JOURNAL OF ECONOMIC DEVELOPMENT
Volume 13, Number 1, June 1988

A Theory of Internationally Diversified Production under Uncertainty:

Effects of Exchange Rate Fluctuations on Return Performance and Risk Associated with Direct Foreign Investment

Yooman M. Kim*

The purpose of this paper is to construct a model which is capable of explicitly incorporating uncertain foreign exchange rate fluctuation to explain international difference of return-risk characteristics associated with direct foreign investment. The empirical evidence provided in this study reveals that international difference of return performance can be explained, for the most part, by international difference of risk associated with foreign investment. Moreover, changes of the equilibrium return-risk relationship in turn can be explained primarily by changes originating from systematic exchange rate risk in the presence of uncertain exchange rate fluctuations.

I. Introduction

Under uncertainty, the classical theory of international capital movements is inadequate to the extent that it considers, ultimately, rates of return alone as the determinant of direct foreign

* Research Director of First Economic Research Institute, Seoul, Korea. The author wishes to thank Herbert G. Grubel of Simon Fraser University, Canada for many valuable comments on an earlier draft, which were essential in completing this paper. I am also deeply indebted to John Curtis of Carleton University, Philippe Callier of Concordia University, and Kenji Okuda of Simon Fraser University for their helpful comments and corrections. The author is solely responsible, of course, for any remaining errors.

investment (DFI), while at the same time ignoring 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 model of portfolio balance developed by Markowitz (1952) and Tobin (1958), however, Grubel has come up with an innovative approach to explain long-term asset holding abroad. 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 investments, 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.

Employing the portfolio model of international diversification, Rugman 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.[1] Such greater stability of earnings for the internationally diversified firm, however, is attributable not only to different phasing of cyclical demand variation, which could simply be taken advantage of by direct exports to foreign countries rather than through direct foreign investments, 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, without at the same

[1] Rugman demonstrates that the multinational firm enjoys the advantages of less variations of its profits, in addition to maximizing its overall profit level at the same time. Specifically, stability of earnings through time is shown to be an increasing function of the ratio of foreign to total operations.

time necessarily sacrificing the level of its overall earnings. The considerations of expectations of return and risk, therefore, are assumed to be the primary factors affecting the decision making of a firm in the context of a global operation in an uncertain production milieu.[2] Consequently, the international diversification of a firm's operations leads to an internationalization of production activities, tantamount to acquisition of multi-plants by the firm operating under uncertainty that has its production facilities extended beyond its own national boundaries. Clearly, this line of reasoning provides us with an argument giving rise to a motive for direct foreign investment, which differs conceptually from the traditional arguments assuming the existence of an international market imperfection.[3]

In the past, however, it has been argued on the contrary by those who believe that when investors are capable of directly acquiring foreign securities, thus forming internationally diversified portfolios themselves, the international diversification motive of multi-national corporations (MNC) for direct foreign investment might disappear.[4] But even in the unlikely cases when MNCs can produce the same results both quantitatively and qualitatively with respect to international diversification effect, regardless of whether they directly acquire foreign securities or foreign production facilities, MNCs are more than likely to have a predilection for DFI activities instead on the belief that DFI is clearly a more efficient way to achieve their international diversification objectives. This seems an eminently plausible argument especially when there are firm reasons on the part of on-going MNCs for believing that their comparative advantages with respect to achieving optimal combination of earning and risk lie in their production-related activities conducted on a global scale through directly acquiring foreign plants.

Of course, this line of reasoning is not to deny that whatever

[2]Helleiner has employed return and risk consideration as the theoretical foundation for explaining traditional motives for investing abroad by multinational firms in manufacturing. Thus, he argues that "while one must be cautious of attributing complete 'rationality' to the decision making of the multinational manufacturing firm, upon which the internationalization 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 35-40 for these arguments by Helleiner.

[3] In contrast, Kindleberger, Johnson, and Caves have argued that the motivation of direct foreign investment at the firm level is due to an international market imperfection.

[4] See Solnik, B.H., (1975).

the motives for DFI, other incentives and motives for increasing global production will conintue to coexist with the MNC's international diversification motive. More realistically, however, there exist in many instances numerous institutional constraints imposed by foreign governments that limit the industry type and quantity of the foreign securities MNCs are permitted to acquire, thereby effectively limiting the extent to which MNCs can exercise control over production management indirectly via acquiring the foreign securities. This aspect of the present argument takes on a critically important meaning in the case of on-going MNCs with vertically-integrated production structure already in place, for there constantly exist risks that can bring the entire international production process to a halt as a result of supply disruption in a single foreign production facility. Component supply disruption resulting from labor strikes or political disturbances, for example, can become a critical risk factor to an on-going MNC's operations. In such cases, portfolio diversification of component production in terms of global location can obviously reduce these risks. Consequently, directly acquiring foreign securities cannot be a perfect substitute, or even a viable alternative, for direct foreign investment for the purpose of diversifying this type of risk.[5]

II. A Model of Return-Risk Analysis in Direct Foreign Investment

A. Derivation of an IML Model under Exchange Rate Fluctuations

Our objective for this section is to incorporate explicitly stochastic exchange rate fluctuations into the traditional model of multi-plants. For this purpose, we will develop an "Investment Market Line" (IML) model under exchange rate uncertainty. There are a number of approaches one can take in order to stochasticize the traditional multi-plant firm model. Since we are concerned with the innate risk present in direct foreign investment-related activities, however, we will choose to introduce

5 See Helleiner, G.K., 31-40.

uncertainty,[6] represented by a random variable e*, via foreign production conditions rather than via demand conditions as others have done.[7] Consequently, international firms are assumed to know world demand conditions with certainty, just as in the traditional model, the only difference here being that the firm's foreign production function contains the random variable over which the international firms have no control. The firms are thus assumed to maximize the expectation of utilities as in the following:

$$Eu_i(\Pi) = \int u[\sum_j R_{ij}(Q_j) + \sum_j R^*_{ij}(Q_j) - \sum_j C_{ij}(Q_j) - \sum_j C_{ij}(Q^*_j)]\, P(e^*)\, de^*$$

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.

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

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

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

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

$Q_j = h(K^*_j, L^*_j, e^*)$, representing jth foreign production function.

$P(e^*)$ = the subjective probability density function.

6 In this paper, we make no distinction between risk and uncertainty. These two concepts are used interchangeably throughout this paper.

7 This approach is adopted, primarily, to reflect that a large portion of direct foreign investment activities on the part of international subsidiaries is based on supply considerations rather than demand considerations, especially in the case of foreign investments taking place in developing countries for reducing production costs.

Assume that initially all foreign exchange rates are perfectly stable such that all figures are free of exchange rate fluctuations.[8] We can differentiate the expected utility function in the above Equation (1) with respect to capital, and evaluate at the optimum to obtain the following Paretian efficiency conditions under uncertainty:

(2.a) $d[Eu_i(\Pi)]/dK_j = E[u_i'(\Pi)\,(m_j - r)] = 0.$

(2.b) $d[Eu_i(\Pi)]/dK_j^* = E[u_i'(\Pi)\,(m_j^* - r)] = 0,$

where

$u_i'(\Pi) = du_i(\Pi)/d\Pi$, representing the marginal utility of investor i.
$m_j = dR/dK_j$, representing the jth domestic marginal revenue product of K.
$m_j^* = dr/dK_j$, 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, Equations (2.a) and (2.b) can also be written as follows:

(3.a) $m_j - r = 0.$

(3.b) $E(m_j^* - r) = -\mathrm{Cov}\,[u_i'(\Pi),\ (m_j^* - r)]/Eu_i'(\Pi)$

Condition (3.a) 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.[9] However, Condition (3.b) shows the stochastic analog for capital assets that have been invested abroad through direct foreign invest-

[8] This assumption, however, will be relaxed shortly in the next section.

[9] 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 condition hereof, so long as foreign investment abroad is deemed to be riskier than domestic investment.

ment.[10] Thus, if the utility function of the investor reveals diminishing marginal utility, then at any given level of output, $u_i'(\Pi)$ and $(m_j^* - r)$ are inversely related since a higher profit resulting from a higher marginal revenue product will lower the investor's marginal utility. Consequently, Equation (3.b) must have positive values from noting that $Eu_i'(\Pi)$ is always positive by assumption.

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 in the amount of the above covariance term shown in the right-hand-side of Equation (3.b).[11]

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., $\Sigma\, \Pi_{ij}$.

W_i = $\sum_i (K_{ij} + K_{ij}^*)$, representing U.S. dollar value of $_i$th investor's total capital asses, 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_o.

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

r_m = the stochastic nominal rate of return on a market portfolio.

X_j = the stochastic value of jth foreign exchange rate level in U.S. dollars.

x_j = the stochastic rate of change in the jth exchange rate level.

10 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 specified in the above Equation (3.b).

11 For a general equilibrium analysis of a firm under uncertainty, see Batra and Ullah.

m_j^* = the stochastic real rate of return on jth foreign investment.

r_j^* = $m_j^* + x_j$, representing the jth stochastic nominal rate of return.

$Cov(r_j^*, r_m)$ = the covariance between r_j^* and r_m.

$Cov(r_j^*, x_j)$ = the covariance between r_j^* and x_j.

V_m = the variance of the market rate of return.

V_j^* = the variance of jth exchange rate fluctuations.

b_j = $Cov(r_j^*, r_m)/V_m$, representing the slope cofficient of jth characteristic line with respect to r_m, i.e., the "market rate beta," which represents the undiversifiable systematic market rate risk.

b_j^* = $Cov(r_j^*, x_j)/V_j^*$, representing the slope coefficient of jth characteristic line with respect to x_j, i.e., the "exchange rate beta," which represents the undiversifiable systematic exchange rate risk.

In order to characterize the equilibrium relationship between expected return and risk, we have assumed, for comparability with other models, that all investors have quadratic utility functions of terminal profits defined in real terms:

$$(4) \qquad u_i(\Pi) = \Pi_i - c_i \Pi_i^2, \text{ with } c_i > 0.$$

Substituting the above equation in the equilibrium condition (3.b) and summing over all investors i in the resulting system of i linear euations, we can rewrite the equilibrium relationship (3.b) as in the following expression:

$$(5) \qquad Er_j^* = r_o + Ex_j + W[Cov(r_j^*, r_m) - Cov(r_j^*, x_j)] / \sum_i (1/2c_i - E\Pi_i)$$

where

$$r_o = m_o$$
$$r_j = m_j + x_j$$
$$W = \sum_i \Pi_i / r.$$

Let q be the positive weight of the jth investment's return such that

$$(6) \qquad r_m = \sum_j q_j r_j + \sum_h q_h^* r_h^*,$$

where

M = the total number of domestic assets.
N = the total number of foreign assets.

Substituting the above Equation (6) into Equation (5) and noting their r is independent of x whenever $h \neq k$, we can write it as follows:

$$(7) \qquad Er_j^* = r_o + Ex_j + W[Cov(r_j^*, r_m) - q_j^* Cov(r_j^*, x_j)] / \sum_i (1/2c_i - E\Pi_i).$$

The above Equation (7) represents equilibrium condition on foreign earnings under stochastic exchange rate fluctuations. We will call such an equilibrium relationship the "Investment Market Line" (IML) in difference to its counterpart developed by Lintner, Mossin, and Sharpe in financial economics literature, viz, the Security Market Line (SML).

Equivalently, we can rewrite the above Equation (7) as follows:

$$(8) \qquad Er_j^* = r_o^* + \lambda^* B_j^*,$$

where

$$r_o^* = r_o + Ex_j$$
$$\lambda^* = 1/\sum_i (1/2c_i - E\Pi_i)$$
$$B_j^* = W[Cov(r_j^*, r_m) - q_j^* Cov(r_j^*, x_j)].$$

The traditional version of Capital Asset Pricing Model (CAPM) can then be obtained from the above Expression (8) by setting x_j equal to zero. Thus, our IML model represented by Equation (8) is an expanded version which includes the traditional results of the SML model as a special case where exchange rates are perfectly stable.

B. Effects of Systematic Risks under Exchange Rate Fluctuations

The IML model's equilibrium condition (7) can be expressed alternatively as follows:

$$(9) \qquad Er_j^* = r_o + Q_m \mathrm{Cov}(r_j^*, r_m) + Q_j \mathrm{Cov}(r_j^*, x_j),$$

where

$$Q_m = W/[\sum_i(1/2c_i + rW + \sum_j K_{ij} Ex_j) - (r_o K + \sum_j K_{ij} Er_j^*)]$$

$$Q_j = -q_j^* Q_m.$$

Q_m is the slope coefficient of the ordinary security market line, representing the so-called Price of Market Risk (PMR), i.e., the excess return required per unit of systematic market risk investors are willing to accept in the traditional SML model. Q_j represents the portion of the total risk attributable to systematic exchange rate risk only, which we will call "Price of Foreign Exchange Risk" (PER).[12]

From the above expression for the price of market risk in Equation (9), it becomes immediately apparent that the price of market risk hypothesized under the traditional SML model overstates the true equilibrium price of market risk if exchange rates are expected to move upwards. Likewise, the SML model understates the true equilibrium price of market risk in the case when exchange rates are expected to drift downwards. Consider a positive value for the exchange rate risk, i.e., $\mathrm{Cov}(r_j^*, x_j) > 0$. This would indicate that *ceteris paribus,* the jth random 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 Equation (9) larger than it would otherwise be. In this situation, the SML

12 See Solnik, B.M. for a different approach to international pricing of risk.

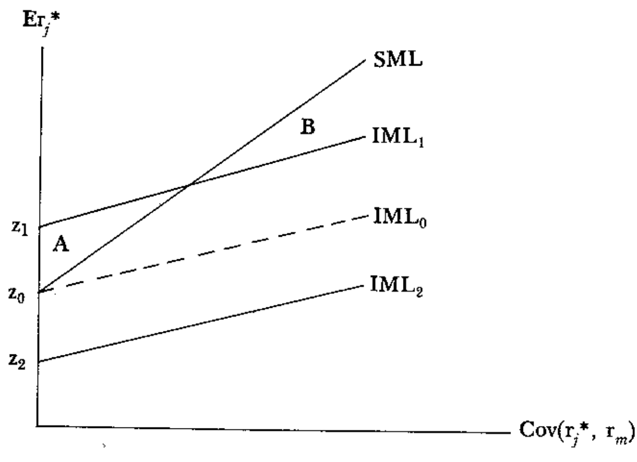
model results in understanding true total risk. Consequently, this misspecification of the relevant risks introduces biases in the investment decision criterion under the traditional SML model. The nature of these biases in turn depends on the nature of the foreign exchange rate fluctuations, distinguished in terms of whether they are exchange-averse, exchange-neutral, or exchange-preferred fluctuations.

Case 1. Exchange-Neutral Investment:

For the purpose of isolating the effects of an overall appreciation of foreign exchange rates, we will consider the case in which $Ex_j > 0$ and $Cov(r_j^*, x_j) = 0$. First, the appreciation of foreign exchange rates must result in capital gains on the capital assets invested abroad. This has the effect of rotating downward, as it were, the SML schedule of Figure (1) to the hypothetical IML_0 schedule at the initial intercept z_0. Consequently, the SML schedule must have a steeper slope than the hypothetical IML_0 schedule in the return-risk space of Figure (1). This causes the traditional SML model to overstate the equilibrium market price of risk due to ignoring the assumed appreciation of foreign exchange rates. Second, we can see from Equation (7) that the

Figure 1

EFFECTS OF EXCHANGE RATE FLUCTUATIONS ON SML AND IML



positive constant assumed for Ex_j must also make the intercept of the IML schedule to shift upwards, hence increasing it from the initial value z_o to the final value z along the vertical axis of Figure (1). A final position of the equilibrium relationship in the case of the exchange rate appreciation is indicated by IML_1 in Figure (1).

For example, the points located in area A of Figure (1) would be incorrectly accepted, while the points in area B would be incorrectly rejected according to the traditional SML model. 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.

Case 2. Exchange-Preferred Investment:

Consider the case in which expected appreciation of foreign exchange rates is a positive constant, and the value of $Cov(r_j^*, x_j)$ is also a positive constant for all foreign investments. Two events must happen: First, as already discussed in the previous case, the expected appreciation must make the market price of risk lower, hence making the slope of an IML schedule flatter than that of an SML schedule in the return-risk space. Second, the intercept of an IML schedule is now affected by the value of $Cov(r_j^*, x_j)$, as well as by the value of Ex_j. Consequently, the initial position of an SML curve will shift depending on the relative magnitudes of Ex_j and Q_j $Cov(r_j^*, x_j)$, which can be seen directly from Equation (9).

Suppose that the value of expected appreciation Ex_j is greater than the value of Q_j $Cov(r_j^*, x_j)$. In this case, we obtain results qualitatively identical to those of the exchange-neutral case, and the corresponding explanations apply here as well. On the other hand, if the value of Ex_j is less than the value of Q_j $Cov(r_j, x_j)$, the final position of intercept at z_2 must be lower than z_o. The corresponding return-risk relationship is represented by IML in Figure (1). It is shown in Figure (1) that the IML curve must also lie below the SML curve at all positive levels of market risk. Consequently, the level of the downward bias introduced by SML, with respect to the level of exchange-preferred investments, is greater than that of the preceding case. In other words, when we make investment decisions according to SML, we are led to reject incorrectly all of those exchange preferred investments whose return-risk combinations are located in the area between SML and IML in Figure (1).

III. Empirical Estimation of IML Model under Exchange Rate Fluctuations[13]

In order to investigate the hypotheses suggested by the SML and IML models, we estimated regression equations of the following form:[14]

(10) SML: $Er_j = z + \lambda b_j + e$

(11) IML: $Er_j{}^* = z + \lambda b_j + z^* Ex_j + \lambda^* b_j{}^* + e_j$

From taking partial derivatives of the above equations with respect to the relevant regressors of the respective models specified above, we have extracted the following testable hypotheses.

H1(IML) : The estimated coefficients for the intercept and the slope of the market rate risk variable both should be positive,[15] i.e., $z, \lambda > 0$ for the IML.

[13] Our main objective of this section is to estimate the SML and IML model developed in the last section. It is not intended to provide any systematic investigation on the validity of CAPM. See Cheng and Grauer for the discussion on the subject matter. Instead, our express purpose is to capture empirically the effects of exchange rate fluctuations and to expose any quantitative differences between the two models reflecting the type of qualitative differences enunciated in the last section.

[14] Following the convention adopted by *Survey of Current Business*, we measured rate of return by calculating income-after-tax divided by mean of current and preceding year-end book values of U.S. direct foreign investment position in manufacturing. From the annual average dollar prices of a foreign currency, we calculated expected exchange rate fluctuations based upon rates of change in the annual average foreign exchange rate levels.

[15] Market rate beta for a given investment was generated by estimating the characteristics line of the investment's return performance with respect to a single index market rate of return, which is represented by a weighted average of individual investment's annual average rates of return realized on both U.S. domestic and all U.S. direct foreign investments in manufacturing industries.

H2(IML) : The estimated coefficient for exchange rate fluctuations should be positive and approximately unity, i.e., $z^* = 1$.

H3(IML) : The estimated coefficient for the exchange rate variable should be negative,[16] i.e., $\lambda^* < 0$.

The first hypothesis H1(IML) states that both the risk-free rate and the marginal effects of market rate risk should be positive. We should notice, however, that in the case of the SML model it has the effects of exchange rate risks embedded in its estimated coefficient for the market rate risks in Equation (10). The second hypothesis H2 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 third hypothesis H3 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 1. The results show that the risk-free rates represented by the intercepts 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 models, 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 magnifitude 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.

In order to capture the time profile of the equilibrium relationship by identifying the inter-temporally shifting pattern of

16 Exchange rate beta for a given investment was generated by estimating the characteristic line of the investment's return performance with respect to the corresponding exchange rate fluctuations.

Table 1

EMPIRICAL ESTIMATION OF SML AND IML MODELS

SML: $Er_j = z + \lambda b_j + e_j$
IML: $Er_j = z + z^* Ex_j + \lambda b_j + \lambda^* b_j^* + e_j$

	z	z*	λ	λ*	t(z)	t(z*)	t(λ)	t(λ*)	Corr
SML_j	11.2123	—	2.2828	—	4.3670	—	.7058	—	.1854
IML_j	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: *Survey of Current Business,* 1967 through 1984.
Federal Reserve Bulletin, 1967 through 1984.

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. Durbin-Watson test was performed on the portfolio data employed for estimating the IML model. The computed statistic for the autocorrelation of residuals was 2.0834, 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 1.3074, 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 = .82 and d = 1.75 at 5% level of significance.
* denotes statistical significance at 1% level, and
** at 5% level.

equilibrium, we performed second-pass regressions for the SML and IML models according to subperiods.[17] Thus, we repeated the regressions identical to the previous ones, but employing the cross-sectional data generated from subsets of the time-series used above, distinguished in terms of subperiods. The complete patterns of equilibrium return-risk relationships are presented in Table 2. First, Table 2 shows that the estimated coefficient for the expected exchange rate variable is shown to have steadily decreased over the years, falling from the initial value of 1.1061 to

[17] The time-period under present analysis is subdivided into six moving marginal subperiods, each subperiod being ten years in length. Thus, each marginal subperiod was formed by deleting the oldest observation from the previous subperiod's data set and then simultaneously adding to new observation to the current subperiod's data set. The first subperiod in the present investigation is between 1967 and 1976.

the final value of .2756. This result also agrees with the empirical result established elsewhere,[18] which shows that while foreign return performance has grown more sensitive inter-temporally to exchange rate fluctuation, it has grown at the same time in a manner that wiped out all distinguishable characteristics between portfolios with regard to the level of exchange rate fluctuation. What is distilled from empirical analyses of foreign investment is the unavoidable fact that the key to explaining observed variations in return performance lies neither in the level of market risk nor in the level of exchange rate fluctuation per se; changes in the equilibrium return-risk relationship of foreign investment, for the most part, are explained primarily by systematic exchange rate risk.

Second, the result obtained from the SML model indicates that the price of systematic market risk has been steadily 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 rate of return requirement by more than two percentage points. In view of our earlier argument, however, the negative price for systematic market risk resulting from the SML model should not come as a surprise. According to the theory, the SML model may give a negative value for the estimated price of market risk, not because investors are intrinsically risk-lovers, but because the equilibrium return-risk relationship represented by the SML model misspecifies the true relationship by neglecting to correctly account for the presence of stochastic exchange rate fluctuations.[19]

Third, according to the empirical results of the IML model,

[18] See Kim, Y.M. Ch. VII.

[19] This result may appear odd at a first glance, but we have argued that equilibrium foreign earnings are related to systematic exchange rate risk in addition to systematic market risk. Consequently, the estimated slope coefficient of the SML model reflects not only the marginal effect of systematic market risk, but it also picks up indirectly the marginal effect 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 risk variable, which is not explicitly shown in the SML model but nonetheless embedded in its estimated market price, is sufficiently large in magnitude as to dominate the positive value associated with the systematic market risk.

Table 2

EMPIRICAL ESTIMATION OF SML AND IML ACCORDING TO SUBPERIODS

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

IML: $Er^*_{ps} = z_s + z^*_s Ex_{ps} + \lambda_s b_{ps} + \lambda^*_s b_{ps} + e_{ps}$

	z	z*	λ	λ*	t(z)	t(z*)	t(λ)	t(λ*)	Corr
SML1	13.11	—	.43	—	41.44	—	.39	—	.1369
IML1	15.81	1.10	1.4	-9.63	13.05	5.5	1.89	-2.80	.9170
SML2	12.82	—	1.93	—	16.53	—	1.04	—	.3465
IML2	14.93	.96	1.33	-7.27	5.87	2.24	1.13	-1.17	.7684
SML3	13.11	—	1.81	—	15.19	—	1.09	—	.3615
IML3	12.37	.64	2.69	-2.08	7.94	3.61	2.06	-.63	.8949
SML4	11.38	—	4.28	—	14.38	—	3.41	—	.7698
IML4	13.41	.52	3.04	-6.01	21.98	3.56	3.78	-4.67	.9552
SML5	14.49	—	-.78	—	20.47	—	-.80	—	-.2739
IML5	16.26	.34	2.91	-13.66	50.33	3.07	4.60	-8.02	.9613
SML6	15.57	—	-2.41	—	13.57	—	-2.28	—	-.6276
IML6	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.

the estimated market price of systematic exchange rate risk has also increased during the same time-span, albeit the rate of increment was less than that of the estimated price of systematic market risk, thus making foreign return performance increasingly sensitive to changes originating from systematic exchange rate risk also. Except during one subperiod (1970-1979), the estimated price of systematic exchange rate risk, however, has remained far higher than the estimated price of the corresponding market risk during all the other subperiods we examined. Furthermore, systematic exchange rate risk has become far more dominant, in terms of absolute magnitude of its marginal effect on foreign earnings of subsidiaries, than any other factors including the systematic market risk variable; in other words, systematic exchange rate risk is capable of virtually swamping all other effects brought to bear on the equilibrium foreign returns.

IV. Concluding Remarks

This paper has attempted to provide a model that is capable of explicitly incorporating exchange rate fluctuations to explain international difference of return-risk characteristics associated with direct foreign investment. The empirical tests on the hypotheses suggested by the IML model entertained, essentially, nothing beyond the explicit introduction of exchange rate fluctuations in addition to putative assumptions specified for a return-risk tradeoff of the traditional SML models. For the theoretical framework, we have employed the traditional model of a multi-plant firm under uncertainty extended to build a mean-variance framework for analyzing the equilibrium return-risk relationship of direct foreign investment by introducing uncertain exchange rate changes. The IML model developed in this paper has revealed that effects of exchange rate changes reach far deeper than initially supposed, affecting the entire spectrum of the equilibrium return-risk relationship of foreign investment during the time period under present study.

Although neither SML model nor IML model can avoid being subjected to intertemporally shifting equilibrium parameters, the IML model developed in this paper has performed well beyond a reasonable expectation in every subperiod we examined. However, the same can hardly be claimed for the SML model that does not consider exchange rate influences as specific regressors in empirical analyses of foreign investment. While the primary virtue of our IML model may have been confined to the simplicity of its approach to incorporate uncertain exchange rate fluctuations as the theoretical underpinning of the equilibrium return-risk relationship, its theoretical implications are pervasive in the analyses of foreign investment, and its empirical results have been demonstrated to be robust over time. In particular, the findings of this study have revealed that while international difference of return performance can be explained, for the most part, by international difference of risk associated with direct foreign investment, uncertain exchange rate fluctuation in turn plays the key role, quintessential in explaining the international equilibrium return-risk relationship.

References

Batra, R.N., and A. Ullah, "Resource Allocation in a General Equilibrium Model of Production under Uncertainty," *Journal of Economic Theory,* 8, 1, Mar. 1974, 50-63.

Caves, R.E., "International Corporations: The Industrial Economics of Foreign Investment," *Economica,* 38, Feb. 1971, 1-27.

Cheng, P.L., and R.R., Grauer, "An Alternative Test of Capital Asset Pricing Model," *American Economic Review,* 70, Sep. 1980, 660-71.

Grubel, H.G., "International Diversified Portfolios: Welfare Gains and Capital Flows," *American Economic Review,* 58, Dec. 1968, 1299-313.

Helleiner, G.K., "Manufactured Exports from Less Developed Countries and Multinational Firms," *Economic Journal,* 83, Mar. 1973, 21-47.

Johnson, H.G., "The Efficiency and Welfare Implications of the International Corporations," C.P. Kindleberger, ed., *The International Corporation,* MIT Press, 1970.

Kim, Y.M., "A Theory of Internationally Diversified Production under Uncertainty," unpublished Ph.D. Dissertation, Simon Fraser University, Canada, 1985.

Kindleberger, C.P., *American Business Abroad,* Yale University Press, New Haven, 1969.

Mossin, J., "Equilibrium in a Capital Asset Market," *Econometrica,* 34, 1966.

Rugman, A.M., "Risk Reduction by International Diversification," *Journal of International Business Studies,* Fall 1976, 75-80.

Solnik, B.H., "The International Pricing of Risk: An Empirical Investigation of The World Capital Market Structure," *Journal of Finance,* May 1974, 365-378.

———, "The Advantages of Domestic and International Diversification," Elson and Gruber, eds., 1975.