizontally to the right or left, following an exogenous change in equilibrium demand conditions underlying the DD' schedule for direct foreign investment. Thus, for example, if the feedback-effect on indigenous output increases exogenously for one reason or another, this will shift the DD' schedule upward, hence raising n^*, as well as n_o, at all given levels of K^*. This, of course, is equivalent to shifting the DD' curve horizontally to the right at all given levels of n^*. The effects on equilibrium values (μ^*_e, K^*_e), however, must account for changes occuring along the supply schedule SS' and the demand schedule DD' simultaneously. This is the topic we discuss in the next section.

FIGURE (III.1)

Demand Schedule for Direct Foreign Investment



III-3. Comparative Static Properties

Combining the SS' schedule from Figure (I.1) and the DD' schedule from Figure (III.1) in a single diagram shown in Figure (III.2), we can represent the equilibrium by the point (μ^*_e, K^*_e) where the aggregate supply of all foreign investment occuring in a host country is just equal to the aggregate demand for investment from abroad. A host country can be a supplier as well as a demander of direct foreign investment such that the intersection point of SS' and DD' schedules can take place on either side of the vertical axis of Figure (III.2). But the host country is assumed to be a net demander of direct foreign investment from abroad, in which case, the intersection point must lie on the right-hand-side of the Figure (III.2).

In order to analyze effects on equilibrium values of direct foreign investment and rates of return resulting from changes in the initial equilibrium conditions underlying demand and supply of direct foreign investment, we differentiate totally equations (I.7) and (III.4) simultaneously for which $d\mu^*_e = dn^*_e$, and the feedback-effect (dg/dQ^*) is an exogenously given constant Ω.

$$\begin{bmatrix} 1 & -G' \\ (1+\Omega)f'' & -1 \end{bmatrix} \begin{bmatrix} dK^* \\ d\mu^* \end{bmatrix} = \begin{bmatrix} G'dd + (G'SD/F^2)dF \\ -f'd\Omega \end{bmatrix} \qquad \text{(III.9)}$$

By solving the above simultanenous equation for (dK*, dμ*), we can obtain explicit expressions for the effects of, for example, accelerated economic depreciation prevailing in the home country as follows:

$$dK^* = -(G'/H)\ dd > 0 \qquad (III.10)$$

$$d\mu^* = -\ G'f''(1+\Omega)\ dd/H < 0 \qquad (III.11)$$

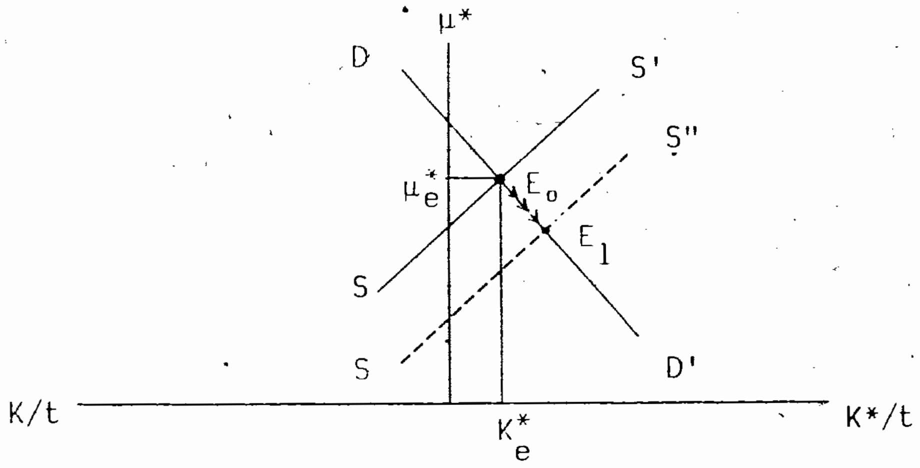
where

$H = [G'f''(1+\Omega) - 1] < 0$, which is the value of the determinant of coefficients from the equation (III.9).

In other words, the above expressions state that accelerated depreciation results in increasing the equilibrium inflow of direct foreign investment and simultaneously lowering the rate of return on foreign investment in the new equilibrium situation. This can be shown in a diagrammatic exposition, as the initial SS' schedule in Figure (III.2) shifts to a new position SS" along the given DD' schedule, following the exogenous increase of the depreciation rate.

FIGURE (III.2)

Effects of Accelerated Depreciation



Similarly, we can derive the effects on the equilibrium values of (K^*_e, μ^*_e), following an exogenous increase of initial feedback-effect brought on by direct foreign investment on the levels of indigenous output, by solving the equation (III.9) as follows:

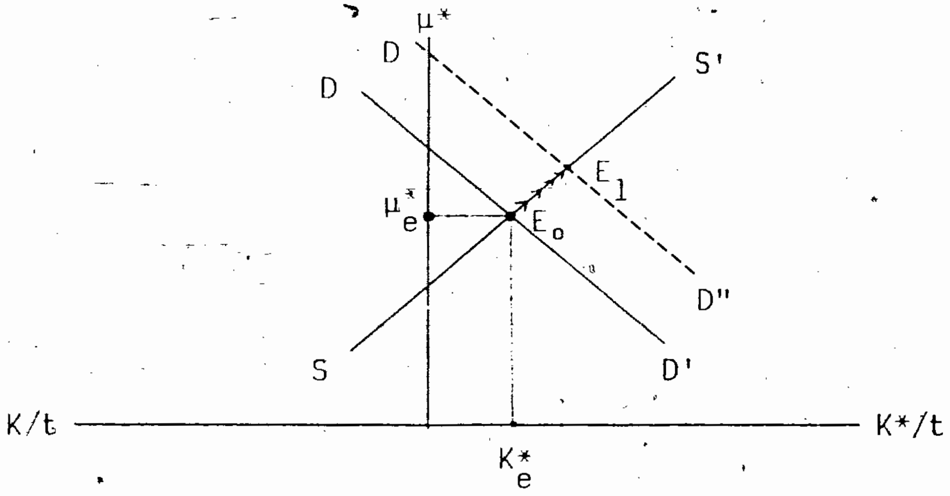
$$dK^* = -(f'G'/H)\, d\Omega > 0 \tag{III.12}$$

$$d\mu^* = -(f'/H)\, d\Omega > 0 \tag{III.13}$$

Thus, as a result of the exogenous increase in external benefits that can be induced from direct foreign investment-related activities, the equilibrium inflow of direct foreign investment as well as the rate of return realized on the investment will be both higher than their initial values. These are depicted in Figure (III.3), as the initial DD' schedule is shifted along the given SS' schedule to a new position DD" with its new equilibrium denoted by E_1. Next, we will turn to investigate empirically the nature of return characteristics, distinguished in terms of domestic rate of return vis-a-vis foreign rate of return. This is the topic we discuss in the next chapter.

FIGURE (III.3)

Effects of Increased Feedback on Indigenous Output



CHAPTER IV EMPIRICAL ANALYSIS OF DFI IN MEAN-VARIANCE MODEL

IV-1. Hypotheses-Testing of Direct Foreign Investment Vs. Domestic Investment

In order to investigate empirically the nature of differences in return-risk characteristics of direct foreign investment in comparison to those of domestic investment, we have collected information on rate of return realized from U.S. direct foreign investment and U.S. domestic investment in manufacturing industries. The relevant data are presented in Table (IV.1). The reported data cover the time-period from 1968 to 1982, for which relatively reliable time-series are available for the comparative study on rates of return earned from direct investments and their variability. The rate of return is defined to be, as before, the earnings after income taxes divided by the mean of current and preceding year-end book values of invested assets in all manufacturing[1], including both durable and non-durable goods industries. The definition of the manufacturing sector we adopted for collecting the data reported in Table (IV.1) is based on the 1972 Standard Industrial Classification (SIC). The distinction between developed countries and developing countries is made following the criteria adopted by the U.S. Department of Commerce, Bureau of Economic Analysis.

The research methodology employed here is designed to facilitate a comparative study of returns and risk characteristics of U.S. direct foreign investment abroad and U.S. domestic investment.

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[1] Petroleum is combined with manufacturing industry classification.

First, in order to probe into the empirical results reported in Table (IV.1), based on the traditional mean-variance criterion, we have devised, specifically, the following two hypotheses:

H1: U.S. direct foreign investment abroad has been riskier, in terms of a higher variability of its foreign earnings, in comparison to its domestic investment.

H2: There have been positive levels of risk-premium required for the U.S. direct foreign investment abroad, as evidenced by higher rates of return on the foreign investment in comparison to those available from its domestic investment alone.

The above hypotheses were tested individually against their respective null hypotheses that there were no statistically significant differences between foreign and domestic investment. Therefore, acceptance of the above hypotheses and rejection of their null hypotheses would give statistical support to the argument that direct foreign investment tends to be, generally speaking, riskier than a comparable domestic investment. Consequently, it requires a positive level of risk-premium, in the form of a higher expected rate of return from committing a long-term investment abroad, as compensation for the international investor's aversion to the risk associated with taking on the foreign venture with more uncertain outcomes. The statistical results reported in Table (IV.2) indicate that the null hypothses can be rejected at less than a 5 % level of significance, favoring the above-stated alternative hypotheses. In other words, it is likely, at more than 95 % level of confidence, that direct foreign investment is significantly riskier than its domestic counterpart, and that the positive level of risk-premium is statistically significant, as evidenced by significantly higher returns realized from direct foreign investment in comparison to the domestic rate of return in manufacturing industries. As suggested by the hypotheses, foreign investment was shown to be far riskier relative to domestic investment, in terms of a significantly higher variance of foreign returns ($V^* = 14.91$ for foreign rates of return and $V = 4.25$ for domestic rates of return). As well, the mean of foreign rates of return was significantly higher at $\mu^* = 14.99$, in comparison to the mean domestic rate of return at $\mu = 12.07$. It is also worth noting that except for two years, 1968 and 1977, direct foreign investment performed consistently better than comparable U.S. domestic investment.

In one sense, these results are in agreement with those obtained by others regarding the evidence on higher variance and mean return earned by subsidiaries from direct foreign investment. Caves (1971), for example, has argued that "Finally, the greater risk of foreign investment rationalizes the survey evidence showing that a significant minority of firms insist on a higher expected rate of return before approving a foreign-investment project than they would on a comparable domestic investment, and that those who succeed earn more than their competitors in the host country." It could also be argued, however, that the higher rates of return earned by foreign subsidiaries reflect, to a degree, the common practice of transferring implicit rents from the use of trade marks, technical know-how and the like in the form of profits rather than service charges[2]. This argument is valid when it is employed to compare the rate of return earned by the foreign subsidiaries of the U.S. firms and the rate earned by their local counterparts. But it is entirely irrelevant for comparing the rate of return between those earned by the U.S. domestic firms and their foreign subsidiaries. From a direct comparison of the rates of return between the U.S. domestic investment and the U.S. foreign investment, the higher rate of return earned by the foreign subsidiaries must reflect the risk-premium, required by the U.S. firms with risk-aversion against operating in riskier foreign environment. This higher rate of return, reflecting the positive risk-premium, must in turn be interpreted to reflect that it has been actualized from lower production costs resulting from more efficient management technique, lower wage rates, and/or higher depreciation allowances available abroad, in comparison with those available at home.

In order to differentiate direct foreign investments, distinguished in terms of those invested in developed region and those invested in developing region, we have presented the data separately for the two regions in Table (IV.1). We then tested the above hypotheses against their respective null hypothesis of no difference in return and risk characteristics of U.S. domestic returns in comparison to those of each region.

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[2] For example, see Caves (1971), page 14, Footnote (3).

TABLE (IV.1)

Growth Rate and Earnings of U.S. Domestic Investment V.S.
U.S. Foreign Investment in Manufacturing Industires, 1968-1982

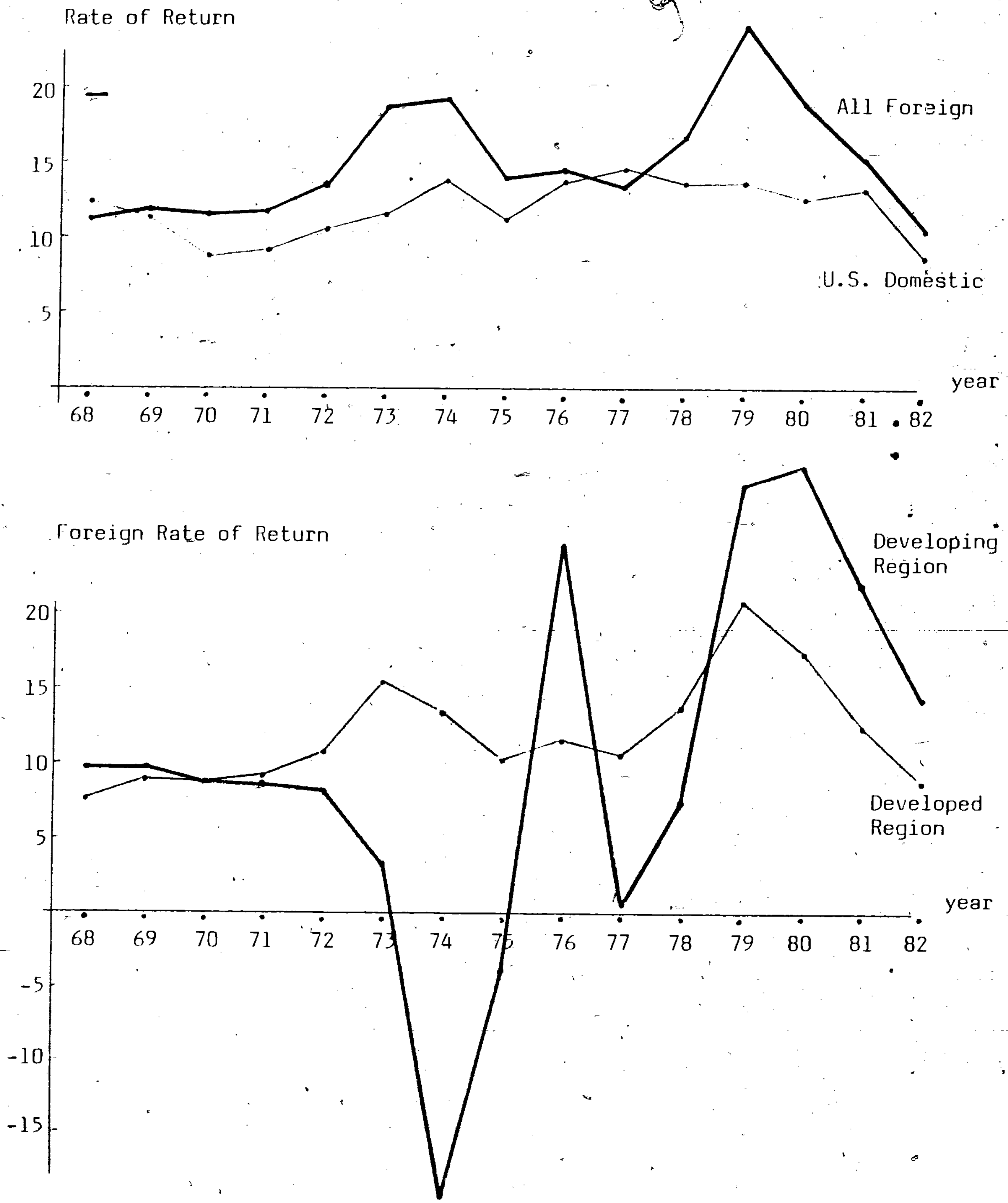
year	DOMESTIC		ALL FOREIGN[1]		DEVELOPED		DEVELOPING		U.S. TOTAL[2]	
	g	μ	g	μ*	g	μ*	g	μ*	g	μ**
1968	7.0	12.3	9.8	11.0	9.6	7.5	21.3	9.7	7.4	12.1
1969	8.9	11.4	10.0	11.7	10.0	8.9	20.1	9.7	9.0	11.5
1970	5.0	8.9	10.3	11.6	10.9	8.7	18.4	8.6	5.8	9.3
1971	3.4	9.2	10.6	11.9	11.0	9.0	20.3	8.6	4.6	9.7
1972	6.4	10.6	10.2	13.3	10.7	10.7	21.9	8.0	7.0	10.6
1973	8.5	11.6	11.2	18.8	13.5	15.1	32.8	3.1	8.9	12.8
1974	5.0	13.9	8.3	19.2	15.5	13.1	51.4	-19.0	5.6	14.9
1975	6.9	11.1	8.8	14.0	11.6	10.0	40.7	-4.0	7.2	11.6
1976	8.8	13.9	11.2	14.4	9.9	11.4	31.2	24.2	9.3	13.9
1977	7.9	14.4	4.8	13.3	6.3	10.2	32.4	0.3	7.4	14.2
1978	9.5	14.6	5.7	16.8	6.1	13.6	36.0	7.1	8.8	15.0
1979	10.3	14.7	14.8	24.1	13.0	20.4	44.4	28.2	11.1	16.4
1980	10.0	12.7	16.7	19.0	13.9	17.0	28.2	29.6	11.3	13.9
1981	11.5	13.3	10.4	15.2	7.1	12.1	26.6	21.6	11.3	13.6
1982	3.7	8.9	4.1	10.6	0.1	8.7	16.5	14.0	3.6	9.2

Source: <u>Economic Report of the President</u>, February 1984, p.318.
<u>Survey of Current Business</u>, August 1983, p.22, August 1980, p.24.

Note: (1). ALL FOREIGN = DEVELOPED + DEVELOPING.
(2). U.S. TOTAL = DOMESTIC + ALL FOREIGN.

FIGURE (IV.1)

Investment Performances by Major Areas



The statistical results from comparing the mean-variance characteristics of the developing region and the U.S. indicate that as expected, their respective null hypothesis must be rejected at less than 1% level of significance. The mean foreign rate of return from the developing region is 29.48%, as compared to the U.S. domestic rate of return of only 12.07%, while the variance of the foreign returns is 106.56% as compared to the variance of domestic returns of only 4.25%. These results give clear indications that direct foreign investment in developing countries is far more profitable and at the same time, far riskier than comparable U.S. domestic investments (as far as the investments in manufacturing industries are concerned.)

In order to examine whether or not earnings from direct foreign investment in developed countries also have been higher and more unstable compared to those of U.S. domestic investment, we repeated the above hypothesis-testing. The statistical result from testing H1 indicates that its null hypothesis regarding the equality of stabilities of the earnings must also be rejected at less than 5% level of significance, in favor of the alternative hypothesis H1. In other words, these statistical results confirm the traditional argument that direct foreign investment generally tends to be riskier, in terms of higher variability of the foreign earnings as compared to domestic earnings, irrespective of whether the foreign investment takes place in developed or in developing regions of the world.

TABLE (IV.2)

STATISTICAL SUMMARY: U.S. DOMESTIC INVESTMENT AND U.S. DIRECT FOREIGN INVESTMENT IN MANUFACTURING INDUSTRIES, 1968-1982

Area	Average Growth	t-value	Average Return	t-value	Variance	F-value
U.S. Domestic	7.52	-----	12.07	-----	4.25	-----
All Foreign	9.79	2.1234*	14.99	2.5836*	14.91	3.5082*
Developed	9.95	2.0626*	11.76	-.2915	12.72	2.9929*
Developing	9.98	.7358	29.48	6.4055*	106.56	25.0729*
U.S. Total	7.88	-----	12.58	-----	4.98	-----

Note: Asterisk denotes statistical significance at 5% level of Type I error.

In the case of direct foreign investment in developed countries, however, we could not find any statistical evidence that the higher level of instability of returns was accompanied by a correspondingly higher mean value of returns earned by U.S. foreign subsidiaries. The null hypothesis regarding equality of the rates of return from the developed region and the U.S. could not be rejected. In fact, as Table (IV.1) shows, foreign return earned from investments in developed countries was lower than the domestic rate of return, contrary to earlier claims made by others. Thus, the statistical evidence provided here appears to suggest that international firms making direct foreign investments in developed countries may have been motivated to invest abroad, not by the consideration achieving the maximum rate of return, by consideration of more recently identified factors, such as market-share argument for differentiated products, intra-industry investment for monopolistic competition, or international diversification of risks via direct foreign production[3].

It is clear from the above analyses that the reason the overall foreign return is higher than the U.S. domestic return is solely due to inordinately high profitability of investing in developing countries (29.48%), in spite of the fact that the rate of return on investments in the developed countries (11.76%) was lower than U.S. domestic rate of return (12.07%). As a result, it should not come as a surprise that the overall U.S. return earned from

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[3] See also Grubel and Rugman.

investment, including both domestic and foreign investment, has also turned out to be higher than the U.S. domestic rate-of-return. Likewise, neither should we be surprised to observe that U.S. foreign investment has turned out to be riskier, ex post facto, than U.S. domestic investment, in terms of the higher variance calculated. What arrests our attention in the reported results of Table (IV.2), however, is that it would be inappropriate to view direct foreign investment occuring in the developed region of the world as being driven by the pursuit of maximum return without regard to risk factors associated with such foreign investment. On the other hand, the reported results indicate that as far as direct foreign investment taking place in the developing region of the world is concerned, they may have been motivated, for the most part, by return-maximization as the principal objective. Consequently, our next objective is to expand the present model of return-maximization in order to have the risk of foreign investment explicitly structured into a return-risk framework. This is one of the tasks we take up in the second part of this thesis. Before proceeding with that task, however, we will pause briefly to reexamine the statistical meaning of the quantitative risk or instability surrogate measures employed in traditional return-risk trade-off analyses.

IV-2. Reexamination of Meaning of Stability and Risk

Webster's dictionary defines risk as being "the possibility of loss or injury." Verbal definitions, however, are usually not explicit enough to allow measurement of the term thus defined, and therefore do not yield themselves to rankings and comparisons to facilitate rigorous empirical analyses. Clearly, a quantitative surrogate for risk is required in order to facilitate rigorous analyses. The purpose of this section is to reexamine critically its meaning.

Typically, the traditional models employed for analyzing risk have focused on probability distributions of the rates of return from investment and measure the second moment about the mean of the distribution of the random variable, i.e., variance, or some variant thereof, such as standard deviation, semideviation or semivaiance of the rate of return over its probability distribution. All of these measures indicate the extent of dispersion of the rate of return over the entire probability distribution, which are then used as a quantitative risk surrogate in investment analysis. This approach to quantifying risk, however, is inadequate for the following three reasons.

First, this approach presents us with a theoretical problem arising from adopting a variant of second moment as the quantitative risk surrogate - a source of white noise in empirical analysis. The reason for this problem is due to the statistical property that variance or any other variant of a second moment increases with the absolute magnitude of individual observations of a data set. Therefore, the variance calculated from a set of large values in general exceeds the variance obtained from a set of small values. For example, if a set of data, denoted (μ_1, μ_2, ----, μ_T), is scaled upwards by a constant factor of k to give ($k\mu_1$, $k\mu_2$,----, $k\mu_T$), then we would find that the variance calculated from the new data set is increased by a factor of k^2, i.e., $Var(k\mu) = k^2 Var(\mu)$. Since rates of return are larger for U.S. direct foreign investment than those of U.S. direct domestic investment, as can be seen in Table (IV.1) or Table (IV.2), we would know, a priori, that the variance calculated from returns of foreign investment abroad typically exceeds the variance of returns from direct domestic investment. Therefore, a part of the difference in the calculated variance, at least, can easily be explained.

Because of this statistical property, we cannot attribute all of the differences in observed variances to "true" stability or risk characteristics inherent to the factors that account for fundamental differences in an economic sense. In other words, the portion of their differences arising from statistical white noise mentioned above must be quieted down before comparing variances and analyzing their differences can make sense in an economic sense[1].

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[1] It is because of this reason that Arrow (1965) employed the notion of a pure uncertainty-increasing spread, represented by a multiplicative shift of a random variable's distribution about a non-negative center, for analyzing the demand for risky assets. See chapter 3.

Second, the traditional approach of representing variance as a quantitative surrogate for a stability or risk index gives nonsensical statistical results in empirical analyses. This is because, as explained above, a data set with larger values tends to have a larger mean value associated with it and at the same time, a larger variance than those calculated from the data sets with smaller values of observations. In other words, variance increases with mean value of returns so that they become positively correlated in the traditional mean-variance trade-off. Since we know from earlier chapters that direct foreign investment responds positively to changes in rate of return inter-temporally as well as inter-spatially, this result combined with the positive correlation between rate of return and variance in turn implies that investment would increase when there occur increments to instability and/or risk, represented by increases of variance of returns, regardless of whether ex ante or ex post data on returns are used. Consequently, if we compared the growth rate of direct foreign investment to the pattern of instability or risk, as measured by variance, then we would find that they are positively correlated, contrary to what we would expect intuitively from our understanding of the common notion of instability or risk and their effects on direct foreign investment. For example, the correlation coefficient between mean rates of return from direct foreign investment in various countries and their variances is a positive value (r=.9354). But the correlation coefficient between mean growth rates of direct foreign investment and variance of returns from individual countries is also a positive value (r=.6666). The two facts together would imply incorrectly that direct foreign investment responds positively to increases of instability or risk, rather than to their decreases as we might expect. No doubt, this result is nonsensical, but it nonetheless should not surprise us since we knew, *a priori*, that foreign investment and the variance of returns are bound to become positively correlated on purely theoretical grounds to the extent that mean returns and their variances tend to move together in the same direction as argued in the preceding paragraph. Obviously, this is a serious problem that requires a close reexamination before the calculated variance figures can be employed as a quantitative risk surrogate in empirical analyses. We will return to this discussion in the next section.

Third, at a more practical level, the problem has to do with interpreting the quantitative surrogate, when it is represented by calculated variances of returns, to measure the extent of instability or risk associated with direct foreign investment. This problem arises because the traditional method of denoting variance or any of its variant to indicate the degree of instability or risk attaches a same value and a same ranking to a sample distribution of random returns from a particular investment, which is determined irrespective of the sample distribution's relative position in comparison to the true population distribution of all returns from all direct foreign investment abroad. Thus, so long as two sample distributions of returns from two different foreign countries have equal variances, they are considered to be equally risky. This will be the case when we use the simple variance measures, even though a sample data set of returns from a particular foreign country might be distributed strictly in the lower half of the entire distribution of all returns, while the sample data set of returns from another foreign country might lie entirely in the upper half of the population distribution of all returns, so that the two mean values obtained from the two separate samples differ significantly. For example, the variance calculated from returns earned by U.S. investment in Canada is approximately equal to that of returns realized from U.S. investment in Ireland (V=3.22 from Canada and V=3.36 from Ireland). However, the rate of return earned from U.S. operations in Canada has been lower than the rate of return earned from U.S. operations in Ireland in every year for which data are available. Moreover, the highest rate of return earned by U.S. firms' Canadian operations in their best year (μ^* = 13.8 in 1979) is in fact smaller than the lowest rate of return earned by Irish operations of U.S. subsidiaries in their worst year (μ^* = 19.0 in 1980). As a matter of fact, Ireland has been one of the most profitable and at the same time, one of the least risky places in the world as far as the variance of earnings realized on the U.S. DFI is concerned. For this reason, it would be absurd, if not erroneous, to assert on the basis of the traditional variance criterion alone that direct foreign investment in Canada and Ireland are equally risky, just because their respective variances calculated happen to be the same. Yet, when we use the traditional approach of quantifying risk strictly in terms of the calculated variances, this is what we are led to believe.

In recognition of the inadaquacy associated with using variances as the quantitative surrogate for risk, therefore, Markowitz reformulated it using only disappointing outcomes in the left tail of a probability distribution of returns in order to form a quantitative risk surrogate which he called the semivariance. Since the semivariance is calculated only with disappointingly low returns, while ignoring high returns, it could be interpreted as a measure of risk, reflecting unexpected financial losses for a firm undertaking risky foreign ventures in an uncertain environment. However, a moment's reflection will reveal that the semivariance criterion for quantifying and comparing risks still suffers from the afore-mentioned three problems we encountered in conjunction with using the second moment as a risk surrogate. Moreover, the semivariance is an inefficient statistic for measuring risk, to the extent that it now wastes information available from the right tail of the probability distribution of random returns, This discussion concerning the semivariance as a possible measure of risk will not be carried further since it is clear that the second moment or any of its variant, including the semivariance, should be left alone to measure only the extent of dispersion or variability of a random variable about the mean over its entire probability distribution, which it was originally intended to measure. Nevertheless, the line of argument enunciated in this section behoves us to adopt some other measure that is better suited to capture the notion of risk.

In order to formulate the concept of a quantitative risk surrogate in the context of direct foreign investment, however, we need a specific model under uncertainty, formulated in terms of portfolios of production facilities; for much of the attraction of foreign investment comes from the fact that its earnings are less than perfectly correlated with domestic earnings. This in turn requires that stochastic exchange rate fluctuations be explicitly incorporated into such a stochastic model, for it will be demonstrated empirically as well as theoretically in the following chapters that exchange rate fluctuations play the key role in foreign return performance, and that foreign earning variations are explained, for the most part, by exchange rate variations. However, these tasks will take us far beyond the scope of our discussions intended for this chapter, and therefore will be taken up in later chapters for thorough treatment. In the meantime, there exists a legitimate sense in which variance of earnings can be represented as a quantitative surrogate for stability. Aside from the exchange rate effect on calculated variances of foreign earnings, we must still contend with the problem arising from statistical white noise we pointed out in our first criticism before we can safely employ the variance measures as our instability surrogate. This is the topic we proceed to follow up in the next section.

IV-3. Quantitative Stability Surrogate Redefined

Before we can use the simple variance measure as a quantitative surrogate to represent stability or instability of returns, the first two problems discussed in the preceding section still must be dealt with. This can be accomplished by calculating the so-called mean-preserving variance by centering all sample distributions at a common reference point in order to take out scale effects from various sample data sets, and hence from their calculated mean values and variances[1]. The mean-preserving variances, denoted by the symbol V', are calculated by first, dividing each observation of a given data set by a constant scale factor k, which is the mean value of the data set divided by a particular reference value selected for centering all sample distributions, and then by taking the variance of the scale-adjusted observations of the data set around the common reference point, which we denote by the symbol μ_o. In other words, we define the mean-preserving variance V' with respect to the common reference point μ_o to be as follows:

$$V' = \sum_{t=1}^{T} (\mu_t^*/k - \mu_o)^2 / (T - 1) \qquad \text{(IV.1)}$$

$$= \sum_{t=1}^{T} (\mu_t^*/k - \bar{\mu}^*/k)^2 / (T - 1)$$

$$= V/k^2,$$

where $k = \bar{\mu}^*/\mu_o$.

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[1] See Arrow (1965), page 106 for a theoretical discussion of a pure increase in uncertainty. See also Sandmo (1971) for its application in stochastic models.

For example, if we observe a data set X = (1,2,3) and another data set Y = (2,4,6), then the variance increases from $V_x = 1$ to $V_y = 4$, just because the observations in Y are increased from the data set X by a constant scale factor of 2. Taking the scale factor out of the data set Y, however, would preserve the initial mean value at 2 and leave the mean-preserving variance unchanged from the initial value of 1. On the other hand, suppose that we have two data sets, X = (1,2,3) and Y = (3,4,5). Initially, the set X has $\bar{\mu}_x^* = 2$ and $V_x = 1$, while the set Y has $\bar{\mu}_y^* = 4$ and $V_y = 1$, so that they would have been considered equally unstable or risky, i.e., $V_x = V_y$, according to the traditional variance criterion. However, taking the scale factor $k = \bar{\mu}_y^*/\mu_0 = 2$ with $\mu_0 = \bar{\mu}_x^*$ out of the data set Y would indicate that the mean-preserving variance decreases from the initial value of $V_y = 1$ to $V_y' = 1/4$, that is, $V_y' = V_y/k^2$, and the two sample mean values are preserved at 2, that is, $\bar{\mu}_x^* = \bar{\mu}_y^* = 2$. The above examples make it clear that the mean-preserving variances are what we must work with in order to quantify properly stability levels of random returns. This is because simple variance measures are not independent of their respective means of individual samples, hence engendering the statistical white noise mentioned in the preceding section.

Following the procedure suggested above in order to obtain a proper surrogate measure representing the stability of returns, we calculated the mean-preserving variances with respect to a constant reference point represented by the U.S. mean rate of return from Table (IV.1).

The relevant results following the recalculation are reported in Table (IV.3). To see if there are any significant differences in the recalculated stability patterns, adjusted for the common reference point, of U.S. domestic returns and foreign returns, we tested again the first hypothesis H1 of section (IV-1) using mean-preserving variances.

In consequence of taking the mean-preserving transformation of the data provided in Table (IV.2), we can notice three things right away about the statistical results reported in Table (IV.3): First, the mean-preserving variance of overall foreign return is reduced to only 9.67, as compared to the initial value of 14.99 before the transformation, representing a 35 % reduction in the measure of instability.
As a result, we can no longer reject at the 5% level of statistical significance that U.S. domestic returns and foreign returns are the same with respect to the stability characteristics of their earnings pattern (if the mean-preserving variance is employed as our quantitative surrogate representing the degrees of instability in the earnings pattern.)- That is, statistically speaking, we cannot conclude that returns from U.S. direct foreign investment abroad are significantly more unstable than those of U.S. domestic investment. It remains ture, however, that the calculated variance from the foreign returns is still higher in comparison to the variance of the U.S. domestic returns, even after having taken the mean-preserving transformation of the foreign returns initially observed. Secondly, the adjusted variance of foreign returns, in the case of direct foreign investment in <u>developed countries</u>, however, has increased from the initial value of 12.72 for its simple variance measure, i.e.,

unadjusted for the common reference point, to 13.4 for the mean-preserving variance. Therefore, we can reject, as before, the null hypothesis of no difference in the instability of the returns between the U.S. domestic investment and foreign investment in the developed region of the world, in favor of accepting the alternative hypothesis that the earnings performance of U.S. direct foreign investment is indeed more unstable as compared to its domestic counterpart. Thirdly, in the case of foreign returns realized from U.S. foreign investment in *developing countries*, on the other hand, the calculated value for the quantitative instability surrogate has decreased dramatically, following the transformation of the foreign returns observed, from its initial value of 106.56 down to only 17.86. But it remains still far above the variance of U.S. domestic returns so that the null hypothesis of no difference in the instability measures between the U.S. domestic investment performance and the foreign investment performance ~~in this~~ case must be rejected. Consequently, we accept the hypothesis that foreign returns from the developing countries tend to be more unstable than domestic returns, albeit not nearly as unstable as the simple variance approach to quantifying the instability surrogate would have us to believe.

Our next objective is to formulate the concept of risk in the context of direct foreign investment. To the extent that direct foreign investment involves production activities, however, we will require a model of production under uncertainty. Furthermore, we will need to incorporate explicitly stochastic exchange rate fluctuations into such a model. For these purposes, we will turn to next chapter.

TABLE (IV.3)

STATISTICAL SUMMARY: MEAN RATE OF RETURN AND MEAN-PRESERVING VARIANCES OF U.S. DIRECT FOREIGN INVESTMENT ABROAD IN MANUFACTURING INDUSTRIES

Area	μ	V	F-value	k	V'	F-value
U.S. Domestic	12.07	4.25	-----	1.0000	4.25	-----
All Foreign	14.99	14.91	3.5082*	1.2419	9.67	2.2753
Developed Area	11.76	12.72	2.9929*	.9743	13.40	3.1529*
Developing Area	29.48	106.56	25.0927*	2.4424	17.86	4.2024*
U.S. Total	12.58	4.98	-----	1.0422	4.58	-----

Note: Asterisk denotes statistical significance at 5% level of significance.

V stands for the simple variance measures.

V' stands for the mean-preserving variances, i.e., adjusted for the common mean for all the individual distributions of returns.

CHAPTER V. A STOCHASTIC MODEL OF DIRECT FOREIGN INVESTMENT

V-1. Factor-Price-Equalization and Role of Risk in Foreign Investment

In our discussion of direct foreign investment so far, we have not explicitly incorporated into our analysis either the risk associated with direct foreign investment or risk-aversion in the decision maker's utility function facing the prospect of uncertain rates of return on their direct foreign investment. Thus, under the assumption that international investors are concerned about maximizing the rate of return on their investment, the decision to invest abroad was relatively straightforward: a U.S. firm invests in South Korea if direct foreign investment yields a higher expected rate of return after adjusting for technological changes and expected forward exchange rate changes. In the traditional explanation of the Heckscher-Ohlin model, the causes of these differences in rates of return were considered to arise from differences in relative factor endowments and factor returns which persist in the presence of impediments to international mobility of commodities or factors[1]. Under the further assumption of perfect mobility of capital through the adjustment process of direct foreign investment discussed in preceding chapters, the traditional theory of motives behind direct foreign investment thus could explain why international firms make direct foreign investment in host countries[2].

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[1] See Jones (1956).

[2] See Mundell (1957).

Extending this line of reasoning in a non-stochastic framework, Mundell (1957) suggested the hypothesis that "It is equally true that perfect mobility of factors results in factor-price equalization and, even when commodity movements cannot take place, in a tendency toward commodity-price equalization." However, this holds under a set of stringent assumptions, applicable to the case of certainty situations only, and a straightforward extension of the Factor Price Equalization Theorem to the case of direct foreign investment under uncertainty is not possible. Even if international flow of capital were perfectly mobile, the presence of uncertainty invariably results in unequalized factor-prices internationally, including returns to capital, because of greater risks intrinsic in foreign investment-related activities. Typically, international investors must face many types of risk in connection with their foreign investment. Profits from foreign investment may decline because of cyclical economic disturbances, poor management, government regulations, and so forth. Such changes in profits are ultimately reflected in lower returns earned from foreign investment and reduced capital value of their foreign assets. In the extreme, every international investor faces the risk that an investment abroad may become worth next to nothing as a result of bankruptcy, war, or outright confiscation by hostile host governments. To confound the matter, many developing countries lack, in many instances, what most developed countries regard as basic commercial laws that govern domestic and international business, including direct foreign investment. It is not unusual to find many international firms operating under poorly developed bodies of labor law, patent law, joint-venture law, etc. When they do exist, often there are no regulations implementing them.

Many foreign corporations investing in South Korea, for example, have complained that they have been subjected to new and conflicting interpretations regarding these laws by local authorities[3]. This would make many foreign firms hesitant to invest for a long-term commitment in developing countries even if there exists a potential for large profits from such investments. Under these circumstances, foreign investment in developing countries may involve to a large extent an act of faith, other than purely economic decision. In the case of foreign investment in developing countries, many of these risks are bound to become exacerbated and magnified due to poorly developed market, inadequate legal structure, extensive involvement of host government, political instability, and fluctuations in foreign exchange rates. These considerations rationalize the argument that international investors require a higher rate of return from direct foreign investment than they would from a comparable domestic investment, earning a higher return than either counterparts in their domestic market or local competitors in the foreign market. In consequence, it is highly unlikely that international mobility of factors, even when they are perfectly mobile, results in internationally equalized returns to factors of productions, including, in particular, internationally equalized returns to capital.

To the extent that foreign production costs are lower, or that the implicit rents internalized from the use of trade marks, superior technical know-how, and the like manifest themselves in a higher expected rate of return which can be earned from foreign investment, we can reasonably expect the foreign rate of return to be generally

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[3] Elimination of this type of risk caused by sporatic policy shifts of an LDC would likely result in attracting more DFI than actually observed in many instances by enhancing stable environment for DFI.

higher than the domestic rate. But even if these implicit rents are properly included as a part of production costs reflecting their service charges, and even after the rents are eventually competed away, we would still expect rates of return earned from foreign investments to be higher as long as there remain higher levels of risks related to the foreign operations, and investors reveal risk-aversion in their utility function. For these reasons, neither the Paretian efficiency results of the Heckscher-Ohlin model regarding internationally equalized marginal products of capital nor the Mundellian argument for factor-price equalization through perfect mobility of capital can be assumed to hold for a firm operating in uncertain foreign markets. Instead, one would expect that international investors do require, a priori, a higher expected return on a direct foreign investment project than they would on a comparable domestic investment, and that on the average, they do earn a higher rate of return on capital invested in the host country than on their domestic capital or what their local competitors in the host country could obtain[4]. Thus, while it may be possible in a theoretical model under certainty outcomes that we could achieve internationally equalized factor-prices and hence, internationally equalized marginal products of capital, it is not probable in a world of uncertainty because of the intrinsically higher levels of risks associated with foreign investment. These of course are hypotheses that require detailed theoretical analyses in a stochastic framework under the presence of uncertainty as well as empirical validation thereof.

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[4] See Caves (1971)

In the world of uncertainty, therefore, the theoretical model we have constructed for the classical theory of international capital movements is inadequate as well, to the extent that it considers, ultimately, rates of return alone as the determinant of direct foreign investment, while at the same time ignoring the greater risks associated with such investment abroad. In particular, the classical theory in its basic form cannot explain the real world phenomenon of simultaneous direct investments taking place between two countries, such as European DFI in the United States and U.S. DFI in Europe, for example. By employing the models of portfolio balance developed by Markowitz (1952) and Tobin (1958), however, Grubel (1968) has come up with an innovative approach to explain long-term asset holding abroad[5]. He has argued that an efficient frontier of an internationally diversified portfolio in the return-risk space is likely to permit investors to attain a higher level of welfare than the portfolio that includes domestic investments only. This welfare gain has come about since at a given rate of return expected from investment, variations in the return performances can be reduced at the margin by including foreign investments than is possible without the foreign investments included in the portfolio. The empirical evidence provided in the Grubel's study implies availability of substantial benefits from internationally diversifying investments. It is clear that risk reduction subsequent to portfolio diversification represents the source of an entirely new kind of world welfare gain that had not been considered in traditional arguments.

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[5] See Grubel (1968)

Although the portfolio model of international diversification was developed, originally, in order to explain holding of foreign financial assets, it can be used to explain international movements of physical capital assets as well. Employing this model, Rugman (1976) has shown that stability of overall earnings realized from all operations is an increasing function of a firm's direct foreign investment as a proportion of its total[6]. Such greater stability of earnings for the internationally diversified firm, according to Rugman, is attributable not only to different phasing of cyclical demand variation, which could simply be taken advantage of by direct exports rather than by direct foreign investment, but is attributable also to the existence of imperfectly synchronized cyclical variations of production conditions in different countries. The firm then can take advantage of risk reduction by internationally diversifying production activities through direct foreign investment, provided that the fluctuations of these economies are less than perfectly correlated.

In consequence, the international diversification of a firm's operations leads to international production activities, tantamount to acquisition of multi-plants by a firm operating under uncertainty that has its production facilities extended beyond its national boundary.

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[6] Rugman demonstrates that the multinational firm enjoys the advantage of less risk in its profits, in addition to maximizing its overall level of profits. Specifically, stability of earnings through time is shown to be an increasing function of the ratio of foreign to total operations. Although foreign operations are used instead of direct foreign investment due to data limitations, it is clearly direct foreign investment which he had in mind for his analysis.

This in turn suggests that managers of multinational corporations can succeed in reducing overall risk by proper diversification of all of their direct investments, including foreign investments, through extending their production activities globally, without at the same time sacrificing necessarily the overall level of earnings. Clearly, this argument provides us a valid line of argument that give rise to a motive for investing abroad under uncertainty, which differs conceptually from the traditional arguments[7]. In the next section, we will therefore proceed to construct a theoretical model of a multi-plant firm under uncertainty, that is motivated to invest abroad following the line of reasoning provided in this section.

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[7] Helleiner (1973) has employed return and risk considerations as the theoretical foundation for explaining traditional motives for investing abroad by multinational manufacturing firms. Thus, he has argued that "While one must be cautious of attributing complete 'rationality' to the decision making of the multinational manufacturing firm, upon which the internationalisation of production depends, it is safe to assume that its investment plans and sourcing strategies are based primarily upon expectations of return and risk factors." See page 35 through 40 for these arguments by Helleiner. In contrast, Kindleberger (1969), Johnson (1970), and Caves (1971) have argued that the motivation of direct foreign investment at the firm level is due to an international market imperfection. It must be noted, however, that all of these arguments are developed heuristically, without specifying their theoretical models explicitly.

V-2. A Stochastic Model of an Internationalised Multi-Plant Firm

In order to explain internationally unequalized factor returns to capital, the residual difference between returns earned by a foreign subsidiary and its domestic counterpart must be analyzed not within the certainty model of rate of return maximization but by relaxing the assumption of perfect certainty conditions which underlie the traditional arguments derived from the Heckscher-Ohlin framework. In that sense, much of the model to be developed in this section can be regarded as a direct extension of the traditional model to a stochastic framework as well as an extrapolation of Professor Grubel's results[1] established in internationally diversified portfolio of financial assets to the case of internationally diversified production via direct foreign investment. However, my arguments will follow closely the traditional model of a multi-plant firm in the context of a global operation under an uncertain foreign production milieu.

For this purpose, consider first an international firm which produces a single product line and sells its output in the world market, but producing in two separate plants, one and the other foreign, both operating in a riskless environment. Its profit is simply the difference between its total revenue and its total production costs for both plants. Under this situation, Pareto's production efficiency conditions require that the marginal cost in each plant be equal to the marginal revenue of the output as a whole. Furthermore, it is also necessary that the marginal revenue product of an input must be

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[1] See Grubel (1966).

the same as the input's marginal factor cost in each plant in order to achieve the efficiency condition for production.

However, we will show that the above results must be abandoned once we recognize that an international firm must operate in more uncertain environment abroad than in its domestic production activities. There are a number of ways one can take in order to stochasticize the traditional multi-plant model. Since we are concerned with the innate risk present in direct foreign investment-related activities, we will choose to introduce uncertainty, represented by a random variable $\tilde{e}^*$, via foreign production conditions rather than via demand conditions[2]. Consequently, international firms are assumed to know world demand conditions facing their products with certainty, just as in the traditional model, the only difference being that the firm's foreign production function contains the random variable e^* over which the international firm has no control.

We make no attempt in this thesis to distinguish the situations characterized by risk (known probabilities) and those characterized by uncertainty (unknown probabilities). These two will be used interchangeably. It is sufficient to assume that the decision maker under stochastic situations is able to assign probabilities to different outcomes, and that he can act upon them consistently in one way or another. The international firms are thus assumed to maximize the expectation of utilities of stochastic profits:

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[2] For stochastic models under demand uncertainty, see Baron (1970), Sandmo (1971), and Leland (1972).

$$Eu_i(\tilde{\pi}) = \int u[\sum_j R_{ij}(Q_j) + \sum_j R^*_{ij}(\tilde{Q}^*_j) - \sum_j C_{ij}(Q_j) - \sum_j C_{ij}(\tilde{Q}^*_j)]\, P(\tilde{e}^*)\, d\tilde{e}^*, \tag{V.1}$$

where

E = the expectation operator of investor i.

u_i = the strictly concave utility function with $u_i' > 0$ and $u_i'' < 0$.

$R_{ij}(Q_j)$ = the jth domestic revenue function expressed in U.S. dollars.

$R^*_{ij}(\tilde{Q}^*_j)$ = the jth foreign revenue function expressed in U.S. dollars.

$C_{ij}(Q_j)$ = the jth domestic cost function expressed in U.S. dollars.

$C^*_{ij}(\tilde{Q}^*_j)$ = the jth foreign cost function expressed in U.S. dollars.

$Q_j = f(K_j, L_j)$, representing jth domestic production function.

$\tilde{Q}^*_j = h(K^*_j, L^*_j, \tilde{e}^*)$, representing jth foreign production function.

$P(\tilde{e}^*)$ = the subjective probability density function.

Assume that initially all foreign exchange rates are perfectly stable such that all figures are free of exchange rate fluctuations. We can differentiate the expected utility function in the above equation (V.1) with respect to capital, and evaluate at the optimum to obtain the following Paretian efficiency conditions under uncertainty:

$$d[Eu_i(\tilde{\pi})]/dK_j = E[u_i'(\tilde{\pi})\ (m_j - r)] = 0. \tag{V.2}$$

$$d[Eu_i(\tilde{\pi})]/dK^*_j = E[u_i'(\tilde{\pi})\ (\tilde{m}^*_j - r)] = 0, \tag{V.3}$$

where

$u_i'(\tilde{\pi}) = du_i(\tilde{\pi})/d\tilde{\pi}$, representing the marginal utility of investor i.

$m_j = dR/dK_j$, representing the jth domestic marginal revenue product of K.

$\tilde{m}^*_j = d\tilde{R}^*/dK^*_j$, representing the jth foreign marginal revenue product of K*.

r = the marginal factor cost of capital.

Noting that the expected value of the product of two terms is equivalent to the product of their expected values plus their covariance, equation (V.2) and (V.3) can also be written as follows:

$$(m_j - r) = 0. \tag{V.4}$$

$$E(\tilde{m}^*_j - r) = - \mathrm{Cov}[u'_i(\tilde{\pi}), (\tilde{m}^*_j - r)]/Eu'_i(\tilde{\pi}) \tag{V.5}$$

Condition (V.4) states, as in the certainty case, that the marginal revenue product of domestic capital is equal to the marginal factor cost of capital, and there is nothing new about the result[3]. However, Condition (V.5) shows the stochastic analog for capital assets that have been invested abroad through direct foreign investment. Thus, if the utility function of the investor reveals diminishing marginal utility, then at any given level of output, $u'_i(\tilde{\pi})$ and $(\tilde{m}^*_j - r)$ are inversely related since a higher profit resulting from a higher marginal revenue product will lower the investor's marginal utility. Therefore, their covariance is negative, and the covariance term of the equation (V.5) as a whole results in yielding a positive value from noting that $Eu'_i(\tilde{\pi})$ is always positive by assumption. Consequently, the equation (V.5) must also have positive values. In other words, the risk-averse investor requires that the expected marginal revenue product of the capital invested abroad be greater than the marginal factor cost of capital, thereby rejecting the traditional efficiency condition, which requires equality between the two at the optimum[4].

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[3] This condition is imposed for the purpose of expediting theoretical expositions only. The core substance of ensuing arguments, however, is not altered by relaxing the certainty assumption hereof.

[4] For a similar, see Baron (1970).

It should be noted that the above result holds also in cases[5] where both plants are operating under uncertainty, as long as foreign investment is deemed to be riskier. The extent to which the marginal revenue product associated with foreign operation must exceed the cost of capital in equilibrium, however, depends on the extent of investors' risk-aversion and the corresponding risk-premium to compensate for the reduced utility level from operating abroad. For this discussion, we need to introduce explicitly into our model the risk associated with the foreign investment.

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[5] To the contrary, Mayer (1976) claims that the content of the Factor-Price Equilization theorem, as well as Rybczynski, Stolper-Samuelson and Reciprocity theorems under certainty situations, can be carried over to uncertainty models in a straightforward manner. It is alleged that the only modification required for the difference between the certainty and uncertainty model is having to replace certainty commodity price in the former model with expected price in the latter. Thus, he asserts that "My findings are very straightforward and extremely comforting. -- Subject to one small modification, the introduction of price uncertainty does not destroy the validity of any of the above-stated theorems and relations. The modification consists of replacing the words 'change in price' in the certainty model with the words 'change in expected price, with higher central moments constant' in the uncertainty model. The claim that these theorems can conveniently be extended to the uncertainty case is quite surprising since we explicitly introduced risk-averse behavior on the part of firms." No matter how striking these assertions may be, however, they are devoid of any theoretical substance, once we dig beneath the surface of such a set of statements. This is because the above-stated assertions are cruicially dependent on the extremely stringent restrictions that firms in a given industry have, in addition to the usual assumptions specified for such models, identical probability beliefs in both countries and identical utility functions, as well as identical levels of uncertainty in both countries. In this situation, there remains clearly no salient feature that can distinguish a foreign operation from a domestic operation for all practical purposes.

V.3. Theory of Risk-Premium in Direct Foreign Investment

The purpose of this section is to show a way in which risk-premium enters into our model of direct foreign investment and to relate the effect of its presence to the results of the preceding section. For this purpose, we will describe risk-aversion as unwillingness to engage in fair gambles with the prospect of winning or losing an amount with equal probability. We also employ the Arrow-Pratt's definition of risk-premium[1]. In the context of direct foreign investment analysis, however, the total risk-premium connected to foreign investment must be the amount by which expected profit must be increased from an initial certainty-equivalent profit and still leave the investor's expected utility of stochastic profits at the same level as the initial utility level achieved from the smaller certainty-equivalent profit. Denoting total risk-premium by Z and the certainty-equivalent profit by π_0, it follows that $E\tilde{\pi}$ must equal $(\pi_0 + Z)$ such that $Eu_i(\tilde{\pi})$ is equal to $u_i(\pi_0)$. Put another way, the risk-premium is the difference between expected profit and certainty-equivalent profit such that investors are indifferent between uncertain profit and initial certainty-equivalent profit:

$$Z = E\tilde{\pi} - \pi_0 \quad \text{such that } Eu_i(\tilde{\pi}) = u_i(\pi_0), \text{ that is, } Eu_i(\tilde{\pi}) = u_i(E\tilde{\pi} - Z). \tag{V.6}$$

The positive amount a risk-averse investor requires as the risk-premium for investing abroad for uncertain profits is shown diagrammatically as the horizontal distance between π_0 and $E\pi$ in Figure (V.1)[2].

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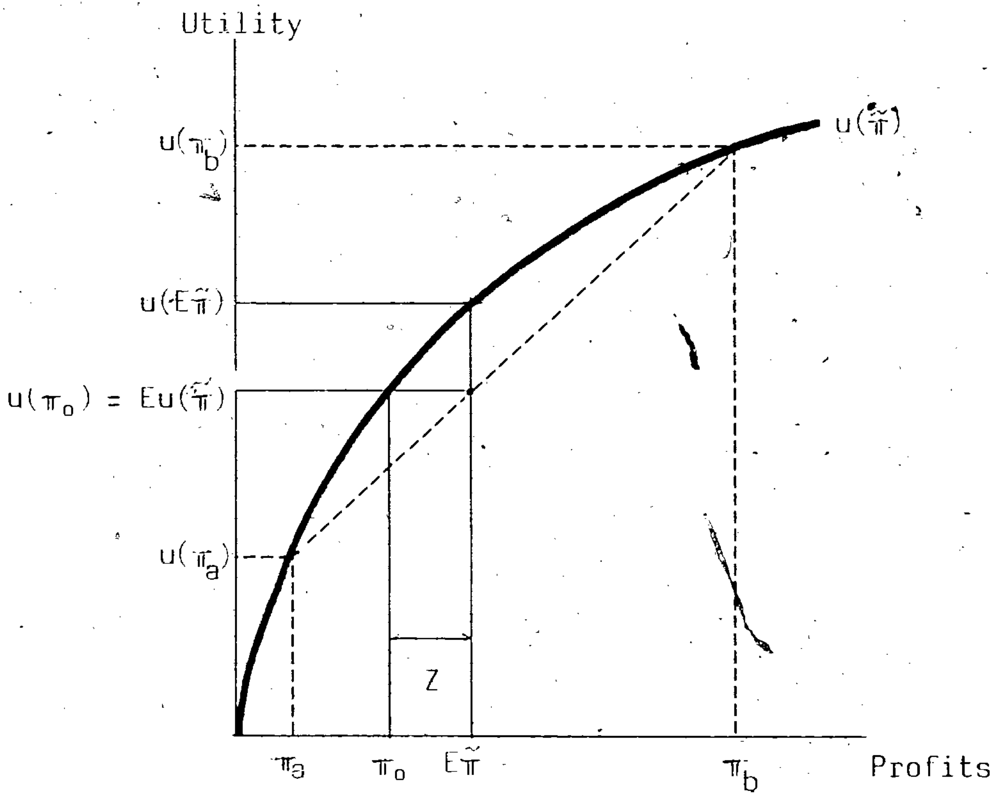
[1] See Arrow (1965) and Pratt (1964).

[2] The author is grateful to Professor Cheng for the diagram and other helpful suggestions on numerous occasions.

FIGURE (V.1)

Risk-Aversion and Risk-Premium



In order to demonstrate how the stochastic efficiency condition (V.5) is affected by the presence of risk-premium, we differentiate the above equation (V.6) with repect to K_j^* and evaluate at the optimum:

$$u_i'(\tilde{\pi})\,[E(\tilde{m}_j^* - r) - dZ/dK_j^*] = 0. \tag{V.7}$$

Since marginal utility is assumed to be always positive for $\tilde{\pi} > 0$, it can be dropped from the above equation and rewritten as follows:

$$E(\tilde{m}_j^* - r) = dZ/dK_j^*. \tag{V.8}$$

It is clear that the equation (V.8) should be equivalent to the equilibrium condition (V.5), implying that in equilibrium, we must have

$$-\,\mathrm{Cov}[u_i'(\tilde{\pi}), (\tilde{m}_j^* - r)]/Eu_i'(\tilde{\pi}) = dZ/dK_j^*. \tag{V.9}$$

Consequently, the above equation (V.9) shows us that the covariance term we derived for production efficiency in equation (V.5) is nothing but the increase of risk-premium demanded in return for providing additional foreign investment at the margin. Since we know from equation (V.5) that the covariance term yields a positive value, the risk-premium attributed to the foreign investment must be also positive for risk-averse investors, i.e., dZ/dK_j^* is also positive. In other words, the stochastic variant of the production efficiency condition implies that in equilibrium the marginal revenue product of the capital invested abroad must exceed the cost of capital by the capital's marginal impact on the level of total risk-premium.

From either way of formulating the equilibrium condition under uncertainty, we draw two conclusions from the above analyses. First, the Paretian equilibrium condition for productive efficiency, which requires the equality between marginal revenue product and cost of capital, cannot hold in a stochastic world. Second, the Mundellian argument, which asserts that international mobility of factors can result in equalized returns to factors of production, cannot hold because of differing levels of risk associated with investing abroad under uncertainty.

Moreover, a number of other important implications have also been extracted from the above analyses. In particular, one such implication suggests categorically that a marginal increase in uncertainty emanating from abroad should discourage growth of direct foreign investment and related production activities in general by their subsidiaries[3]. In the past, some analysts have succeeded, while others have failed, in deriving mathematically the categorical effects of the marginal increase of uncertainty under specific assumptions regarding utility functions and uncertainty. These proofs typically entail elongated procedure and elaboration of highly technical details. No matter how elegant the proofs, however, the analytical tools employed in such arguments are not incisive enough to warrant such assertions. This is because much of their relevance is lost, and the theoretical discussions take on a new dimension once we recognize that much of the attraction of foreign investment comes from the fact that its earnings variations are less than perfectly correlated with domestic earnings variations.

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[3] For a general equilibrium analysis, see Batra and Ullah (1974).

Thus, while the above analysis is mathematically correct insofar as it went, it does not do justice just to consider the individual risk-premium only in terms of the marginal disutility cost of risk associated with foreign investment. Specifically, this is because the covariance term, representing the risk-premium in the equation (V.1), is a composite of both what the financial economics literature refers to as the "market price of risk" for an asset facing the prospect of an uncertain outcome plus the "systematic market risk" that cannot be diversified away by forming portfolios. Consequently, we must do two things in order to disentangle conceptually these two measures buried in the above covariance term: First, with regard to market price of risk, we must make specific assumptions about investors' preference structure. Second, with regard to systematic market risk, we must isolate the portion of systematic risk, which arises from exchange rate fluctuations. For these purposes, we will proceed to extend the present framework to encompass these considerations in the next chapter.

CHAPTER VI. A MODEL OF RISK ANALYSIS IN DIRECT FOREIGN INVESTMENT

VI-1. Derivation of IML Model under Stochastic Exchange Rate Fluctuations

The preceding model is derived without explicit consideration of foreign exchange rate fluctuations, by expressing all variables converted to U.S. dollars. Consequently, the effect of stochastic changes in the exchange rates could not be analyzed within the context of an equilibrium foreign investment model. The purpose of this chapter is to incorporate explicitly stochastic exchange rate fluctuations into the model we have developed in the last chapter. Based on the expanded model, we will provide a theoretical discussion, as well as empirical analyses, regarding the categorical effects of stochastic exchange rate fluctuations on the rate of return, its stability, and systematic risks associated with direct foreign investment abroad.

For these purposes, we will derive an "Investment Market Line" model under stochastic exchange rate fluctuations, and make the following assumptions in the subsequent analyses:

(1) All investors are Markowitz-efficient diversifiers.

(2) All investors possess identical preference structure represented by a quadratic utility function of terminal real profits over the same one-period investment horizon.

(3) All investors have homogeneous expectations regarding probability distributions of stochastic foreign rate of return and foreign exchange rate fluctuations, and the distributions are stationary.

(4) All investment is perfectly divisible.

In the theoretical derivation of the IML model and empirical estimation, we have adopted the following notations:

K_{ij} = U.S. dollar value of ith investor's jth domestic investment.

K^*_{ij} = U.S. dollar value of ith investor's jth foreign investment.

π_i = U.S. dollar value of ith investor's terminal real profits on the portfolio containing both domestic and foreign investments, i.e., $\sum_j \tilde{\pi}_{ij}$.

$W_i = \sum_j (K_{ij} + K^*_{ij})$, representing U.S. dollar value of ith investor's total capital assets, and $W = \sum_i W_i$.

m_j = the real rate of return on jth domestic investment, assumed to be equal to the constant value m_0.

μ_j = the nominal rate of return on jth domestic investment.

$\tilde{\mu}_m$ = the stochastic nominal rate of return on a market portfolio.

$\tilde{X}_j$ = the stochastic value of jth foreign exchange rate level.

$\tilde{x}_j$ = the stochastic rate of change in the jth exchange rate level.

$\tilde{m}^*_j$ = the stochastic real rate of return on jth foreign investment.

$\tilde{\mu}^*_j = \tilde{m}^*_j + \tilde{x}_j$, representing the jth stochastic nominal rate of return.

$\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m)$ = the covariance between $\tilde{\mu}^*_j$ and $\tilde{\mu}_m$.

$\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j)$ = the covariance between $\tilde{\mu}^*_j$ and $\tilde{x}_j$.

V_m = the variance of the market rate of return.

V^*_j = the variance of jth exchange rate fluctuations.

$b_j = \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m)/V_m$, representing the slope coefficient of jth characteristic line with respect to $\tilde{\mu}_m$, i.e., the "market rate beta", which represents the undiversifiable systematic market rate risk.

$b^*_j = \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j)/V^*_j$, representing the slope coefficient of jth characteristic line with respect to $\tilde{x}_j$, i.e., the "exchange rate beta", which represents the undiversifiable systematic exchange rate risk.

From equation (V.5) of the previous chapter, we have reproduced the following equilibrium condition with m_j replaced by m_0 for all j:

$$E\tilde{m}^*_j = m_0 + \mathrm{Cov}[-u'_i(\tilde{\pi}_i), (\tilde{m}^*_j - m_0)]/Eu'_i(\tilde{\pi}_i). \qquad (\mathrm{VI.1})$$

In order to characterize the equilibrium relationship between the expected rate of return and risks, we have assumed that all investors have quadratic utility functions of terminal profits in real terms as specified below:

$$u_i(\tilde{\pi}_i) = \tilde{\pi}_i - c_i\tilde{\pi}_i^2, \text{ with } c_i > 0. \qquad (\mathrm{VI.2a})$$

Therefore,

$$u'_i = (1 - 2c_i\tilde{\pi}_i). \qquad (\mathrm{VI.2b})$$

Substituting the above expression (VI.2b) into the equilibrium condition (VI:1) and noting that real rate of return is nominal rate of return minus rate of exchange rate change, i.e., $m^*_j = \mu^*_j - x_j$ and $m_0 = \mu_0$, we obtain:

$$E(\tilde{\mu}^*_j - \tilde{x}_j) = \mu_0 + \mathrm{Cov}[-(1 - 2c_i\tilde{\pi}_i), (\tilde{\mu}^*_j - \tilde{x}_j - \mu_0)]/E(1 - 2c_i\tilde{\pi}_i). \qquad (\mathrm{VI.3})$$

The above equation (VI.3) gives us a system of linear equations with constant coefficients for all investors i in jth market. Summing over all investors in the jth equation, we obtain the following aggregate equilibrium condition for the jth market:

$$E(\tilde{\mu}^*_j - \tilde{x}_j) = \mu_0 + \mathrm{Cov}[\sum_i\tilde{\pi}_i, (\tilde{\mu}^*_j - \tilde{x}_j - \mu_0)]/\sum_i(\frac{1}{2c_i} - E\tilde{\pi}_i). \qquad (\mathrm{VI.4})$$

Substituting for $\sum_i\tilde{\pi}_i$ and rearranging the covariance term[1], the above expression (VI.4) simplifies to:

$$E\tilde{\mu}^*_j = \mu_0 + E\tilde{x}_j + W[\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m) - \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j)/b_j]/\sum_i(\frac{1}{2c_i} - E\tilde{\pi}_i). \qquad (\mathrm{VI.5a})$$

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[1] This follows from noting that $\sum_i\tilde{\pi}_i = \sum_i\sum_j\tilde{\pi}_{ij} = W\mu_m$ by definition and substituting jth characteristic relation in the second covariance term.

Substituting for the individual covariances in terms of the betas[2], the above equation (VI.5a) can be expressed alternatively as follows:

$$E\tilde{\mu}^*_j = \mu_o + E\tilde{x}_j + W(V_m b_j - V^*_j b^*_j/b_j)/\sum_i(\tfrac{1}{2}c_i - E\tilde{\pi}_i). \qquad \text{(VI.5b)}$$

Equivalently, we can rewrite the above equations (VI.5a) and (VI.5b) as follows:

$$E\tilde{\mu}^*_j = \mu^*_o + \lambda^* B^*_j, \qquad \text{(VI.6)}$$

where

$$\mu^*_o = \mu_o + E\tilde{x}_j. \qquad \text{(VI.7)}$$

$$\lambda^* = 1/\sum_i(\frac{1}{2c_i} - E\tilde{\pi}_i). \qquad \text{(VI.8)}$$

$$B^*_j = W[\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m) - \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j)/b_j], \text{ or} \qquad \text{(VI.9a)}$$

$$B^*_j = W(V_m b_j - V^*_j b^*_j/b_j). \qquad \text{(VI.9b)}$$

The above equation (VI.6) represents an equilibrium condition on the rate of return from foreign capital investment under stochastic exchange rate fluctuations. Therefore, we will call such an equilibrium relation the "Investment Market Line" (IML) in deference to its counterpart developed by Lintner, Mossin and Sharpe in financial economics, namely, the Security Market Line (SML)[3]. It should be noticed that to derive our IML model, we entertained nothing other than introduction of stochastic exchange rate fluctuations to the traditional model of a multi-plant firm under uncertainty.

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[2] Substitute $\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m) = b_j V_m$ and $\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j) = b^*_j V^*_j$ in equation (VI.5a).

[3] See Rubinstein (1973) also for a mean-variance synthesis of portfolio theory.

We can also obtain the traditional version of the SML model by setting $\tilde{x}_j = 0$ in the IML model. Consequently, the IML model is simplified to:

$$E\mu_j^* = \mu_0 + \lambda b_j \tag{VI.10a}$$

where

$$\lambda = 1/\sum_i \left(\frac{1}{2c_i} - E\check{\pi}_i\right), \text{ and} \tag{VI.10b}$$

$$b_j = W \, Cov(\tilde{\mu}_j^*, \tilde{\mu}_m). \tag{VI.10c}$$

Equation (VI.10a) is the same SML model obtained by Mossin, except that his model is developed in terms of stock analysis rather than flow analysis. Thus, his model starts out by defining the stock of investor's terminal real wealth, and maximizes the investor's expected utility of the stochastic terminal real wealth.

On the other hand, the approach taken in developing our IML model takes a step backward, and starts from maximizing the expected utility of profits that incorporate the production sector of the economy. However, the IML model also takes a small step forward in order to incorporate explicitly the effects of foreign exchange rate fluctuations on the equilibrium rate of return and risk-premium. It is noteworthy that it is entirely possible to derive the same results obtained from the financial sector of the economy following the SML model by directly starting from the real sector of the economy following our IML model instead. The model of international capital investment, developed in the last chapter, made it possible, consequently, for us to derive the traditional results of the SML model as a special case of the more general IML model derived here.

Thus, we have succeeded in deriving a simple, but important, formula representing the equilibrium rate of return on direct foreign investment. It is the sum of the three terms; the risk-free rate represented by domestic rate of return, expected rate of change in foreign exchange rates, and risk-premium. As a result, it is clear that foreign exchange rate changes affect directly the level of the equilibrium rate of return on foreign investment, its stability measured in terms of its variance, and systematic market risk measured in terms of its covariance with the market rate of return. Specifically, our model implies that the traditional SML model's intercept is underestimated when the expected foreign exchange rate change is positive, and it is overestimated when the expected change in the foreign exchange rate is negative. Our model also gives the implication that market risk measured by the SML model is either overestimated or underestimated according as to whether the expected foreign exchange rate change is positively or negatively correlated with the other variables. Consequently, these considerations give rise to our present criticism that if expected foreign exchange rate fluctuations are nonzero, then the traditional SML model misspecifies the true equilibrium relationship between rate of return and its risk measure, based on our theoretical analyses[4]. We will return to examine empirically these and other criticisms raised by Professor Cheng and Professor Grubel, regarding time-independence of the estimated parameters and its related methodological ambiguities embedded in the traditional SML model.

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[4] See Cheng and Grauer (1980)

While the traditional SML model specifies the equilibrium return in terms of a simple linear relationship to systematic market risk only, our IML model makes it explicit, however, that the equilibrium return is neither a function of b_j only, nor is it a linear function of b_j if foreign exchange rates are stochastic[5]. Instead, our IML model specifies in equation (VI.5b) that the equilibrium return is related to the market risk b_j in a non-linear fashion, and that it is also related to the exchange rate risk b^*_j as well as the market rate risk b_j. Thus, the traditional SML model misspecifies the true equilibrium relationship between return and risks when uncertain exchange rate fluctuations are present. As a result of its preoccupation with the simple linear relationship between return and market risk, and the resulting specification of the return-generating process, the SML model has implanted, a priori, a fundamental source of ambiguity that is bound to show up in its empirical results. In subsequent analyses, its implications are discussed in terms of its effects on market price of risk and systematic market risks within a theoretical framework, and their empirical estimates are provided.

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[5] As can be noted from inspection of equation (VI.10a), two most prominent implications of the traditional SML model are that the expected return and its market risk are related positively and linearly in equilibrium, and that market risk is the only measure we need in order to explain differences among expected returns. Clearly, these propositions cannot hold except in extremely restrictive cases, once exchange rate fluctuations are explicitly introduced to the model.

VI-2. Market Price of Risk (MPR) under Stochastic Exchange Rates

The risk-premium term is comprised of two components, both in the traditional SML model and in our IML model. The first component denoted by λ is the same for all firms i and for all investment projects j, under the assumption of identical utility functions. It is the market risk-aversion factor, reflecting the identical quadratic utility functions. Since it serves as a weighting factor for the firm's risk factor, represented by b_j, it has been dubed in financial economics literature as the Market Price of Risk (MPR).

MPR can be shown to be the harmonic mean of all investors' expected risk-aversion measures, defined in terms of Arrow-Pratt's absolute risk-aversion indexes. To see this, denoting A_i to represent ith investor's absolute risk-aversion, we have

$$\begin{aligned} A_i &= -u_i''(\tilde{\pi}_i)/u_i'(\tilde{\pi}_i) \\ &= 2c_i/(1 - 2c_i\tilde{\pi}_i). \end{aligned} \tag{VI.11}$$

Rewriting the expression for MPR from equation (VI.8) or (VI.10b) in terms of the absolute risk-aversion gives us the following expression:

$$\begin{aligned} \lambda &= [\sum_i E(1 - 2c_i\pi_i)/2c_i]^{-1} \\ &= [\sum_i E(1/A_i)]^{-1} \end{aligned} \tag{VI.12}$$

Thus, our measure, representing the market price of risk in the IML model, takes accounts of all investors' absolute risk-aversion indexes A_i. This measure of the market price of risk is appropriate to all firms and for all investment projects, either in the SML or IML model. However, this is the point where the two models' qualitative similarity ends and departs to take on dissimilar quantitative values for the market price of risk in the respective models.

The SML model's equilibrium condition (VI.10a) can be expressed alternatively as follows:

$$E\tilde{\mu}^*_j = \mu_o + \Omega_m \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m), \qquad \text{(VI.13a)}$$

where

$$\Omega_m = W/\textstyle\sum_i[(1/2c_i + rW) - (\mu_o K + \sum_j K^*_{ij} E\tilde{\mu}^*_j)]. \qquad \text{(VI.13b)}$$

It is clear that the Ω_m is the slope coefficient of the equilibrium return-risk trade-off, i.e., the slope of the security market line. In other words, Ω_m is the excess return required per unit of systematic market risk, measured in terms of covariance, that investors are willing to accept in the traditional SML model.

The corresponding expression under stochastic exchange rates can be obtained from the equilibrium condition (VI.5a) for the IML model as follows:

$$E\tilde{\mu}^*_j = \mu_o + E\tilde{x}_j + \Omega^*_m \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{\mu}_m) - \Omega^*_j \mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j) \qquad \text{(VI.14a)}$$

where

$$\Omega^*_m = W/\textstyle\sum_i[(1/2c_i + rW + \sum_j K^*_{ij} E\tilde{x}_j) - (\mu_o K + \sum_j K^*_{ij} E\tilde{\mu}^*_j)]. \qquad \text{(VI.14b)}$$

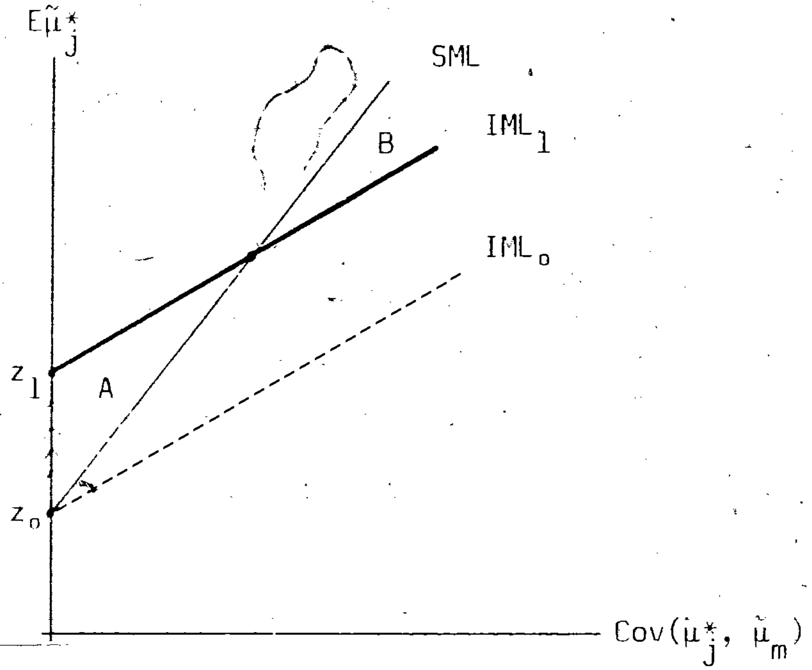
Thus, Ω^*_m is interpretted to mean the price of market risk, appropriate to all firms and investments, in the presence of stochastic exchange rate fluctuations. For the purposes of comparing the market price of risk between the two models, however, Ω^*_m includes only the price of risk attributable to systematic market risk, but excludes the portion attributable to systematic exchange rate risk. On the other hand, Ω^*_j, which is defined to be $(\lambda^* W/b_j)$, represents the portion of the total price of risk attributable to systematic exchange rate risk only.

From comparing the two expressions for the market price of risk in equations (VI.13b) and (VI.14b), it becomes apparent that Ω_m derived under the traditional SML model overstates the true equilibrium market price of risk if exchange rates are expected to move upwards. This can be seen by noting that expectation of upward movements in the exchange rates makes the denominator in the equation (VI.14b) larger, and therefore, makes the calculated market price of risk smaller for the IML model than is indicated by the SML model. In other words, the traditional SML model overstates the true equilibrium market price of risk in the case when the level of exchange rates is expected to move upwards. Likewise, the SML model understates the true equilibrium market price of risk if on the other hand, the level of exchange rates is expected to drift downwards. This also can be seen from noting that expectation of downward movements in exchange rate levels makes the denominator smaller in the same equation, hence making the value of the equilibrium market price of risk larger than the value indicated by the SML model in equation (VI.13b). In this case, the traditional SML model clearly understates the true equilibrium market price of risk.

In the context of a decision criterion for international investments, the present analysis gives the implication that, as a result of following the traditional SML model, some foreign investments would be incorrectly discouraged, and at the same time, some other investments would be incorrectly encouraged. This can be understood most readily by recognizing that the intercept as well as the slope of the SML schedule would be affected if expected exchange rate fluctuations are nonzero. In particular, if exchange rate levels are expected to move upwards, the SML model tends to be biased upwards for those investments with low levels of systematic market risk, and at the same time, tends to be biased downwards for those investments with high levels of systematic market risk. As a result, the level of investments, for those with low levels of market risk, tends to be higher than warranted, and at the same time, lower than warranted for those with high levels of the market risk. This may not be apparent and requires further explanations.

For the purpose of isolating the effects engendered by the upward movements of the overall foreign exchange rate levels, we will assume that the investments are exchange-neutral initially. In other words, we assume that the exchange levels are expected to shift upwards once and for all without at the same time introducing exchange rate risks. For ease of exposition, we can assume, without loss of generality, that the exchange rate levels are expected to increase by a positive constant rate g, vis-a-vis the level of U.S. dollars, such that $E\tilde{x}_j = g$ with $\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j) = 0$. Consequently, two events must happen: First, as we argued above, the upward movements in the foreign exchange rate levels must result in capital gains on direct foreign investments. This in turn results in reducing the market price of risk. This effect is indicated in Figure (VI.1) where the initial SML schedule is rotated downward, as it were, to the hypothetical IML_0 schedule at the initial intercept z_0 held constant on the vertical axis. In other words, the hypothetical schedule IML_0 in Figure (VI.1) must have a flatter slope in the return-risk space. This is what caused, in the above discussion, the traditional SML model to overstate the equilibrium market price of risk due to ignoring the assumed upward movement of exchange rates. Second, as we can see from the equation (VI.14a), the positive value of $E\tilde{x}_j$ must also make the intercept of IML schedule shift upwards at the the same time, hence increasing it from the initial value z_0 to the final value z_1 along the vertical axis of Figure (VI.1). The final position of the equilibrium relationship is indicated by the line IML_1 below.

FIGURE (VI.1)



The investment criterion under the traditional SML model requires that any investments with a return-risk combination plotted above the SML schedule be accepted as being high performance investments at given market risk levels. At the same time, it rejects those investments with return-risk combinations plotted below the SML schedule as being high risk investments at given levels of return. For example, the points located in area A of Figure (VI.1) would be incorrectly accepted, while the points in area B would be incorrectly rejected according to the traditional SML model. Because the SML model does not consider explicitly the effects of exchange rate fluctuations, it results in incorrectly accepting all of those investments trapped in the lower wedge A between the SML and IML_1 schedules. Likewise, the traditional SML model results in, at the same time, incorrectly rejecting all of those investments with return-risk combinations trapped in the upper wedge B, when in fact, they should be accepted according to IML_1. For those points located elsewhere, however, both SML and IML models give correct investment decisions. Consequently, it follows that the SML model is biased upward for those investments with low levels of market risk in the sense that it accepts incorrectly some undesirable investments. This tends to make the level of those investments higher than warranted. At the same time, the SML model is biased downward for those investments with high levels of market risk in the sense that it incorrectly rejects some desirable investments. Therefore, the level of those investments tends to be lower than warranted in the case when exchange rate levels are expected to move upwards.

It is clear that qualitatively similar results would follow if instead a negative value is assumed for the value of g, representing the expectation of a downward movement of the exchange rate levels. This case can be analyzed in an analogous fashion by simply switching the SML and the IML schedules. The explanations of this section, however, are based on the assumption that all foreign investments are exchange-neutral, and that equilibrium relationships are <u>linear</u> in the return-risk space. But the upshot of our IML model is precisely that the equilibrium relationship between return and risk is <u>non-linear</u> in the same space[1]. This is because when exchange rate levels fluctuate in a random fashion, systematic exchange rate risk is not likely to remain exchange-neutral over time. Consequently, total risks associated with foreign investments, i.e., the second component of the total risk-premium including exchange risk-premium, are bound to become affected by the way in which the returns are correlated with corresponding exchange rate fluctuations. This is the topic we pick up for a detailed discussion in the next section.

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[1] This can be seen immediately from inspecting equation (VI.5a) or from taking a second derivative of equation (VI.14a) with respect to the market risk, i.e., $\text{Cov}(\mu_j^*, \mu_m)$ or b_j, which gives a non-zero value. Thus, denoting $\text{Cov}(\mu_j^*, \mu_m)$ by C_j and $\text{Cov}(\mu_j^*, x_j)$ by C_j^*, we have:

$$\frac{d^2 E\tilde{\mu}_j^*}{d\,C_j^2} = \frac{d}{dC_j}\left[1 + \frac{V_m C_j^*}{C_j^2}\right]\Omega^*, \quad \text{where } \Omega^* = \frac{W}{\Sigma(1/2c_i - E\tilde{\pi}_i)},$$

$$= -2\Omega^* V_m C_j^*/C_j^3.$$

Clearly, this cannot be zero, whenever C^* is not zero, indicating that the equilibrium relationship is not linear in the return-risk space.

VI-3. Systematic Risks under Stochastic Exchange Rate Fluctuations

The second component of the risk-premium term is the relevant risk measure associated with direct foreign investment, measured in terms of covariances as in equation (VI.9a) or betas as in equation (VI.9b). Either type of measure has been referred to as "systematic market risk", which cannot be eliminated by diversification. Ordinarily, systematic risk has been defined in the literature only in terms of covariance measures between a security's rate of return and the market rate of return. Our IML model developed in this chapter, however, has derived systematic risk incorporating, also, the covariance between returns and corresponding exchange rate fluctuations, in addition to the ordinary covariance. In other words, the appropriate total risk in our IML model reflects not only the systematic market risk represented by $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{\mu}_m)$ but also systematic foreign exchange rate risk represented by $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{x}_j)$ if the effects engendered by foreign exchange rate fluctuations on the levels of foreign earnings are nonzero. For this reason, we will call the portion of total risk attributed to $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{x}_j)$ to be the "foreign exchange risk" vis-a-vis the traditional market risk measure of SML model which accounts for the portion attributed to $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{\mu}_m)$ only. Consequently, if foreign exchange rates are not perfectly stable, foreign exchange risk must be accounted for in order to arrive at a net systematic risk measure.

A positive value for the exchange rate risk, i.e., $\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j) > 0$, indicates that, ceteris paribus, the jth return is likely to be higher when its corresponding exchange rate changes move in an upward direction. We will denote such investment to mean the "exchange-preferred" investment. Likewise, an investment will be denoted to be an "exchange-averse" investment when its return is negatively correlated with the corresponding exchange rate fluctuations. Thus, when a foreign investment is exchange-preferred, total risk, including both systematic market risk and systematic exchange rate risk, tends to be smaller than it would otherwise be, meaning that the traditional SML model overstates the true risk associated with the investment. On the other hand, an exchange-averse investment leads to increasing the total risk by making the sum of the two covariance terms of the equation (VI.8) larger than it would otherwise be. Under this situation, the SML model results in understating true total risk. Consequently, this misspecification of the relevant risks introduces biases in the investment decision criterion under the traditional SML model. The nature of these biases in turn depends on the nature of the foreign exchange rate fluctuations, distinguished in terms of whether they are exchange-averse, exchange-neutral, or exchange-preferred fluctuations.

Case (1): Exchange-Averse Investments

First, we will consider the case in which investments are exchange-averse, i.e., $\mathrm{Cov}(\tilde{\mu}^*_j, \tilde{x}_j) < 0$. We know from the last section that the intercept of the SML schedule is lower than that of the IML schedule when $g > 0$. The slope of the SML schedule turns out to be also steeper than the IML schedule, as was the case with the previous case in which the investments were assumed to be exchange-neutral.

From differentiating the equations (VI.13a) and (VI.14a) with respect to the systematic market risk, $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{\mu}_m)$, we obtain the following conditions on the relative slopes of the SML and the IML schedules:

$$\mathrm{Slope(SML)} \gtrless \mathrm{Slope(IML)} \quad \text{iff} \quad \Omega_m/\Omega_m^* \gtrless [1 + V_m \mathrm{Cov}(\tilde{\mu}_j^*, \tilde{x}_j)/\mathrm{Cov}^2(\tilde{\mu}_j^*, \tilde{\mu}_m)]. \tag{VI.15}$$

Expression (VI.15) states that the slope of SML curve is steeper or flatter than the IML schedule, depending on whether the investments are exchange-averse or exchange-preferred. Thus, if investments are exchange-averse, i.e., $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{x}_j) < 0$, it follows that the SML schedule in Figure (VI.2) must have a steeper slope than the IML_2 schedule at all given levels of the market risks. This can be seen from noting that Ω_m/Ω_m^* is greater than unity, as was established in the last section, while its right-hand-side expression is always less than unity as long as the investments are exchange-averse.

Consequently, we obtain the results qualitatively similar to those of the previous case, except that the IML_2 schedule in the present analysis represents a non-linear, convex relationship of equilibrium returns with respect to market risk in the return-risk space of Figure (VI.2)[2]. In other words, investors now require proportionally higher returns in exchange for additional market risk they are willing to undertake in the case when investments are exchange-averse. However, it remains true that the traditional SML model is biased upward for those investments

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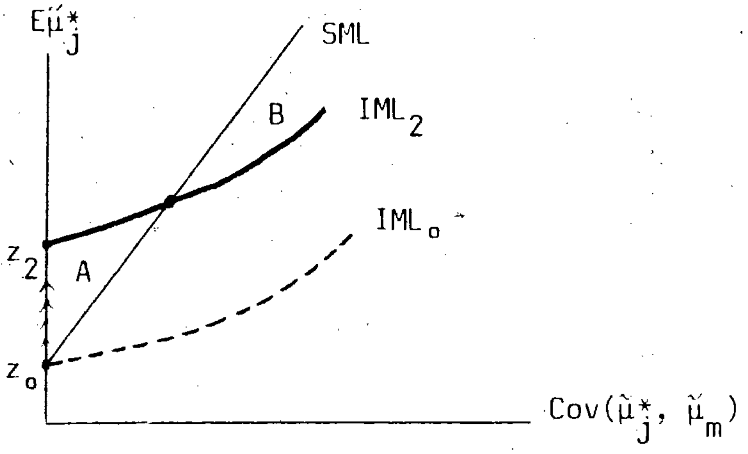
[2] This can be seen by taking a second derivative of the equation (VI.14a) with respect to $\mathrm{Cov}(\tilde{\mu}_j^*, \tilde{\mu}_m)$, which gives $-2V_m\Omega_m^*\mathrm{Cov}(\mu_j^*, x_j)/\mathrm{Cov}^3(\mu_j^*, \mu_m)$, a positive value whenever $\mathrm{Cov}(\mu_j^*, \mu_m)$ is positive, indicating convexity of IML schedule in the return-risk space.

with low levels of the market risk in the sense that it accepts incorrectly some undesirable investments which should be rejected. This is indicated by the area A in the lower wedge between SML and IML_2 schedules below. Consequently, foreign investments with low market risk levels tend to be encouraged by the traditional investment criterion in spite of the fact that the investments under present analysis are exchange-averse. On the other hand, the SML model is biased downward, at the same time, for those investments with high levels of market risk since it rejects incorrectly some desirable investments. This is indicated by the area B in the upper wedge formed by SML and IML_2 schedules. As a result, the level of exchange-averse investments tends to be lower than warranted if they reveal high levels of systematic market risk.

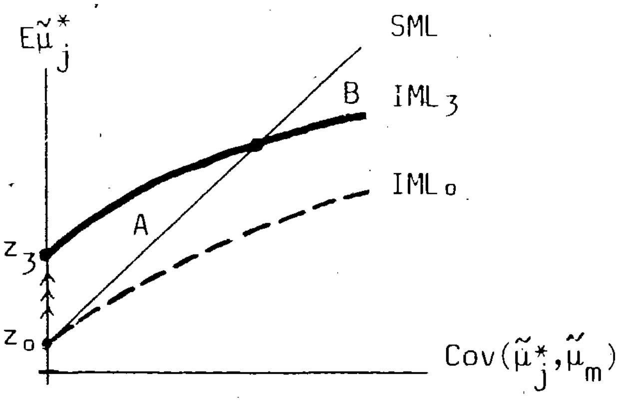
FIGURE (VI.2)



Case (2): Exchange-Preferred Investments

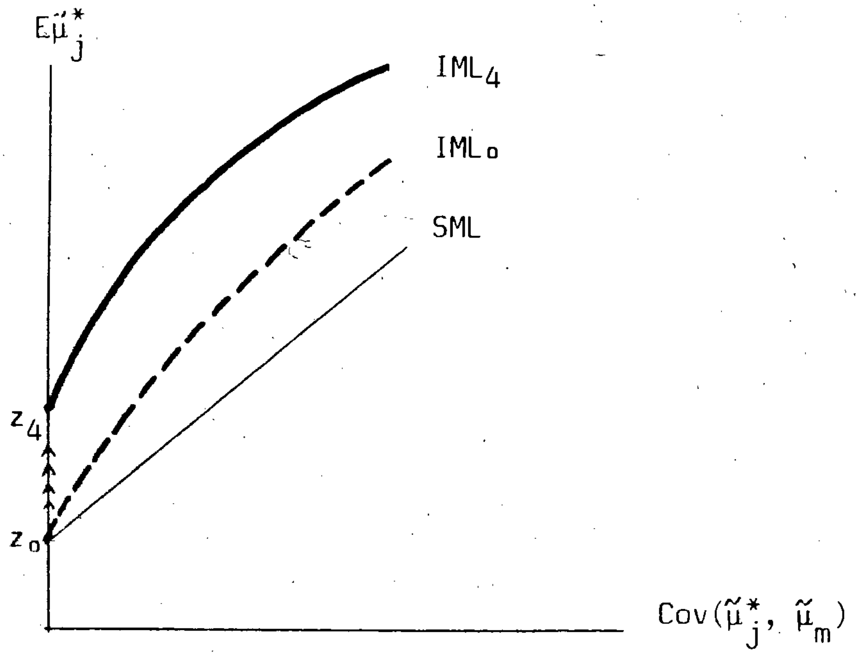
Consider the case in which the investments are exchange-preferred, that is, $\mathrm{Cov}(\mu_j^*, x_j) > 0$. From the expression (VI.15), it can be seen that the slope of SML schedule may be either steeper or flatter depending on the values of Ω_m/Ω_m^* in relation to its right-hand-side expression. Thus, if Ω_m/Ω_m^* is greater than the right-hand-side value in the expression (VI.15), the SML schedule in Figure (VI.3) must have a steeper slope than the IML_3 schedule. Consequently, we obtain qualitatively similar results again as those of the two previous cases, except that the present IML_3 schedule represents a non-linear, concave relationship of the equilibrium returns with respect to market risk levels in the return-risk space of the Figure (VI.3). In other words, investors require proportionally smaller returns for additional market risk they are willing to undertake in the case when the investments are exchange-preferred. As before, however, the traditional SML model is biased upwards—for those investments with low levels of market risk, resulting in higher levels of those investments than warranted. At the same time, the SML model is biased downwards for those investments with high levels of market risk in spite of the fact that the investments are exchange-preferred. The corresponding biases are indicated, respectively, by the areas A and B in Figure (VI.3).

FIGURE (VI.3)



If on the other hand, Ω_m/Ω_m^* is less than its right-hand-side value in the expression (VI.15), the SML schedule must have a flatter slope than the IML_4 schedule in Figure (VI.4). Consequently, the SML schedule must lie strictly below the IML_4 schedule since its intercept z_0 is located below z_4 corresponding to the IML_4 schedule. According to traditional investment criterion under the SML model, therefore, we are led to accept incorrectly all of those exchange-preferred investments when their return-risk combinations are trapped within the area between SML and IML_4 in the Figure (VI.4). Resulting from this, the level of exchange-preferred investments tends to be higher than warranted at all levels of market risk, and hence, the SML model is biased upward since it incorrectly accepts some undesirable investments that should be rejected according to IML_4.

FIGURE (VI.4)



VI-4. Empirical Estimation of IML Model under Exchange Rate Fluctuations[1]

The purpose of this section is to estimate the SML and IML models developed in this chapter and present preliminary results to set the stage for further analyses, investigating the effects on the equilibrium return-risk relationship brought about by stochastic exchange rate fluctuations. For preparing the input required for the empirical analyses, we have converted all relevant data to U.S. dollars. First, rate of return in year t -- is defined to be the annual average rate of aggregate returns earned from all types of manufacturing. Time-series on the returns from individual investments are those obtained in chapter II. Second, foreign exchange rates are defined to be the annual average price levels per unit of a foreign currency in terms of U.S. dollars. From the annual average dollar prices of a foreign currency, we calculated an expected rate of change in annual average price levels to obtain the expected exchange rate fluctuations in year t. Repeating this procedure for each year, we generated the corresponding time-series on the expected rate of fluctuations in exchange rate levels. Third, a single-index market rate of return is obtained by calculating a weighted average of the individual investment's annual average rates of return in year t, which includes both U.S. domestic and all U.S. foreign investments abroad in manufacturing industries. Iterating this procedure, the time-series on the single index market rate of return was generated for employment as our proxy to represent market rates of return.

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[1] The stated objective of our empirical investigation is not to test CAPM model, nor is it to verify the validity of such test methodology employed elsewhere. See Cheng and Grauer (1980) for a modern approach to the subject matter. Instead, our express purpose is to capture empirically the effects of exchange fluctuations and to expose quantitative differences between the two models, reflecting the type of qualitative differences enunciated in this chapter.

Market rate beta for a given investment was generated by estimating the characteristic line of the corresponding investment's return with respect to market rates of return obtained above, that is, by performing a simple first-pass regression of the investment's return on the market index rate's time-series. This procedure was repeatedly applied for all individual investments, thus generating a set of cross-sectional data on market rate betas. Likewise, the exchange rate beta of a given investment was generated by estimating the characteristic line of foreign investment returns with respect to exchange rate fluctuations obtained above. In other words, we estimated the investment's simple first-pass regression equation by regressing the time-series of investment returns linearly on the time-series of the corresponding exchange rate fluctuations. This procedure applied to all foreign investments generates a set of cross-sectional data corresponding to exchange-rate betas over the cross-section of individual foreign investments.

Employing the above-generated data sets, we propose to investigate the hypotheses suggested by SML and IML models. For this purpose, we estimated the respective equilibrium relationship specified under the two models by performing simple second-pass regressions, i.e., by running linear regressions over the cross-sectional data sets generated from the above simple first-pass regressions. In order to estimate equilibrium return-risk relationship, we could represent risks either in terms of the betas or equivalently in terms of covariances. In this thesis, we adopted to carry out all of our empirical analyses in terms of the betas, following the equation (VI.5b). Therefore, we estimated regression equations of the following forms:

SML: $E\tilde{\mu}^*_j = z + \lambda b_j + e_j$ (VI.15a)

IML: $E\tilde{\mu}^*_j = z' + \lambda' b_j + z^* E\tilde{x}_j + \lambda^* b^*_j + e'_j$ (VI.15b)

From taking partial derivatives of the equation (VI.5b) with respect to the relevant regressors of the respective models specified above, we have extracted the following testable hypotheses:

H_1(SML): The estimated coefficients for the intercept and the slope of the market rate risk variable should be both positive, i.e., $z, \lambda > 0$ for the SML model.

H_2(IML): Likewise, $z', \lambda' > 0$ for the IML model.

H_3(IML): The estimated coefficient for exchange rate fluctuations should be positive and approximately unity, i.e., $z^* \cong 1$.

H_4(IML): The estimated coefficient for exchange rate fluctuations should be negative, i.e., $\lambda^* < 0$.

The first two hypotheses state that both the risk-free rate and the marginal effects of market rate risk should be positive. But it should be noted that the SML model's slope coefficient for the market rate risks include the indirect effects on returns, which can be seen to come about, in the equation (VI.5b), from market rate risks interacting with their corresponding exchange rate risks in a non-linear and composite fashion. The third hypothesis H_3 of the IML model states that an increase of the expected exchange rate should lead to a higher return earned on the corresponding investment. Moreover, it should affect the equilibrium return in an equiproportional amount in the same direction. Lastly, the fourth hypothesis H_4 of the IML model states that foreign returns investors are willing to accept are smaller, in equilibrium, where the investments tend to be exchange-preferred. In other words, the more total risk of an investment is reduced by offsetting exchange rate risk, the smaller will be the return required by investors in equilibrium.

Empirical results of the above regressions are reported in Table (VI.1). The results show that the estimated intercept terms of the SML and IML models are both positive, and they are statistically significant at the 99 % level of confidence. Likewise, the estimated slope coefficients of market rate risks are positive for both model, but the statistical significance could not be established for the IML model. The estimated slope coefficient for the exchange rate variable is positive and statistically significant at the 95 % level of confidence. Moreover, its magnitude is estimated to be .7901, thus roughly approximating the value of unity as the theory suggested. Lastly, the estimated slope coefficient of exchange rate risk from the IML model is negative, as was specified in the last hypothesis, but its statistical significance could not be established for the test's time-period between 1968 to 1982.

The correlation coefficients are .1854 for the SML model, and .6296 for the IML model. Thus, judging from the two models' correlation coefficients alone, one could make an argument that the IML model performed significantly better than the traditional SML model. However, the level of explanatory power in both models was distressingly low to warrant such a claim, although it was considerably higher in the IML model in comparison to the SML model. Thus, we are hesitant at this stage of the investigation to conclude definitively one way or the other, and henceforth, we proceed to carry out our empirical analyses by employing portfolio data.

Although it is not one of our principal objectives to present any systematic treatment on various econometric problems of employing individual investment's betas[2], we adopted the following portfolio approach mainly to obtain more efficient ex post estimates of ex ante conditional return distributions, and thereby to improve the statistical quality of empirical results as compared to the above approach. The portfolio approach taken in this thesis includes all U.S. domestic investments and U.S. foreign investments in eight individual countries for all types of manufacturing. Thus, the rate of return earned on portfolio p in year t was calculated by taking a simple weighted average of the individual investments' annual averages of aggregate returns previously calculated. The corresponding exchange rate variable was calculated in analogous manner. Iterating this procedure over time generated a set of time-series on a portfolio's return and exchange rate data. Replicating the above procedure, we formed nine more marginal portfolios, each portfolio formed by replacing successively one investment from a previous portfolio with a new investment.

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[2] The primary problem with such an approach arises from the well-known "errors-in-the-variables".

From estimating the respective characteristic lines by use of thus-generated time-series, we obtained cross-sectional data sets corresponding to market rate betas and exchange rate betas. Next, from averaging, on an annual basis, a portfolio's time-series of earnings, and repeating the calculations for all other portfolios, we generated the cross-sectional data set corresponding to portfolio earnings. Likewise, cross-sectional data sets for the exchange rate variable were generated in strictly analogous manner.

Employing thus-generated cross-sectional data sets, we estimated again the regression equations (VI.15a) and (VI.15b), to test the four hypotheses stated earlier. The empirical results obtained from the present regressions are reported on the lower half of the Table (VI.1). First, the reported results from the SML model show that the statistical significance of its estimated slope coefficient for the market rate risk variable still cannot be established. The statistical significance for λ has worsened from the initial value of .7058 to the value of .1201, as a result of employing portfolio data. More seriously, the correlation coefficient has deteriorated to such an extent that there was virtually no explanatory power left in the SML model.

Second, the quality of empirical results obtained from the IML model has improved significantly across the board following the use of portfolio data. The statistical significance of each parameter estimated has improved markedly. As well, the correlation coefficient obtained from the IML model has also improved dramatically from the initial value of .6296 to the value of .9404, thus explaining nearly 90% of total variations of the equilibrium relationship. According to empirical results of Table (VI.1), the slope coefficient of market rate risk estimated from our IML model is far greater than the value estimated from the traditional SML model, indicating that the nature of the equilibrium returns is far more sensitive to market rate risk than indicated by empirical results of the SML model. Moreover, judging from the astoundingly improved correlation coefficient due to introducing stochastic exchange rate fluctuations in our IML model, we are inclined to conclude that the role of exchange rate fluctuations, sine qua non, for explaining equilibrium return performances, is far more crucial than any other considerations. This is substantiated by the observation that once exchange rate influences are removed from a regression, such as the SML model, virtually all of the explanatory power simply evaporates leaving nothing to the remaining variables.

In addition to our previously enunciated importance of exchange rate fluctuations for its inclusion in the IML model on purely theoretical grounds, we are led to conclude on empirical basis also that our IML model performs more precisely and is qualitatively superior to the traditional model. The theoretical results and empirical findings obtained in this chapter suggest that the role of the exchange rate fluctuations for explaining equilibrium returns on foreign investment is, indeed, essential.

TABLE (VI.1)

EMPIRICAL ESTIMATION OF SML AND IML MODELS

	z	z^*	λ	λ^*	$t(z)$	$t(z^*)$	$t(\lambda)$	$t(\lambda^*)$	Corr
SML	11.2123	----	2.2828	----	4.3670*	----	.7058	----	.1854
IML	13.9725	.7906	.9532	-3.9904	5.1973*	2.6101*	.2798	-.5899	.6296
SML_p	12.7505	----	.3579	----	5.3630*	----	.1201	----	.0424
IML_p	12.8332	.6035	4.6552	-7.8437	9.5517*	3.3353*	2.2513**	-6.3528*	.9404

Sources: <u>Survey of Current Business</u>, August 1967 through August 1984 for data used in the rate of return variable.

<u>Federal Reserve Bulletin</u>, 1967 through 1984 for the data used in the exchange rate variable.

Note: The subscript p stands for the portfolio approach, which is used to avoid the measurement error problem of the estimated betas employed in the above second-pass regressions. Since there is a large econometric literature on the errors-in-the-variables problem, it is not intended to consider the technical aspects of the problem in any formal way here. See Johnston (1972), pp. 281-292, for a rigorous exposition. In intuitive terms, however, the problem arises from the fact that if a proxy variable (i.e., estimated variable) is used in the above second-pass regressions, the computed regression coefficients do not have the same properties as if the true measure of the regressors (i.e., population parameters) were used. Thus, we formed marginal portfolios to lessen the problem based on individual investments in nine countires, each of which is chosen according to decreasing order of the magnitudes in the exchange rate betas estimated for the individual investments. Durbin-Watson test was performed on the portfolio data employed for estimating the IML model. The computed statistic for the autocorrelation of residuals was 2.08348, thus indicating no evidence of the autocorrelation problem. However, the same could not be claimed for the regression employing individual data. Its computed value for the Durbin-Watson statistic was 1.30745, indicating inconclusive evidence of the serial correlation. The lower and upper critical values with 15 degrees of freedom and 3 exogenous variables are, respectively, $d_L = .82$ and $d_u = 1.75$ at 5 % level of significance.

* denotes statistical significance at 1 % level, and ** at 5 % level.

Aside from the afore-mentioned criticisms of the traditional SML model that it results in a misspecification of the true equilibrium return-risk relationship when exchange rate fluctuations are uncertain, it is also subject to another kind of criticism. Specifically, Professor Cheng has argued that the traditional SML model results in contradiction because systematic market risk is a function of time, which cannot be held constant over time. Consequently, it results in misspecifying the true equilibrium return-risk relationship in any empirical tests because systematic market risk, as a population regression coefficient, is not independent of the regressor representing the market rate of return. In the context of our present analysis, the relevance of this criticism is heightened by the time-dependent nature of exchange rate fluctuations and its corresponding coefficients from one equilibrium situation to another. In a stochastic world, an investment cannot be expected to remain either exchange-preferred or exchange-averse at all times, between different equilibrium situations. Consequently, we expect the equilibrium relationship to shift over different time-periods. In the following chapters, we will attempt to provide a systematic treatment of the effects of exchange rate fluctuations, focusing on the way in which the equilibrium level of return, its stability, and the systematic risks are affected in individual investments and in portfolios, as well as on the way in which these estimated effects shift over time. For this purpose, we proceed to criss-cross over various aspects of the equilibrium return-risk relationship, always putting forth the role played by exchange rate fluctuations for subsequent investigations.

CHAPTER VII. EFFECTS OF EXCHANGE RATE FLUCTUATIONS ON MEANS AND VARIANCES OF FOREIGN RETURNS

VII-1. First-Pass Regression Analysis on Foreign Exchange Rates and Returns

In order to investigate empirically the effects of foreign exchange rate fluctuations on rates of return earned by U.S. wealth holders, all relevant data are converted to U.S. dollar figures. This was done for calculating rates of return on individual foreign investment and on portfolios containing investments in manufacturing industries. Foreign exchange rates are the annual average figures of U.S. dollar prices per unit of foreign currency. From the annual average dollar price of each foreign currency, we have calculated the annual average rates of change in foreign exchange rates. These figures for annual average foreign rates of return and exchange rates are then used to carry out first-pass regressions for time-series analyses on the return performance of foreign investment.

The time-period under present investigation is between 1968 and 1982. This period is subdivided into 6 moving marginal subperiods, each marginal subperiod being 10 years in length. In other words, each marginal subperiod was formed by successively deleting the oldest observation from the previous subperiod's data set, using the first subperiod between 1968 and 1977 as our starting base-period, and then simultaneously adding a new observation to the current subperiod's data set. For example, our second marginal subperiod is formed by deleting 1968 from the base-period, but at the same time, adding 1978 to the second subperiod, giving us another subperiod from

1969 to 1978. From each marginal subperiod, we calculated the period's average values for the variables analyzed in this study. The subperiods' average figures of the 10 annual average values were then used in order to expose any time-dependent shifts of estimated regression coefficients between the subperiods. For each subperiod, we also ran second-pass regressions for the purposes of cross-sectional analysis between portfolio performances in terms of portfolio's return, stability and systematic risk.

Since all data are converted to U.S. dollar figures, changes in exchange rates are invariably embedded in foreign rate of return. The purpose of this section is to isolate and empirically test the effects of foreign exchange rate fluctuations on individual countries' return performance as well as on portfolios' return performance. Specifically, this section investigates the hypothesis that foreign return performance has a positive functional relationship with changes in foreign exchange rates.
In other words, we propose to test empirically whether increases in foreign exchange rates exert a positive impact on rate of return earned on foreign investment, and if so, to what extent the foreign rate of return is affected by exchange rate fluctuations.

As a point of reference, we first ran first-pass regressions, i.e., time-series regressions, for each of ~~the~~ 16 countries reported in Table (VII.1). A simple regression was run for each investment to fit the time-series on rate of return and exchange rate fluctuations, reflecting the hypothesis that over time, there exists a functional relationship between the two variables. Denoting the symbol μ^*_{jt} for the annual average return on jth investment, and x_{jt} for annual average value in jth exchange rate variable in period t, the first-pass regression of the following simple linear form was estimated for each jth investment:

$$\mu^*_{jt} = a_j + b^*_j x_{jt} + e_{jt}, \qquad \text{(VII.1)}$$

where

$x_{jt} = d\ln X_{jt}/dt$.

X_{jt} = jth exchange rate's annual average in year t.

The relevant regression results are provided in Table (VII.1). The reported results show definite indications of a positive relationship between the two variables in all regressions. Slope coefficients for the foreign exchange rate variable are all positive and less than unity, ranging from .1774 in the case of Italy to .6444 in the case of Germany. Positive value for slope coefficients indicate that a one percent increase of the rate of change in foreign exchange rates would lead, over time, to increasing the rate of return on foreign investment, but at a rate somewhat slower than the pace at which the exchange rate variable increases.

Regression coefficients are statistically significant at more than 95% level of confidence, except in the cases of Canada, Italy, and Sweden. The correlation coefficient between the foreign rate of return

TABLE (VII.1)

	a	b^*	$t(a)$	$t(b^*)$	$E(\mu^*)$	$E(x)$	$V(\mu^*)$	$V(x)$	Corr
Austrialia	10.22	.39	12.75	3.48	10.09	-.36	17.30	54.22	.6954
Belgium	11.61	.41	11.94	4.15	12.01	.96	30.30	101.24	.7549
Canada	10.04	.20	16.40	1.16	9.87	-.84	5.42	11.79	.3075
Denmark	12.33	.28	9.80	1.99	12.11	-.78	28.54	84.53	.4844
France	11.89	.48	14.08	5.92	12.22	-1.37	36.08	110.16	.8542
Germany	16.34	.64	9.31	3.62	18.78	3.78	73.60	89.05	.7088
Italy	16.96	.17	10.81	1.14	16.15	-4.57	30.05	87.58	.3029
Japan	17.24	.40	14.12	3.29	18.39	2.83	30.95	97.22	.6742
Netherland	13.58	.44	15.25	4.38	14.64	2.39	25.36	76.96	.7724
New Zealand	12.23	.52	14.69	5.44	11.06	-2.24	29.51	74.72	.8336
Norway	10.82	.30	14.77	3.58	10.85	.09	14.85	79.13	.7047
South Africa	15.28	.38	9.54	2.04	14.38	-2.34	43.53	70.43	.4927
Spain	7.90	.61	5.36	4.37	5.87	-3.33	68.18	106.71	.7715
Sweden	11.24	.20	10.47	1.48	11.04	-.98	18.49	63.82	.3816
Switzerland	15.79	.35	13.75	3.87	17.85	5.72	31.16	129.60	.7320
U.K.	12.53	.50	9.92	3.63	11.25	-2.56	41.20	81.86	.7097

Sources: Survey of Current Business, 1967 through 1984 for the data used in rate of return calculations.

Federal Reserve Bulletin, 1967 through 1984 for exchange rates.

Notes: Correlation coefficients obtained from the above characteristic line with respect to exchange rate fluctuations are substantially higher than those from the characteristic lines with respect to market rate of return in the case of the returns on direct foreign investments. For comparison, see Table (VIII.1) of this thesis. However, the reported correlation coefficients in this table are comparable to those obtained for the more than 1000 individual NYSE stocks, most of which show correlation coefficients between .50 and .70.

and exchange rate fluctuations ranges between .3029 in the case of Italy and .8542 in the case of France. Thus, as the IML model has suggested, changes in foreign exchange rates exert a direct and a positive impact on the rate of return earned on foreign investments. Other results from the regressions are reported in Table (VII.1).

Next, following the same procedure taken above, we also carried out first-pass regressions by use of portfolio data prepared in the last chapter. A simple regression was performed to fit the time-series of portfolio returns and exchange rate fluctuations, reflecting our present hypothesis that over time, there exists a simple functional relationship between the two sets of time-series. Denoting the symbol μ^*_{pt} to stand for annual rate of return on portfolio p in year t, and x_{pt} to represent the annual average of exchange rate fluctuations for the corresponding portfolio, we ran the first-pass regression of the following simple linear form for each portfolio:

$$\mu^*_{pt} = a_{pt} + b^*_p x_{pt} + e_{pt}. \qquad \text{(VII.2)}$$

The relevant regression results are reported in Table (VII.2). The results show a definite indication of a positive relationship between the two variables in each of the regressions we performed. The estimated slope coefficients of the exchange rate variable are all positive and smaller than unity. Their magnitudes are approximately the same as those obtained earlier, ranging between .1814 and .5025 for the present regressions using portfolio data. Thus, we would expect that a one percent increment of the portfolio's exchange rate results in raising the return earned on the portfolio over time, but at a rate slower than the pace at which the exchange rate is expected to rise.

It is noteworthy that resulting from the use of our portfolio data, we were able to reduce significantly the level of instability in the estimated slope coefficients, in addition to observing the usual reduction in the variance of returns following portfolio formation. At the same time, it was possible to enhance the statistical quality of the empirical results. Regression coefficients obtained for equation (VII.2) were statistically significant at more than 99% level of confidence, except in the case of PORT10. The correlation coefficient between the two time-series of the corresponding portfolio data ranged between .4260 and .8877. Except for two cases, the correlation coefficient exceeded .75 level. In other words, the exchange rate variable alone is capable, over time, of explaining substantially more than 50% of the total variation of return in the other eight cases. Thus, exchange rate fluctuations provide a consistent explanation for the variations of levels of return earned on either individual investments or on portfolios. As the IML model has stated, exchange rate fluctuations indeed exert a direct and positive impact on levels of return performance. This is further discussed later on, but now we will proceed to dig inside inter-temporal pattern of the relationship between the two variables.

TABLE (VII.2)

$\mu^*_{pt} = a_p + b^*_p \, x_{pt} + e_{pt}$:

	a	b*	t(a)	t(b*)	E(μ*)	E(x)	V(μ*)	V(x)	Corr
PORT1	13.06	.50	22.77	6.34	12.78	-.57	18.77	56.42	.8695
PORT2	12.34	.50	24.83	6.95	11.80	-1.09	15.84	49.42	.8877
PORT3	13.17	.42	22.99	4.87	12.74	-1.03	12.64	44.82	.8042
PORT4	13.62	.44	25.67	5.48	13.51	-.27	13.00	45.80	.8358
PORT5	13.45	.41	26.96	5.64	13.46	.01	11.96	49.36	.8426
PORT6	13.55	.38	26.75	5.09	13.56	.01	10.72	48.92	.8165
PORT7	13.20	.39	27.94	4.92	13.03	-.43	8.87	36.70	.8071
PORT8	13.14	.35	26.84	4.13	12.91	-.66	7.64	34.52	.7539
PORT9	13.14	.29	21.71	3.14	12.68	-1.59	7.68	38.63	.6574
PORT10	14.19	.18	20.60	1.69	13.89	-1.69	7.51	41.44	.4260

Note: All of the estimated regression coefficients are statistically significant, with the exception of PORT10, at less than 1% level of significance.

VII-2. First-Pass Subregression Analysis: Inter-Temporal Patterns of Effects Induced by Exchange Rate Fluctuations

Taking one portfolio data set at a time, we ran six subregressions, each subregression corresponding to a particular subperiod. This procedure was repeated for each portfolio, in order to reveal any time-dependent shifts of the estimated regression parameters. This iterative procedure also enables us to distill the necessary data for further employment in subsequent investigations regarding the stability of returns and the cross-sectional patterns of estimated parameters. However, this procedure has involved sixty separate regressions for this purpose alone. In order to avoid being swamped by a flood of statistical results, we have reported in Table (VII.3) the subregression results of PORT1 only.

We will denote the symbol μ^*_{pst} to represent the annual average rate of return on portfolio p, in subperiod s, in year t, and denote the symbol x_{pst} to represent the corresponding exchange rate variable. We ran the first-pass subregression of the following form in each subperiod for a given portfolio, and iterated the procedure for all the other portfolios:

$$\mu^*_{pst} = a_{ps} + b^*_{ps}\, x_{pst} + e_{pst}. \qquad \text{(VII.3)}$$

The reported results in Table (VII.3) show that there existed a positive relationship between the two time-series in every subperiod we considered for this study. All of the estimated regression coefficients were statistically at more than a 99% level of confidence. Correlation coefficients remained above .66 level through the entire period..

However, the Table (VII.3) also reveals that the estimated slope coefficients, generated from individual subregressions for a given portfolio, have steadily increased over the time-span of six subperiods we considered. This implies that foreign rates of return have become more susceptible, over the years, to changes in exchange rate fluctuations, meaning that the true equilibrium relationship between the two variables may have been shifting upwards over time. Thus, the magnitude of the marginal effect exchange rate fluctuations can bring to bear upon foreign return performance has increased, for example, from the value of .3438 in SUBP1 to the value of .5260 in SUBP6. In other words, a one percent increment of the exchange rate level has resulted in improving return performance in excess of a half percentage point by the last subperiod. Moreover, the correlation coefficients also have improved steadily over the same time-span, from the value of .7021 in SUBP1 to the value of .8911 in SUBP6. In other words, the exchange rate variable alone could explain nearly 80 % of the total variation in return performance by the last subperiod.

These findings in turn increase our suspicion that the characteristic relations of return performance with respect to exchange rate fluctuations may not be stable from period to period, i.e., may not be time-independent. In order to investigate empirically this possibility,

TABLE (VII.3)

	a	b*	t(a)	t(b*)	E(μ*)	E(x)	V(μ*)	V(x)	Corr
SUBP1	13.19	.34	18.89	2.78	13.57	1.09	8.28	34.31	.7021
SUBP2	13.59	.33	17.88	2.52	14.20	1.79	8.32	32.22	.6663
SUBP3	13.78	.36	16.48	2.62	14.68	2.44	9.66	33.28	.6809
SUBP4	13.24	.40	15.99	2.95	14.26	2.48	10.57	33.03	.7227
SUBP5	13.28	.44	18.13	4.73	13.58	.66	18.00	66.48	.8585
SUBP6	13,16	.52	16.54	5.55	12.38	-1.50	26.48	75.98	.8911

Note: All of the estimated regression coefficients are statistically significant at less than 1% level of significance.

we obtained the time-series on estimated slope coefficients of characteristic lines with respect to exchange rate fluctuations, which we have termed the "exchange rate beta." Each observation point of a given time-series comes from the corresponding first-pass subregression we performed in equation (VII.3). In this way, time-profiles of exchange rate betas are prepared for all the other portfolios. Using these data sets, we propose to test the hypothesis that the exchange rate betas are an increasing function of time.

To test the above hypothesis explicitly, we devised the following simple regression approach without losing the essence of such tests:

$$b^*_{ps} = a_p + c^*_p T_{ps} + e_{ps}, \qquad \text{(VII.4)}$$

where b^*_{ps} represents the exchange rate beta corresponding to portfolio p in subperiod s, and T_{ps} represents the time variable.

In terms of the above regression equation (VII.4), we will focus on testable implications of time-independence of exchange rate betas, i.e., based on the time variable's coefficients:

H_0: The time-coefficients of exchange rate betas are zero, that is, $c^*_p = 0$ for all portfolios.

Table (VII.4) reports the empirical results obtained from the regression equation (VII.4). The reported results indicate that the exchange rate betas have positive time-coefficients in all other than two cases, thus confirming our present hypothesis that exchange rate betas tend to shift upwards with passage of time. However, estimated time-coefficients are statistically significant at 95 % level of confidence in only three of the cases. Thus, while it is true that the estimated exchange rate betas tended to move upwards over time, their statistical significance could not be established unequivocally across the board. In no way do these necessarily imply that the equilibrium exchange rate betas have remained independent of time. To further delve into the question of time-independence of the estimated parameter, we will proceed to investigate empirically the time-profile of its cross-sectional relationship.

TABLE (VII.4)

$b^*_{ps} = a_p + c^*_p T_{ps} + \hat{e}_{ps}$:

	a	c*	t(a)	t(c*)	Corr
PORT1	-2.59	.037	-5.51	6.38*	.9542
PORT2	-1.74	.027	-3.26	4.07*	.8978
PORT3	-1.03	.017	-1.62	2.22*	.7435
PORT4	-.63	.013	-.90	1.51	.6028
PORT5	-.36	.009	-.60	1.25	.5326
PORT6	.16	.002	.22	.28	.1402
PORT7	.25	.001	.30	.13	.0673
PORT8	.18	.005	1.25	1.22	.5237
PORT9	.70	-.015	.95	-.55	.2661
PORT10	.45	-.003	.54	-.29	.1480

Note: * denotes statistical significance at 5% level of significance.

VII-3. Second-Pass Regression Analysis for the Cross-Sectional Effects of Exchange Rate Fluctuations

The question we ask in this section is whether within a given time-period, exchange rate fluctuations exert a positive cross-sectional impact across individual investment return performance, as well as across various portfolio return performance. That is, we propose to test the hypothesis that a positive relationship between returns and exchange rate fluctuations exists across various investments, and also across various portfolios, during a specified time-period. Thus, if indeed there exists a positive relationship between the two variables over a cross-section of individual investment and over a cross-section of individual portfolios, then we would expect the returns earned on an investment or a portfolio to perform better or poorly, depending ~~on~~ whether corresponding exchange rate changes were, respectively, favorable or unfavorable.

For the purposes of testing the above hypothesis, a simple second-pass regression was performed to fit cross-sectional data on average values of return and exchange rate variables, which were obtained from the first-pass regressions we ran in the previous sections. This regression was carried out by employing both individual investment data and portfolio data. It should be remembered, however, that the relevant data used for second-pass regressions are expected values of corresponding time-series, which have been obtained by averaging, on an annual basis, ex post time-series actually observed.

First, we denote $E\mu^*_j$ ~~to~~ represent the expected value of jth investment's annual average rates of return from 1968 to 1982, and denote Ex_j to represent the expected value of the corresponding exchange rate variable. From the simple second-pass regression, we obtained the following:

$$E\mu^*_j = \underset{(.7232)}{13.0975} + \underset{(.2702)}{.7895}\, Ex_j + \underset{(2.8816)}{e_j}. \qquad \text{(VII.5)}$$

Likewise, denoting $E\mu^*_p$ to represent the expected value of pth portfolio's average annual rate of return, and Ex_p to represent the expected value of the corresponding exchange rate variable, we performed the simple second-pass regression using the portfolio data:

$$E\mu^*_p = \underset{(.3116)}{13.2334} + \underset{(.3350)}{.2713}\, Ex_p + \underset{(.6094)}{e_p}. \qquad \text{(VII.6)}$$

As the above results show, the estimated slope coefficient is positive and less than unity in either case. In other words, there exists a positive relationship between the two variables over a cross-section of investments or portfolios. Thus, rate of return tends to be high, on the average, in those investments in which its corresponding exchange rate increment is also high. The estimated slope coefficient was statistically significant ~~at~~ more than ~~99% level~~ of confidence when using the individual investments' data, but its statistical significance, when the portfolio data are used, could not be established at 90 % level of confidence. The correlation coefficients from the above regressions are .6144 and .2753, respectively, for equations (VII.5) and (VII.6). Next, we will proceed to estimate the above regression equations according to subperiods.

VII-4. Second-Pass Subregression Analysis: Inter-Temporal Profiles of the Cross-Sectional Effects Induced by Exchange Rate Fluctuations

The objective of this section is to investigate the inter-temporally shifting patterns of a given subperiod's cross-sectional effects induced by exchange rate fluctuations. For this purpose, we will first examine whether or not the positive cross-sectional effect of the exchange rate fluctuations could be established within a subperiod as well. In other words, we ask whether exchange rate fluctuations exert a positive impact on return performance over a cross-section of portfolios in any given subperiod. Applying this test repeatedly to all other subperiods enables us to force out the time-profile of the exchange rate's cross-sectional effect on return performance, brought about by any shifts of existing equilibrium conditions from one subperiod to another.

Taking one subperiod at a time, we have collected the corresponding cross-sectional data set of returns and exchange rate fluctuations, obtained from the results of the first-pass subregressions we ran in section (VII.2). We then ran the corresponding second-pass regression on this data set. This procedure was iterated succesively for all other subperiods. It may appear, at a first glace, cumbersome to follow this seemingly drudgerious process. But its importance becomes apparent once we recognize that this procedure enables us to penetrate the surface of an essentially static cross-sectional pattern. Consequently, we can capture the time-profile of inter-temporally shifting undercurrents affecting the cross-sectional parameters estimated, and subject it to empirical tests explicitly.

For this purpose, we denote $E\mu^*_{ps}$ to represent the expected value of annual average returns on portfolio p in subperiod s, and denote Ex_{ps} to represent the expected value of the corresponding exchange rate variable. We ran the second-pass regression of the following form in each subperiod:

$$E\mu^*_{ps} = a_s + \lambda_s Ex_{ps} + e_{ps}. \qquad \text{(VII.7)}$$

The relevant results from the above regressions are reported in Table (VII.5). As the results show, the estimated slope coefficients were positive, except in the case of SURP6. In other words, there exists a positive relationship between the two variables over the cross-section of portfolios in every subperiod except SUBP6, meaning that changes in expected exchange rate fluctuations exert a direct effect on corresponding returns in the same direction over the cross-section of portfolios.

The results reported in the Table (VII.5) also indicate that the estimated slope coefficient has consistently decreased in its magnitude, starting from the initial value of .7590 in the first subperiod to the final value of -.0282 in the last subperiod. Likewise, estimated correlation coefficients have decreased from the initial value of .7941 to the final value of .0261. The estimated slope coefficients were found to be statistically significant at the 95% level of confidence in the first three subperiods only.

In interpreting the above results, however, we must bear in mind that the regression equations estimated are not the sort of relationship we would expect to observe in equilibrium situations, other than giving a simple empirical relationship between two variables only.
Indeed, we had argued in the previous chapter that the equilibrium return on foreign investments is related to not only the level of expected exchange rate fluctuations but also other variables. Because of this, poor performance of the present regression is to be expected. We will return to investigate equilibrium return performance by employing multiple regression analyses in the next chapter. But first, we will proceed to examine the manner in which stability of foreign returns are affected by changes in stability of the corresponding exchange rate fluctuations.

TABLE (VII.5)

$E\mu^*_{ps} = a_s + \lambda_s \, Ex_{ps} + e_{ps}$:

	a	λ	t(a)	t(λ)	E(μ^*_p)	E(x_p)	V(μ_p)	V(x_p)	Corr
SUBP1	12.48	.75	54.40	3.69*	13.22	.97	.31	.34	.7941
SUBP2	12.89	.53	34.25	2.14*	13.60	1.32	.49	.63	.6047
SUBP3	13.34	.42	41.09	2.37*	14.04	1.62	.31	.72	.6435
SUBP4	13.57	.25	30.02	1.13	14.05	1.88	.31	.68	.3721
SUBP5	13.95	.01	52.68	.02	13.96	.39	.50	.73	.0080
SUBP6	12.96	-.02	19.28	-.07	13.01	-1.59	.74	.63	-.0261

Note: * denotes statistical significance at 5% level of significance.

VII-5. First-Pass Regression Analysis on Variances of Foreign Return Performance and Exchange Rate Fluctuations

The question we pose in this section is whether and to what extent the total risk level, or equivalently the gross instability level of foreign return performance, is influenced by exchange rate fluctuations. Thus, from noting that the total variance of nominal returns $V(\mu_j^*)$ is the sum of the variance of real returns $V(m_j^*)$ and the variance of exchange rate fluctuations $V(x_j)$ plus $2\mathrm{Cov}(m_j^*, x_j)$, we would expect changes in total risk to be explained, for the most part, by the variance of exchange rate fluctuations alone. This is because if the real return, i.e., the rate of return excluding the foreign exchange rate effect, remains fairly stable, we would expect that its variance and hence its covariance with exchange rates to remain negligible in magnitudes. Specifically, it is hypothesized that the total risk level is an increasing function of the variance of exchange rate fluctuations. Consequently, we propose to test the hypothesis empirically by use of the time-series on variances of returns and exchange rate fluctuations.

In order to investigate inter-temporal effects on the total risk level, we have generated the time-series on the variance of portfolio returns and corresponding exchange rate fluctuations from individual subregressions we performed previously. Thus, each observation point of a given portfolio's data corresponds to a particular subperiod for which the relevant first-pass subregression was performed. In this way, we have generated ten separate sets of time-series, each set corresponding to a particular portfolio's variance of returns and exchange rate fluctuations.

A simple first-pass regression was run to fit the time-series on variance of returns and variance of exchange rate variable, reflecting our present hypothesis that there exists, over time, a positive relationship between the two time-series on variance. We will denote the symbol $V(\mu^*_{ps})$ to represent the variance of returns on portfolio p, obtained from subperiod s, and denote the symbol $V(x_{ps})$ to represent the variance of the corresponding exchange rate variable. The simple regression of the following form was performed on each portfolio:

$$V(\mu^*_{ps}) = a_p + c_p V(x_{ps}) + e_{ps}. \qquad \text{(VII.8)}$$

The reported results in Table (VII.6) show definite indications of a positive relationship between the two time-series of variance. The estimated slope coefficients are all positive, and they were statistically significant at more than a 95% level of confidence in nine cases. As Table (VII.6) shows, statistical significance could not be established only in one case. Disregarding the statistically insignificant case, correlation coefficients ranged from .7097 to .9652. Thus, the variance of exchange rate fluctuations alone could explain, over time, more than 50% of total variation in the total risk level.

It is noteworthy that eight cases had over 70% of total variation in total risk explained by the variance of the exchange rate variable. its explanatory power ranging from 72% to 93%. The variance of the exchange rate variable alone could explain, on average, 82% of total variation in the total risk level. As the theory suggested, changes in total risk can be explained, for the most part, by changes in the variance of the exchange rate variable. The rest of total variations in the total risk measure, i.e., the portion of total variations left unexplained by the exchange rate variable, could still be explained presumably by the other two variables, viz, $V(m_j^*)$ and $Cov\ (m_j^*, x_j)$. However, the empirical evidence provided in this section indicates that the remaining explanatory power attributable to these two variables are insignificant or minor at best. Thus, the empirical findings of this section substantiate Professor Grubel's contention that exchange rate fluctuations can be safely assumed to be the only risk attached to foreign investment. The next section investigates empirically whether or not there exists a positive relationship between the variance of the two variables cross-sectionally.

TABLE (VII.6)

$V(\mu^*_{ps}) = a_p + c_p V(x_{ps}) + e_{ps}$:

	a	c	t(a)	t(c)	EV(μ*)	EV(x)	Corr
PORT1	-2.62	.35	-1.10	7.37*	13.59	45.88	.9652
PORT2	-4.57	.39	-1.50	5.81*	12.32	42.79	.9457
PORT3	-.79	.30	-.32	5.03*	10.99	39.31	.9294
PORT4	1.93	.23	.81	4.10*	11.10	38.78	.8988
PORT5	1.13	.21	.57	4.73*	9.82	39.92	.9212
PORT6	2.25	.16	1.13	3.54*	8.84	40.06	.8712
PORT7	.74	.20	.40	3.52*	6.82	29.80	.8697
PORT8	1.75	.16	1.12	3.24*	6.56	28.46	.8514
PORT9	3.62	.10	2.17	2.01**	6.76	31.33	.7097
PORT10	6.14	.00	4.23	-.01	6.13	29.97	.0042

Note: * denotes statistical significance at 1% level of significance.

** denotes statistical significance at 5% level of significance.

VII-6. Second-Pass Regression Analysis on the Cross-Sectional Patterns of Variances of Returns and Exchange Rates

Having established a positive relationship, over time, between the variance of return performance and the variance of exchange rate fluctuations, we now ask whether we can also establish a positive relationship between the two variables over a cross-section of individual investments and portfolios. Specifically, we propose to test the hypothesis that the variance of foreign returns tends to be high at those places where the variance of the corresponding exchange rate fluctuation is also high. Likewise, the same hypothesis-test is applied to a cross-section of individual portfolios.

For this purpose, a simple regression was run to fit the data on the variances of the relevant variables between 1968 and 1982. Thus, denoting $V(\mu_j^*)$ to represent the variance of the annual average returns on jth investment, and denoting $V(x_j)$ to represent the variance of the corresponding exchange rate fluctuation, we estimated a second-pass regression equation of the following form:

$$\begin{aligned} V(\mu_j^*) &= 4.3549 + .3441\ V(x_j) + e_j. \\ &\quad (13.0837)\ (.1549) \qquad (15.6028) \end{aligned} \tag{VII.9}$$

Likewise, we denoted $V(\mu_p^*)$ to represent the variance of the annual average return earned on pth portfolio, and $V(x_p)$ to represent the variance of the corresponding portfolio's exchange rate variable.

We also estimated the second-pass regression equation of the following form:

$$V(\mu^*_p) = \underset{(4.2129)}{-10.1980} + \underset{(.0934)}{.4854}\, V(x_p) + \underset{(1.9053)}{e_p}. \qquad \text{(VII.10)}$$

As the reported results in the above equations show, the estimated slope coefficients are positive, meaning that variance of returns are positively related to the variance of exchange rate variable. These findings confirm our present hypothesis that the variance of exchange rate fluctuation exerts a positive impact on the variance of the returns over the cross-section of investments. The estimated slope coefficients are statistically significant at more than a 95% level of confidence. It is of some interest to note that in addition to the usual reduction in the calculated variances subsequent to formation of a portfolio, the standard errors in the estimated regression coefficients have dropped precipitously, as we had hoped. On the other hand, the estimated correlation coefficient has increased from .5189 to .8781. Our next objective is to analyze the above cross-sectional relationship according to subperiods. For this task, we will turn to the next section.

VII-7. Second-Pass Subregression Analysis on the Stability Patterns of Return Performances and Exchange Rate Fluctuations

Taking one subperiod at a time, we have generated the corresponding cross-sectional data on the variance of return and exchange rate variables from the first-pass subregressions we ran in the last section. We then performed the second-pass regression over this data set. This procedure was iterated successively for all other subperiods, yielding a time-profile of the estimated regression coefficients.

For the second-pass subregressions, we denote the symbol $V(\mu^*_{ps})$ to represent the variance of annual average returns on portfolio p in period s, and denote the symbol $V(x_{ps})$ to represent the variance of the corresponding exchange rate variable. We ran the regression of the following form, reflecting our present hypothesis that the variance of exchange rate fluctuation exerts a positive impact on the variance of returns:

$$V(\mu_{ps}) = a_s + \lambda_s V(x_{ps}) + e_{ps}. \qquad (VII.11)$$

The empirical results from the above regressions are reported in Table (VII.7). As the reported results indicate, the estimated slope coefficients were all positive ranging from .1610 to .5230. The estimated coefficient in each subperiod was statistically significant at more than a 99% level of confidence. The correlation coefficients ranged between .7858 and .9569. In other words, variance of exchange rate fluctuations was able to explain 62% to 92% of the total change in the variance of the foreign return variable.

In view of the results we had already established in previous sections, the findings of this section might not be surprising. But it was a complete surprise, nonetheless, to observe that the cross-sectional effect of exchange rate variance has more than doubled during the time-period we analysed. Thus, by the last subperiod, the cross-sectional coefficient was found to be .52, in comparison to its initial value of .21 in the first subperiod. These findings give definite indication that the cross-sectional relationship between the variance of foreign returns and exchange rate fluctuations have shifted upwards with the passage of time. The statistical significance of the estimated coefficients for the cross-sectional effect has remained at more than a 99% level of significance throughout the entire period.

These findings in turn increase our suspicion that an equilibrium relationship hypothesized under these conditions might be misspecified, resulting in biased estimates of the supposed equilibrium parameters. The misspecification comes about not only because of incorrectly excluding exchange rate fluctuation, but also in spite of its correct inclusion in a model. This is because the parameters being estimated cannot be held constant over time, which results in the methodological contradiction of attempting to fix quantities constant that are subject to shifts due to changing equilibrium conditions. Specifically, the time-dependence of the estimated parameters results in misspecifying the regression equations simply because the parameters as population coefficients representing the true theorectical relationship are not independent of time. This is Professor Cheng's criticism of the traditional SML model, which is extended to current discussions analyzing the effects of exchange rate fluctuations on equilibrium conditions[1]. The empirical findings obtained from this chapter also give indications that such criticism is valid in the sphere of foreign investment as well.

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[1] See Cheng and Grauer (1980).

TABLE (VII.7)

$V(\mu^*_{pst}) = a_s + \lambda_s V(x_{pst}) + e_{pst}$:

	a	λ	t(a)	t(λ)	EV(μ*)	EV(x)	Corr
SUBP1	.39	.21	.60	9.32*	6.40	28.01	.9569
SUBP2	2.76	.16	3.19	5.11*	7.06	26.67	.8750
SUBP3	1.44	.24	.77	3.74*	8.34	27.85	.7976
SUBP4	-.73	.34	-.51	6.48*	8.34	26.64	.9166
SUBP5	-10.02	.40	-2.59	5.12*	9.44	47.76	.8756
SUBP6	-16.11	.52	-1.77	3.59*	16.18	61.75	.7858

Note: * denotes statistical significance at 1 % level of significance.

CHAPTER VIII EFFECTS OF EXCHANGE RATE FLUCTUATION ON MARKET RISK

VIII-1. Estimation of Characteristic Line

The purpose of this section is to estimate the characteristic line, with respect to market index rate of return, in order to generate the necessary statistical data for employment in second-pass regressions. The second-pass regressions subsequently use these data as inputs in order to investigate the time-profiles of estimated coefficients in the equilibrium relationship of SML and IML models. For this purpose, we estimated individual investments' characteristic lines by performing the simple first-pass regressions of the following form:

$$\mu^*_{jt} = a_j + b_j \mu_{mt} + e_{jt}, \qquad \text{(VIII.1)}$$

where μ^*_{jt} is the annual average rate of return on investment j in period t, and μ_{mt} is the corresponding market rate of return.

We have collected a time-series on the market index rate by calculating the weighted average of individual investments' annual average rates of return, which include all U.S. domestic investment and all U.S. foreign investment in manufacturing industries. Thus, the characteristic line of the jth investment measures investment characteristics in terms of its simple relationship with market rate fluctuations. For this reason, the equation (VIII.1) has also been called the "Single-Index Market Model" for the reason that it has a single explanatory variable, represented by a market index rate, and that the equation provides a model of the systematic way in which earnings from an investment interact with the market index rate according to the specified equation. Thus, the slope coefficient of the above characteristic line has been termed the "market rate beta", reflecting undiversifiable systematic market risk.

Employing this model, we performed first-pass regressions on the return performance of U.S. foreign investment in 17 countries. The investment in a particular country was assumed to be completely homogeneous. Table (VIII.1) reports the relevant statistical results obtained from the above regressions. As the results show, estimated slope coefficients are all positive, ranging from .1358 in the case of Sweden to 1.9136 in the case of Ireland. These results indicate that returns from foreign investment move in the same direction as the market index rate. However, the magnitudes by which individual returns are affected are shown to differ greatly from one investment to another, reflecting a wide divergence of investment characteristics distinguished in terms of systematic market risk.

Traditionally, investment with the value of b_j less than unity, including negative values, has been characterized as defensive investment. It is defensive in the sense that it offers an opportunity to reduce overall portfolio risk by including it in the portfolio, with a smaller value of b_j, contributing a greater reduction in overall risk For the defensive investment, a one percent increment in the market index rate is likely to result in less than a one percent increase in its return.

On the other hand, a one percent drop in the market index rate is likely to result in less than a one percent drop in the investment's return. In this sense, an investment is defended since a major fluctuation of the investment's return performance is mitigated. Likewise, an investment with the value of b_j greater than unity is said to be an aggressive investment, with the greater values of b_j characterizing more aggressive investments.

Upon adopting the use of this terminology, it is clear from the reported results that most foreign investments provide investors with defensive vehicles whereby overall portfolio risk can be reduced. Specifically, out of the total of 17 cases, 13 cases were found to be defensive investments, 3 cases were aggressive investments, and only one case was risk-neutral in terms of estimated market rate betas. In Table (VIII.1), we have reported these findings as well as other relevant results obtained from the above regressions.

Having obtained market beta estimates from the above first-pass regression, we could proceed to perform second-pass regressions on these cross-sectional data of market betas, by simply regressing individual average returns onto estimated market betas of the corresponding investment. As is well-known from time-series studies, however, residual errors resulting from first-pass regressions are usually correlated over time. This non-independence invariably causes a host of econometric problems, resulting in the introduction of bias and inefficiencies that could confound subsequent second-pass regressions.

To minimize these problems, portfolio data were employed as inputs, and the first-pass regression applied to the characteristic line was repeated using the time-series of portfolio returns. As before, denoting μ^*_{pt} to represent the annual average return on portfolio p, in period t, and μ_{mt} to represent the corresponding market index rate, we performed first-pass regressions using the characteristic line of the following form:

$$\mu^*_{pt} = a_p + b_p \mu_{mt} + e_{pt} . \qquad \text{(VIII.2)}$$

The estimated market beta in the above equation represents the measure of the portfolio's return characteristic in terms of its simple relationship with market rate fluctuations over time.

Empirical estimates of the above characteristic lines are reported in Table (VIII.2). The results show that estimated market betas are all positive but less than unity. All of the estimated market betas are statistically significant at the 95% level of confidence. As the reported results indicate, market betas are significantly below unity over the entire cross-section of portfolios. This means that each portfolio is defended against the major risk of a precipitous deterioration in overall portfolio return performance. This of course is the classical argument behind portfolio diversification of investments in the context of reduced systematic market risk.

From the preceding analyses, it follows as a corollary that the total variance of overall returns in a diversified portfolio is lower, ceteris paribus, when its corresponding systematic market rate risk is also lower. This can be seen immediately from noting that total variance in the above characteristic line is simply the sum of systematic risk, i.e., $b_p^2 V(\mu_{mt})$ plus unsystematic risk, i.e., $V(e_{pt})$, assuming that the covariance between the market rate and the residual error is zero. Consequently, a portfolio's overall risk, measured in terms of the total variance of its return, can be reduced by including those investments that will reduce the portfolio's overall systematic risk. This is another variant of the classical argument behind the diversification.

In Table (VIII.2), we reported total risks and systematic market risks, measured in terms of the calculated variance of returns and the market betas, respectively. Two things can be noticed about the reported results. First, total risks associated with holding portfolios have dropped significantly, as expected, from those of individual investments. Second, as we noted in the above paragraph, the portfolios' total risks are lower when their corresponding systematic market risks are lower. These and other relevant results are indicated in Table (VIII.2). What should also be noticed about the reported results is that in the context of direct foreign investment, these reductions of risk measures following international diversification of portfolios represents the source of an entirely new kind of world welfare gains from international economic relations, different from both the traditional gains from trade and increased productivity flowing from the migration of the factors.

It is clear that risk diversification provides a potential motive for foreign investments in physical as well as financial investments[1]. It is clear in the same vein that this kind of welfare gain is available to outgoing investors as well as incoming investors from abroad. Thus, portfolio approaches to analyzing foreign investments can explain two way flows of international capital, which could not be explained otherwise. These of course are the arguments first suggested by Professor Grubel. The findings obtained in this section provide further empirical support to substantiate such arguments. The next section turns to probe the characteristic line in terms of subperiods.

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[1] See Grubel (1968).

TABLE (VIII.1)

$\mu^*_{jt} = a_j + b_j \mu_{mt} + e_{jt}$:

	a	b	t(a)	t(b)	V(μ*)	Corr
Australia	3.84	.53	.78	1.30	17.30	.3412
Belgium	.37	.98	.06	1.97*	30.30	.4807
Canada	5.51	.36	2.09	1.69	5.42	.4251
Denmark	4.29	.66	6.28	.52	28.54	.3327
France	4.82	.54	7.27	.60	36.08	.2423
Germany	8.14	.90	10.27	.85	73.60	.2820
Ireland	1.67	1.91	.85	9.67*	10.56	.9370
Italy	8.14	.68	1.26	1.27	30.05	.3323
Japan	9.25	.77	1.34	1.35	30.95	.3512
Netherland	2.76	1.00	.52	2.29*	25.36	.5364
New Zealand	5.34	.48	.81	.88	29.51	.2329
Norway	1.49	.79	.37	2.38*	14.85	.5521
South Africa	5.35	.76	.68	1.18	43.53	.3111
Spain	-8.45	1.21	-.90	1.56	67.18	.3975
Sweden	9.44	.13	1.76	.30	18.49	.0845
Switzerland	4.76	1.11	.80	2.27*	31.16	.5331
U.K.	.18	.94	.02	1.53	41.20	.3921

Sources: *Survey of Current Business*, 1967 through 1984.
Federal Reserve Bulletin, 1967 through 1984.

Note: * denotes statistical significance at 5% level of significance.

TABLE (VIII.2)

$\mu^*_{pt} = a_p + b_p \mu_{mt} + e_{pt}$:

	a	b	t(a)	t(b)	V(μ*)	Corr
PORT1	2.47	.87	.54	2.32*	18.77	.5426
PORT2	1.93	.83	.47	2.46*	15.84	.5639
PORT3	3.45	.78	.96	2.66*	12.64	.5940
PORT4	3.43	.85	.98	2.96**	13.00	.6356
PORT5	3.60	.83	1.09	3.07**	11.96	.6486
PORT6	3.49	.85	1.19	3.52**	10.72	.6993
PORT7	3.77	.78	1.43	3.60**	8.87	.7074
PORT8	4.75	.69	1.86	3.26**	7.64	.6714
PORT9	4.72	.67	1.80	3.11**	7.68	.6536
PORT10	5.16	.74	2.18	3.77**	7.51	.7235

Note: * denotes statistical significance at 5% level of significance.
** denotes statistical significance at 1% level of significance.

VIII-2. First-Pass Subregression Analysis on Systematic Market Risk

In order to capture shifting patterns of estimated market betas, we performed regressions in each subperiod, taking one portfolio data set at a time. This will generate the necessary data sets to be employed as inputs in subsequent second-pass regressions. For this purpose, 60 separate regressions were performed, each porftolio requiring 6 individual subregressions on the corresponding subperiod time-series. In order to prevent our analyses from being cluttered with myriad of statistical results, however, we will confine our discussion to the subregression results of PORT1 only.

Denoting μ^*_{pst} to represent the annual average return on portfolio p in subperiod s, and μ_{mst} to represent the corresponding market rate of return, we iterated the subregression of the following form for each subperiod of a given portfolio and then repeated the procedure for all the other portfolios:

$$\mu^*_{pst} = a_{ps} + b_{ps}\,\mu_{mst} + e_{pst}\,. \qquad \text{(VIII.3)}$$

Table (VIII.3) reports the relevant statistical results from performing the regressions on PORT1. The reported results for estimated market betas show that they are all positive, ranging from .0257 to 1.3915. The correlation coefficient obtained from the above characteristic line ranged between .0180 in SUBP1 and .7770 in SUBP6.

What astounded us about the reported results in the Table (VIII.3) is the extent which estimated market betas have shifted upwards over the time-span considered. This finding implies that returns have become increasingly sensitive, over the years, to changes in market rate fluctuations. Consequently, regression parameters assumed in the characteristic line may have been steadily shifting upward from period to period. Thus, the magnitude of the marginal effect market rate fluctuations can bring to bear on return levels has increased from virtually nothing in the earlier years to more than one in the later years. In the last subperiod considered, a one percent increment of the market rate has resulted in affecting rate of return observed by 1.3% in the same upward direction. This suggests that foreign investments, on average, have taken on the characteristic of decidedly more aggressive investment, as evidenced by the upward shift of the estimated market beta.

These findings give empirical support to the criticism that the magnitude of equilibrium market betas, and hence, the equilibrium relationship hypothesized under traditional CAPM model are not stable from period to period. In order to investigate the time-dependence of estimated market betas, we obtained time-series on the market beta, by means of estimating slope coefficients from equation (VIII.3). Thus, each observation point of a given time-series corresponds to a particular subperiod. In this way, the time-profile of a given portfolio's market betas was prepared, and likewise, for all the other portfolios. Employing these data sets, we propose to test the hypothesis that market rate betas are positive functions of time.

Specifically, we devised the following simple regression approach, in order to test the above hypothesis explicitly:

$$b_{ps} = a_p + c_p T_{ps} + e_{ps}, \qquad \text{(VIII.4)}$$

where b_{ps} represents the market beta, corresponding to portfolio p in subperiod s, and T_{ps} represents the time variable. In terms of the above regression equation (VIII.4), we will concentrate on testable implications of the time-independence of market betas, based on estimated coefficients of the time variable:

H_0: The time-coefficients of the market rate betas are zero, that is $c_p = 0$ for all portfolios.

Table (VIII.4) reports the empirical results obtained from the above regression equation (VIII.4). The reported results show clear indications that estimated time-coefficients are positive in all but one case, reflecting our present hypothesis that market rate betas are an increasing function of time. The reported results are statistically significant at more than the 95% level of confidence, except in two cases. In other words, we reject the above-stated null hypothesis in eight cases, implying that the corresponding market betas were not independent of time.

What is noteworthy about the reported results is that estimated market betas have steadily increased in magnitude over the years. This result may not be surprising in view of the fact that estimated exchange rate betas also were found to have steadily increased over the same time-span[1]. What arrests our attention here, however, is that we may gainfully entertain the notion of two types of betas being related to each other in some systematic fashion over time. This possibility is considerably strengthened by noting that both market beta and exchange rate beta, as population regression coefficients, are functions of same return variables, as well as other variables. In other words, the return variables are common factors that affect simultaneously the endogenous determination of both types of betas in a population regression reflecting their true theoretical relationship. Furthermore, the rate of return and systematic market risk are both functions of exchange rate fluctuations, according to the arguments of the previous chapters. These considerations increase our present suspicion, sufficient for driving home the point that systematic market risk should also be related empirically to systematic exchange rate risk in some characteristic manner. Therefore, we will proceed to investigate the characteristics emerging from the empirical relationship existing between the two types of risks.

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[1] See section (VII.2) of last chapter and Table (VII.3).

TABLE (VIII.3)

$\mu^*_{lst} = a_{ls} + b_{ls}\,\mu_{mst} + e_{mst}$:

	a	b	t(a)	t(b)	V(μ*)	Corr
SUBP1	13.27	.02	2.24	.05	8.28	.0180
SUBP2	10.70	.29	2.17	.72	8.32	.2482
SUBP3	9.50	.41	1.95	1.08	9.66	.3586
SUBP4	4.86	.74	.89	1.75*	10.57	.5266
SUBP5	-.52	1.08	-.06	1.63*	18.00	.5007
SUBP6	-4.98	1.39	-.97	3.49*	26.48	.7770

Note: * denotes statistical significance at 10% level.

TABLE (VIII.4)

$b_{ps} = a_p + c_p T_{ps} + e_{ps}$:

	a	c	t(a)	t(c)	Corr
PORT1	-21.07	.27	-15.71	16.20*	.9925
PORT2	-17.28	.22	-7.92	8.17*	.9714
PORT3	-16.47	.21	-15.85	16.39*	.9926
PORT4	-16.32	.21	-27.71	28.84*	.9976
PORT5	-13.64	.17	-4.00	4.20*	.9028
PORT6	-9.48	.12	-4.85	5.19*	.9332
PORT7	-7.84	.10	-3.05	3.26*	.8531
PORT8	-7.10	.09	-2.69	2.88**	.8215
PORT9	-4.23	.05	-1.51	1.68	.6436
PORT10	.88	.01	.35	-.10	.0505

Note: * denotes statistical significance at 1% level.

** denotes statistical significance at 5% level.

VIII-3. Inter-Temporal Effects of Exchange Rate Betas on Market Betas

The objective of this section is to investigate whether the type of empirical relationship we established between total risk and exchange rate risk can also be obtained between systematic market risk and the systematic exchange rate risk. For this purpose, we employ the time-series on market betas and the exchange rate betas obtained from previous sections. Using these time-series, we propose to test whether the changes in systematic market risk can be explained, over time, by changes in systematic exchange rate risk.
Thus, we will denote, as before, b_{ps} to stand for the market beta of portfolio p in subperiod s, and b^*_{ps} to stand for the corresponding exchange rate beta. The following regressions were performed on the time-series of the two types of betas for a given portfolio and repeatedly applied to all the other portfolio time-series.

$$b_{ps} = a_p + c_p\, b^*_{ps} + e_{ps}. \qquad \text{(VIII.5)}$$

The relevant empirical results from the above regressions are reported in Table (VIII.5). The reported results show that the estimated slope coefficients are all positive, thus confirming our suspicion that changes in systematic exchange rate risk result in affecting systematic market risk in the same direction.
The correlation coefficients between the two types of betas ranged from .4410 to .9713. The estimated slope coefficients were statisti-

cally significant at 95% level of confidence in 4 cases. For the other cases, however, statistical significance could be established at only the 75% level of confidence.

The order of the portfolios reported in Table (VIII.5) corresponds to the rankings based on the magnitudes of their respective exchange rate betas[1]. Thus, PORT1 has the highest value of b*, and the PORT10 has the lowest value of b*. Resulting from this arrangement of portfolios, it is revealed that estimated market betas tended to be higher in those portfolios in which the levels of corresponding exchange rate betas were also higher. This implies that changes in the level of systematic market risk has been more pronouced precisely in those portfolios in which return performances have been more sensitive to corresponding exchange rate fluctuation over the years. This finding in turn suggests that the two types of systematic risks might be related in some systematic fashion over the cross-section of portfolios. In the next section, we will turn to investigate this possibility empirically.

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[1] These beta rankings are based on the period from 1968 to 1982.

TABLE (VIII.5)

$b_{ps} = a_p + c_p b^*_{ps} + e_{ps}$:

	a	c	t(a)	t(c)	Eb	Eb*	Corr
PORT1	-2.09	6.77	-6.12	8.16*	.65	.40	.9713
PORT2	-2.62	7.32	-6.43	7.82*	.54	.43	.9689
PORT3	-2.17	7.24	-2.10	2.65**	.55	.37	.7992
PORT4	-1.91	6.01	-1.18	1.60	.66	.42	.6255
PORT5	-2.48	8.05	-1.62	2.05**	.64	.38	.7160
PORT6	-.33	2.72	-.26	.78	.66	.36	.3655
PORT7	-.52	2.93	-.56	1.16	.56	.37	.5033
PORT8	-.50	1.50	-1.27	1.39	.48	.36	.5711
PORT9	-.15	2.09	-.24	.98	.46	.29	.4410
PORT10	.37	1.30	1.39	.99	.63	.20	.4466

Note: * denotes statistical significance at 1% level.

** denotes statistical significance at 5% level.

VIII-4. Second-Pass Regression Analysis on the Cross-Sectional Patterns Between Systematic Market Risk and Systematic Exchange Risk

The question we pose in this section is to ask whether we can also establish a positive relationship between systematic market risk and systematic exchange risk over a cross-section of individual investments. Specifically, we propose to test the hypothesis that systematic market risk tends to be high in those investments where corresponding systematic exchange risk is also high.

For this purpose, a simple second-pass regression was performed to fit cross-sectional data on the estimated betas obtained from the respective first-pass regressions. Thus, denoting b_j to represent systematic market risk associated with jth investment, and denoting b_j^* to represent the corresponding exchange risk, we estimated a second-pass regression equation of the following form:

$$\underset{(.1948)}{b_j = .3029} + \underset{(.4648)}{1.1111\, b_j^*} + \underset{(.7763)}{e_j}. \qquad \text{(VIII.6)}$$

Likewise, denoting b_p to represent the systematic market risk associated with pth portfolio, and denoting b_p^* to represent the corresponding systematic exchange risk, we also estimated a second-pass regression equation using the portfolio data generated in the previous sections:

$$\underset{(.0729)}{b_p = .5922} + \underset{(.1821)}{.5199\, b_p^*} + \underset{(.0529)}{e_p}. \qquad \text{(VIII.7)}$$

As the reported results from the above regressions show, estimated slope coefficients are positive, indicating that systematic market risk is positively related to systematic exchange risk. These findings confirm our present hypothesis that systematic exchange risk exerts a positive impact on systematic market risk over the cross-section of investments. The estimated slope coefficient is statistically significant at the 90% level of confidence in the case of using individual investment data, and significant at more than the 99% level of confidence in the case of using portfolio data. The correlation coefficients are, respectively, .5384 from the regression equation (VIII.6), and .7104 from the regression equation (VIII.7). As a result of portfolio formation, therefore, both statistical significance and correlation coefficient have improved in comparison to corresponding statistics we obtained from employing individual foreign investment data.

In spite of the positive cross-sectional relationship between the two types of systematic risks, however, we should also be mindful of the empirical results established previously, regarding non-constancy of the estimated betas over time. Thus, there is no guarantee that the estimated slope coefficients of the above regression equations have not experienced time-dependent shifts. Consequently, there is no guarantee either with respect to the positive sign of the cross-sectional relationship remaining invariant between various time-periods. In the next section, we will probe into this possibility empirically.

VIII-5. Second-Pass Subregression Analysis on Cross-Sectional Patterns Between Systematic Market Risk and Systematic Exchange Risk

The purpose of this section is to investigate whether there exists a consistent cross-sectional relationship between exchange rate betas and market betas. Specifically, we propose to test whether within a given time-period, the two types of betas move in the same direction over a cross-section of portfolios. Applying this test repeatedly for each subperiod enables us to capture the time-profile of shifting cross-sectional relationship between the two types of betas from one subperiod to another.

Taking one subperiod at a time, we performed second-pass regressions on the cross-sectional data of the market betas and exchange rate betas. Denoting b_{ps} to represent the market beta on portfolio p in subperiod s, and b^*_{ps} to represent the corresponding exchange rate beta, we estimated the regression equation of the following simple form:

$$b_{ps} = a_s + \lambda_s b^*_{ps} + e_{ps}. \qquad \text{(VIII.8)}$$

The relevant results from the above regressions are reported in Table (VIII.6). The reported results reveal that estimated cross-sectional coefficients also have been increasing over the years. This result is not surprising, and is completely expected in view of the fact that exchange rate fluctuations have been shown to play increasingly dominant roles in the entire spectrum of our analyses. What may surprise us, however, is the fact that the sign of the estimated cross-sectional coefficient has completely reversed itself over the years. Thus, the reported results show that in earlier subperiods, market betas used to have negative correlations with the exchange rate betas over the corresponding cross-sections of portfolios. In other words, portfolios with high exchange rate betas tended to have low market betas, while at the same time, the portfolios with low exchange rate betas tended to have high market betas. As time went by, however, the shifting pattern of cross-sectional effects has resulted in reversing the direction of the association between the two types of betas such that portfolios with initially high exchange rate betas have turned out to accompany high market risks as well. This is what the empirical results report in Table (VIII.6).

These findings, however, are entirely consistent with previous results obtained from the first-pass regression equation (VIII.2). This is because the estimated coefficients from the first-pass regressions were shown to be higher precisely in those portfolios that had higher rankings in terms of exchange rate betas. In other words, market betas of those portfolios with relatively higher exchange rate betas have been shifting upwards, over time, at a proportionately faster pace in accordance to the correspondingly higher coefficient values of the first-pass equation. However, the extent of upward shifts in market betas has been so much greater as to result in the positive cross-sectional relationship between the two types of betas by the fourth subperiod. This is what the results reported in Table (VIII.6) reveals.

TABLE (VIII.6)

$b_{ps} = a_s + \lambda^*_s b^*_{ps} + e_{ps}$:

	a	λ^*	t(a)	$t(\lambda^*)$	Eb	Eb*	Corr
SUBP1	1.10	-2.51	2.68	-2.13*	.23	.34	-.6018
SUBP2	.77	-1.09	4.37	-2.14*	.40	.34	-.6047
SUBP3	.97	-1.27	5.46	-2.63*	.51	.36	-.6811
SUBP4	.54	.20	3.40	.48	.62	.37	.1689
SUBP5	.06	2.29	-.36	4.65**	.68	.32	.8547
SUBP6	.06	2.38	.55	9.05**	1.06	.42	.9545

Note: * denotes statistical significance at 5% level.

** denotes statistical significance at 1% level.

VIII-6. Conclusion

The purpose of this section is to integrate, by way of summarising, various aspects of the equilibrium relationship discussed heretofore and present an overall picture in the light of the empirical findings obtained in our investigations. For this purpose, we perform second-pass regressions for the SML and IML models accoridng to subperiod. Thus, we repeated the same regressions performed in Chapter VI, but using cross-sectional data obtained from subsets of the time-series, distinguished in terms of subperiods. This will enable us to capture the time-profile and cross-sectional profile of the equilibrium relationship by flushing out, as it were, the shifting pattern of equilibrium in a criss-crossing manner.

The complete patterns of equilibrium return-risk relationships are presented in Table (VIII.7). First, we notice from the reported results that the intercept terms, which represent the riskless rate of return, i.e., free from exchange rate influences, have been generally shifting upwards over the subperiods. The intercepts for both SML and IML models are statistically significant in each subperiod at more than the 99% level of confidence. This reflects the observed empirical fact that even default-free investment returns, the interest paid on U.S. Treasury bonds for example, have been climbing along the upward trend line during the time-span we considered. Thus, our results are in agreement with the argument that there exists no true riskless investment in the sense of the time-independence of its returns: even risk-free investments will experience variability of return over time.

Second, the result obtained from the SML model indicates that the market price of systematic market risk has been falling over the years. But it has fallen so much, the reported result shows, that it has become a minus value, -2.4120 to be exact, meaning that for a one percent increment of market risk, investors are willing to reduce, rather than raise, the necessary return requirement by more than two percentage points. As utterly unrealistic as this particular result is, it nevertheless makes our point most starkly: equilibrium relationship in international investment, when specified without explicit consideration of stochastic exchange rate fluctuations in a model, is misspecified, a priori, and the specification error is bound to rear its face in the form of nonsensical results in empirical studies.

The negative market price of systematic market risk resulting from the SML model, however, should not come as a surprise in view of the theoretical arguments enunciated in Chapter VI. According to the theory, the SML model may give a negative value for the market price estimated, not because investors are intrinsically risk-lovers, but because the equilibrium return-risk relationship attributed to the SML model misspecifies the true relationship by incorrectly omitting the presence of stochastic exchange rate fluctuations. It was argued that equilibrium foreign earnings are related to systematic exchange rate risk in addition to systematic market risk. Thus, the estimated slope coefficient of the SML model reflects not only the marginal effects of systematic market risk, but it also picks up indirectly the marginal effects on the equilibrium return associated with systematic exchange rate risk. Because of this, it is entirely possible that the total market price of risks implied by the SML model would show a negative value in the case when negative coefficient associated with systematic exchange rate risk variable, which is not explicitly shown in the SML model but nonetheless buried in its estimated market price, is sufficiently large in magnitude as to dominate the positive value associated with the systematic market risk. The empirical results obtained from our IML model indicate that the absolute magnitude of estimated market price connected to exchange rate risk is, indeed, quite sizable. In the last subperiod, for example, the slope coefficient of exchange rate risk is estimated to be -18.7712, in comparison to the value of only 4.2405 for the estimated slope coefficient of market rate risk.

On the other hand, the empirical results obtained from the IML model reveal that the estimated market price of systematic market risk has steadily decreased over the years in clear to the result obtained from estimating the traditional SML model. Moreover, the magnitude of the exchange rate risk's slope coefficient is revealed to have increased during the same time-span, thus making foreign returns more sensitive to changes originating from exchange rate fluctuations. Consequently, systematic exchange rate risk has become much more dominant than systematic market risk, in terms of their marginal effects on equilibrium return: Systematic exchange rate risk is capable of virtually swamping systematic market risk's marginal effect on equilibrium return on direct foreign investment.

Third, the estimated coefficient for the expected exchange rate variable is shown to have steadily decreased over the years, falling from the intial value of 1.1061 to the final value of .2756. By no means should this surprise us for we had already established that return preformance has grown more sensitive, inter-temporally, to exchange rate fluctuations, but in a manner that wiped out all distinguishable characteristics between portfolios with regard to the level of the exchange rate. What is distilled from all our analyses over and again is the unavoidable fact that the key to explaining variations in return performances lies neither in the level of market risk, nor in the exchange rate per se: changes in the equilibrium return-risk relationship is explained, for the most part, by the changes in systematic exchange risk level. In this regard, it should be noted that when the regression equations, such as those specified under the SML model, were estimated without explicitly including the exchange risk variable, they produced nonsensical results, or their explanatory powers were too miniscule to be of any importance for all practical purposes. Once we included the exchange risk variable in regression equations, such as in our IML model for example, more than 80% of total variations in the equilibrium return-risk relationship could be explained in most of the cases we considered. The correlation coefficients obtained from running the subregressions are reported in Table (VIII.7).

The reported results in Table (VIII.7) also show that all of the estimated regression coefficients were statistically significant at more than the 99%

level of confidence in most cases of the IML model, which contrast starkly to those of the SML model. These findings give the necessary empirical support to substantiate the theoretical arguments we laid down in the beginning of Part II of this thesis. The empirical tests we performed on the IML model entertained nothing beyond the explicit inclusion of stochastic exchange rate fluctuations in addition to putative assumptions specified under the traditional SML models. Although neither model can avoid being subjected to inter-temporally shifting parameters due to changing equilibrium conditions, the IML model developed in this thesis has performed well beyond a reasonable expectation in each and every subperiod we have examined, but the same can hardly be claimed for the SML model that does not consider stochastic exchange rate fluctuations as specific regressors in empirical analyses of foreign investment. While the primary virtue of our IML model may have been confined to the simplicity in its approach to explicitly incorporate exchange rate influences as the theoretical underpinning of the equilibrium return-risk relationship, its theoretical implications have been proven pervasive for equilibrium foreign investment, and its empirical implications also have been demonstrated consistently robust to empirical tests. Against this background, we draw the final conclusion that exchange rate fluctuations provide the key role, quintessential for explaining return performance, their stability patterns, and systematic risks associated with direct foreign investment.

TABLE (VIII.7)

SML: $E\mu^*_{ps} = z_s + \lambda_s b_{ps} + e_{ps}$

IML: $E\mu^*_{ps} = z'_s + z^*_s Ex_{ps} + \lambda'_s b_{ps} + \lambda^*_s b^*_{ps} + e'_{ps}$

	z	z*	λ	λ*	t(z)	t(z*)	t(λ)	t(λ*)	Corr
SML$_1$	13.11	----	.43	----	41.44*	----	.39	----	.1369
IML$_1$	15.81	1.10	-1.41	-9.63	13.05*	5.5*	-1.89**	-2.80**	.9170
SML$_2$	12.82	----	1.93	----	16.53*	----	1.04	----	.3465
IML$_2$	14.93	.96	-.33	-7.27	5.87*	2.24**	-.13	-1.17	.7684
SML$_3$	13.11	----	1.81	----	15.19*	----	1.09	----	.3615
IML$_3$	12.37	.64	2.69	-2.08	7.94*	3.61*	2.06**	-.63	.8949
SML$_4$	11.38	----	4.28	----	14.38*	----	3.41*	----	.7698
IML$_4$	13.41	.52	3.04	-6.01	21.98*	3.56*	3.78*	-4.67*	.9552
SML$_5$	14.49	----	-.78	----	20.47*	----	-.80	----	-.2739
IML$_5$	16.26	.34	2.91	-13.66	50.33*	3.07*	4.60*	-8.02*	.9613
SML$_6$	15.57	----	-2.41	----	13.57*	----	-2.28**	----	-.6276
IML$_6$	16.83	.27	4.24	-18.77	16.78*	1.29	1.87**	-3.55*	.9221

Sources: Survey of Current Business, 1967 through 1984.

Federal Reserve Bulletin, 1967 through 1984.

Note: * denotes statistical significance at 1% and ** at 5% level.

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