THE JOURNAL OF FINANCE • VOL. XLIV, NO. 3 • JULY 1989

Asset Pricing in Partially Segmented Markets: Evidence from the Finnish Market

PEKKA T. HIETALA*

ABSTRACT

This paper analyzes asset pricing in a partially segmented market where citizens of a small country are allowed to hold only their domestic securities, whereas the rest of the investors ("foreigners") are essentially allowed to hold all securities. In this market setting it may occur that the citizens of the small country are willing to pay less for their domestic securities than are the foreign investors. The paper derives equilibrium required rates of return for different investors in this market setting which perfectly occurred in Finland and tests this equilibrium model using data from the Finnish stock market. Empirical results are consistent with the hypotheses derived from the model.

SEVERAL STUDIES (SEE, E.G., Solnik (1974a) and Grauer and Hakansson (1987)) have shown that investors should diversify internationally as by so doing they can reduce the risk of their portfolio without lowering the expected return. This implies that, if the citizens of a certain country are by legal restrictions prohibited from holding foreign securities, they may require a higher rate of return on the domestic securities than the foreign investors do. This may happen because the domestic investors cannot diversify away the specific country risk in the same way that the foreign investors can. Thus, if we could observe the prices which the foreign and domestic investors are willing to pay for these domestic securities, we would expect them to differ because of this diversification effect.

The Finnish law prohibited Finnish investors from investing in foreign securities until 1986 while simultaneously allowing foreign investors to own up to 20% of the shares of any Finnish company. Moreover, since 1984 the Helsinki Stock Exchange (HSE) has separately quoted the prices for the unrestricted shares which can be owned both by foreign and domestic investors and for the restricted shares owned solely by domestic investors. Thus, the market setting depicted in the previous paragraph occurred perfectly in Finland during the years 1984 and 1985.

In this paper our objective is to develop and test an asset pricing model which takes into account the legal restrictions in the Finnish stock market. In Section I we specify the market structure in the Finnish stock market in more detail by explaining the relevant legal restrictions affecting the market. We also present some descriptive statistics on the prices of the restricted and the unrestricted on

* Insead, Fontainebleau, France. This paper is based on the first chapter of my dissertation submitted at the Graduate School of Business, Stanford University. I want to express my sincerest thanks to my dissertation committee, Michael Gibbons, Bruce Grundy, and Allan Kleidon, for their invaluable comments throughout this dissertation research. I also want to thank Bengt Holmström, Bob Litzenberger, Paul Pfleiderer, Kristian Rydqvist, Myron Scholes, and Eric Terry for their help.

the HSE. In Section II we develop an asset pricing model which takes into account the aforementioned legal restrictions. The model is able to explain why some of the unrestricted stocks are traded at premium prices (i.e., their prices contain premiums above the prices of the restricted stocks) while some other unrestricted stocks carry no such premiums. In Section III we empirically test whether the legal barriers in the Finnish stock market have the effects hypothesized by our model. We also analyze whether those investment barriers which are omitted in our model (e.g., more costly information acquisition process for foreign investors, and foreign investors' dislike for relatively illiquid markets) can explain some portion of the variation in the price premiums between the restricted and the unrestricted shares. Section IV concludes the paper.

I. The Finnish Market Structure

In the Finnish stock market there exist three basic restrictions affecting investors' possible portfolio holdings: two restrictions on the stocks which different investors can hold in their portfolios and a restriction on short sales which apply to all investors.

The Finnish law states that at most 20% of the shares of any Finnish company are allowed to be owned by foreign investors.[1] The only companies which are exempted from this requirement are insurance companies and companies established by foreigners (e.g., Ford and IBM have subsidiaries in Finland). Because of this "20%-law" at least 80% of the shares of many Finnish companies must have an indication (normally a stamp) that the stock is a restricted stock, i.e., it is not allowed to be sold to foreign investors. The rest of the shares, unrestricted shares, are allowed to be owned by both Finnish and foreign investors. In all other respects restricted and unrestricted shares are identical; in particular they have equal voting rights and equal rights to monetary distributions. Foreign investors can thus invest only in unrestricted shares on the HSE.

Finnish investors were not allowed to invest in foreign securities before January 1, 1986 without special permission from the Bank of Finland.[2] Thus, the eligible stocks for Finnish investors were the restricted and unrestricted stocks on the HSE. Figure 1 below shows graphically how the opportunity sets of eligible stocks differ between the two nonoverlapping investor groups.

The third restriction affecting possible stock holdings in the Finnish stock market concerns negative holdings of the stocks listed on the HSE. No short selling is allowed, and, due to the lack of an options market in Finland before 1988, it was difficult for an investor to try to even approximate a short position in any restricted or unrestricted Finnish stock.

The restriction on foreign investors' holdings of Finnish stocks did not prove

[1] Finland is by no means the only country having this kind of restriction in its law. See Eun and Janakiramanan (1986) for a list of countries having this kind of restriction in their laws.

[2] Such permissions were virtually never given to investors before the beginning of 1986: only Finnish banks and insurance companies operating abroad were allowed to invest abroad to some extent. Investors could indirectly invest in foreign securities by buying shares of these banks and insurance companies. These companies' investments in foreign securities have, however, been small compared to their investments in domestic securities. Starting January 1, 1986, the Bank of Finland has allowed individual investors to invest in foreign assets.

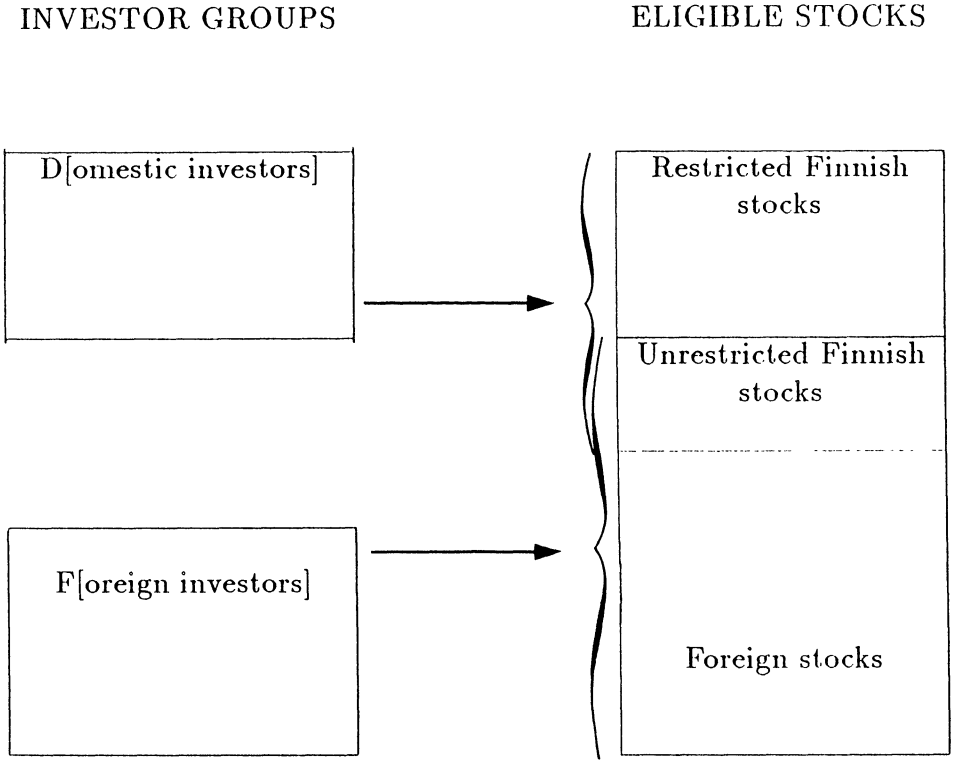

Figure 1. Investor groups and eligible stocks in the Finnish stock market.

to be binding prior to 1983. Thus, before 1983 domestic investors owned all the restricted shares of Finnish companies and most unrestricted shares. On the HSE restricted and unrestricted stocks were not quoted separately, and there was a common price for both stocks.

Circumstances changed during 1983 when more and more foreign investors started to show keen interest in Finnish companies.[3] As more and more unrestricted shares were bought by foreign investors, stockbrockers had an increasing difficulty in finding willing domestic (or foreign) sellers for these unrestricted shares because the HSE still quoted restricted and unrestricted stocks at the same price. Even though this price quotation was officially for both restricted and unrestricted stocks, it was too low for unrestricted stocks given the growth in the demand for the stocks and their scarce supply. By the second half of 1983, the situation was untenable. Sellers were willing to sell only restricted stocks at the quoted prices, and stockbrokers organized an unofficial market for unrestricted stocks.

From the start of January 1984, the HSE began to quote companies' unre-

[3] Foreign investors first became interested in Swedish companies in 1982 and subsequently widened their interest in Finnish companies. The Swedish stock market soared 128% (according to the index used by Capital International Perspective) in the eight months from July 1982 to February 1983—this rise may partially be due to the foreign investors' rush to the stock market. We are not aware of why foreign investors became interested in these two stock markets at this particular time.

stricted and restricted stocks separately. This does not mean, however, that for each of the fifty-five listed companies there were two separate price quotations because 1) some listed companies have either no unrestricted shares outstanding or so trivial an amount of unrestricted shares that they are not listed on the HSE; 2) as mentioned earlier, all the shares of insurance companies and foreign companies are unrestricted; and 3) some listed companies have more than one class of common stocks[4] listed on the HSE and so may have, for instance, four separate price quotations in the list (i.e., two price quotations for both restricted and unrestricted stocks). During the period 1984–1985 altogether twenty-three companies had both restricted and unrestricted stocks listed, and six of these companies had two classes of unrestricted stocks listed.

From the beginning of the system of separate price quotations many unrestricted stocks have traded at substantial premiums relative to the restricted stocks. Figure 2 shows the mean monthly premiums on unrestricted stocks from January 1984 to June 1985.[5] The highest average monthly premium occurred in June 1984 when the mean premium was 41% (the standard error of the mean was 4.2%). The lowest average monthly premium occurred in April 1985 when the mean premium was 11.7% (with a standard error of 4.0%).

Figure 2 also shows the maximum and minimum monthly premiums along with the number of unrestricted stocks which traded at discounts each month. During 1984 unrestricted stocks traded at discounts on only five occasions using monthly observations, and the minimum monthly premium was typically nonnegative. This changed during the first five months of 1985: The minimum monthly premiums were clearly negative, and eight of the unrestricted stocks traded at discounts in April 1985—almost 30% of our sample. (The monthly sample size varied between twenty-four and twenty-nine stocks; in April 1985 there were twenty-seven stocks in the sample.) With few exceptions the maximum monthly premium has fluctuated between 60% and 90% during the sample period. The average monthly premiums for individual stocks (for the time period from January 1984 to June 1985) varied from 2.3% (for *Fiskars*) to 63% (for *Wärtsilä, class II*). The average monthly premium was significantly greater than zero at the 1% level for all but four of the twenty-nine unrestricted stocks. The distribution of the average premiums is given in Table I.

From Table I we can conclude that there exists a lot of variation in monthly premiums across companies. So an acceptable explanation for these premiums has to explain not only their existence, but also the variation across companies. Lower taxes for foreign investors than for domestic investors may be able to explain the general level of the premiums but cannot satisfactorily explain the variation across companies.[6] According to this simple tax explanation the premiums should be constant across companies; this implicitly assumes that poten-

[4] Different classes of common stocks have differences in their voting rights and/or in their rights to monetary distributions.

[5] The data on the second half of 1985 are not analyzed as they may be contaminated by the fact that the Bank of Finland announced in August 1985 that it will allow Finnish investors to invest in foreign securities from the beginning of January 1986.

[6] The relevant Finnish tax laws are described in Appendix I. The Appendix shows that it is not clear that foreign investors pay lower taxes than Finnish investors.

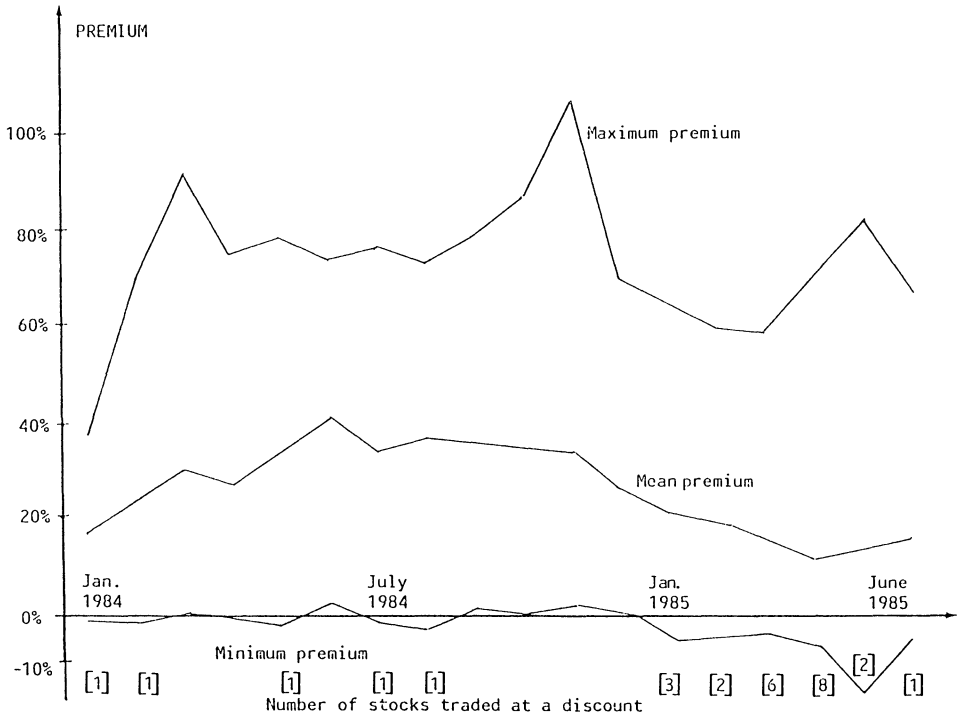

Figure 2. The maximum, minimum, and mean monthly premiums and the number of unrestricted stocks traded at a discount each month on the HSE from January 1984 to June 1985.

Premiums are calculated using the following formula:

$$\frac{\text{Price of the unrestricted stock} - \text{Price of the restricted stock}}{\text{Price of the restricted stock}}.$$

Only real transaction prices were used when the premiums were calculated. For the restricted stock, which invariably is the less frequently traded, the first transaction price in each month was used. For the restricted stock, the price of the transaction which occurred closest to the first transaction in the unrestricted stock was used. For most of the stock pairs, the transaction prices for both the restricted and unrestricted stocks are from the same day. The time difference in the transaction prices for the remainder of the stock pairs does not systematically affect our results. That is, for some stock pairs the transaction in the restricted stock occurs first, and for some other stock pairs the reverse is true.

Table I

The Distribution of the Average Monthly Premiums for Individual Stocks for the Period from January 1984 to June 1985

Average Premium	Number of Stocks
2.3–10%	7
10–20%	5
20–30%	8
30–40%	4
40–50%	2
50–60%	1
60–63%	2

tial differences in the taxation on dividends and capital gains does not cause foreign investors to prefer either high- or low-yield Finnish companies. If this were the case, the tax explanation could also explain the different premiums across companies and the premiums would be correlated with the dividend yields of the stocks. However, the rank correlation between average monthly premiums and the dividend yields was 0.04 using dividend yields from 1983 and −0.16 using dividend yields from 1984.[7] Both of these numbers are insignificantly different from zero even at the 40% probability level, so the tax explanation itself cannot satisfactorily explain the price premiums on the unrestricted stocks. Because of the problems discussed in Appendix I, in particular the problem involved in determining foreign investors' actual marginal tax rates, we do not incorporate taxes into our formal model. Section II shows that the premiums are not inconsistent with equal taxation of domestic and foreign investors.

In the next section we develop equilibrium pricing relations for Finnish companies' restricted and unrestricted stocks, taking into account the portfolio restrictions described in this section. The analysis explicitly demonstrates that these legal restrictions potentially cause some unrestricted stocks to trade at premium prices from the domestic investors' point of view. The model is also consistent with the observed variation in the premiums across different stocks.

The model's predictions are empirically tested in Section III. This paper is the first (to our knowledge) to test an asset pricing model in an international setting which explicitly takes into account the actual investment barriers that prevail. For instance, the Sharpe (1964)-Lintner (1965)-Mossin's (1966) Capital Asset Pricing Model (CAPM) has been tested numerous times at a national level, i.e., with an implicit assumption that international security markets are fully segmented. Most of the tests in an international setting have only examined whether international capital markets are fully integrated or fully segmented (e.g., Solnik (1974a), Stehle (1976), and Jorion and Schwartz (1986)).

At a theoretical level Solnik (1974b) develops an equilibrium model of the international capital markets assuming complete integration in the international capital markets. Trying to relax Solnik's unrealistic assumption, Black (1974) and Stulz (1981) develop equilibrium models of the international capital markets with special taxes if an investor invests in foreign assets. The assumptions in Black's model are, however, unattractive since he effectively assumes a negative tax (i.e., a subsidy) when an investor sells foreign securities short. Stulz improves Black's model by assuming positive taxes on both long and short positions. But the assumption that unlimited short sales are allowed does not seem attractive in an international setting.

Solnik (1977, p. 505) suggests that "the efficient way to test for segmentation would seem to be to specify the type of imperfection which might create it and study its specific impact on portfolio optimality and asset pricing." This is the view adopted in this paper and in recent papers by Errunza and Losq (1985) and

[7] In both cases dividend yields were calculated from the prices of the restricted stocks. Use of the prices of the unrestricted stocks would induce spurious correlation in our test. Those unrestricted stocks which have the highest premiums would also tend to have the lowest dividend yields. However, the correlation remains insignificantly different from zero even if we use the dividend yields of the unrestricted stocks.

Eun and Janakiramanan (1986). Errunza and Losq study the effect of barriers to U.S. investment in LDCs (less developed countries) when residents of LDCs can invest in U.S. markets. They do not, however, specify the legal nature of the barriers against U.S. investors but mainly rely on barriers which they term "perceived." By their definition these "perceived" barriers against U.S. investors exist if in some LDC market U.S. investors are almost nonexistent. Eun and Janakiramanan independently study a problem similar to that investigated here, i.e., a market setting with a constraint on foreign equity ownership. However, they fail to empirically test their model because they do not study existing restrictions in any specific market. Our market setting differs from theirs because we incorporate the specific restrictions related to the Finnish market into our model. Because of this we can also empirically test our model.

II. An Equilibrium Asset Pricing Model in the Finnish Stock Market

To derive the equilibrium asset prices for both the restricted and unrestricted stocks we extend the Sharpe-Lintner-Mossin CAPM to take into account the restrictions in the Finnish stock market. The assumptions of our model are:

(A1) Investors in both investor groups (D and F; see Figure 1) are risk averse and choose their portfolios solely on the basis of the expected value and the variance of the probability distribution of the end-of-period portfolio value.

(A2) All investors have identical beliefs concerning the joint probability distribution of stock returns.[8]

(A3) All investors can borrow and lend in unlimited amounts at the riskless interest rate, which is the same for both investor groups.[9]

(A4) There are two mutually exclusive investor groups D and F. The stock universe is separated into three mutually exclusive sets: set A contains restricted Finnish stocks, set B contains unrestricted Finnish stocks, and set C contains all foreign stocks. The opportunity set facing investor $d \in D$ consists of stock in sets A and B ($A \cup B = G$). The opportunity set for investor $f \in F$ consists of stock in sets B and C ($B \cup C = H$). Finally, no investor is allowed to take a short position in any stock in set A or set B.[10]

(A5) Aside from the investment restrictions described in assumption (A4), capital markets are perfect; i.e., there are no differential taxes, transaction costs are zero, and all assets are infinitely divisible.

[8] We thus assume that the foreign investors are not concerned about the exchange rate risk but that it is a valid approximation that the exchange rate risk is a diversifiable risk. Existing studies point toward this direction by documenting very low correlations between exchange rate movements and stock returns. (See, e.g., Adler and Simon (1986) and Solnik (1984).)

[9] According to the uncovered interest rate parity (UIRP), the interest rates should be the same across different countries after making an adjustment for expected exchange rate movements. We thus assume that the UIRP holds. However, the model could be extended to include different riskless interest rates for different investor groups. In that case the R_f in equations (17a) and (17b) would differ from the R_f in equations (18a) and (18b).

[10] None of the model's conclusions would change if we assumed that short-selling is not allowed in any stock in set C either.

The somewhat tedious derivation of the equilibrium model is relegated to Appendix II, and only the main results from the Appendix are presented here.

Formula (17a) in the Appendix shows that domestic investors' security market plane for their investment opportunity set G is

$$E[\tilde{R}_g] \leq R_f + (E[\tilde{R}_{G^*}] - R_f)\text{var}^{-1}(\tilde{R}_{G^*})\text{cov}(\tilde{R}_g, \tilde{R}_{G^*}) \quad \forall g \in G, \tag{17a}$$

where G refers to domestic investors' investment opportunity set and G^* refers to the set of stocks which domestic investors hold in equilibrium; g and g^* are generic elements from these sets. $\tilde{R}_g$, $\tilde{R}_{G^*}$, and R_f are the return on security g, the return on domestic investors' equilibrium portfolio, and the riskless rate of interest, respectively.

To emphasize the difference between sets G^* and $G - G^*$, we can split (17a) into two parts:

$$\begin{cases} E[\tilde{R}_{g^*}] = R_f + (E[\tilde{R}_{G^*}] - R_f)\text{var}^{-1}(\tilde{R}_{G^*})\text{cov}(\tilde{R}_{g^*}, \tilde{R}_{G^*}) & \forall g^* \in G^*. \\ E[\tilde{R}_g] \leq R_f + (E[\tilde{R}_{G^*}] - R_f)\text{var}^{-1}(\tilde{R}_{G^*})\text{cov}(\tilde{R}_g, \tilde{R}_{G^*}) & \forall g \in G - G^*. \end{cases} \tag{17b}$$

Formula (17b) tells us that, for those stocks which domestic investors hold in positive amounts, the expected return is the riskless return plus the market's risk premium times the risk which is priced in the market. The market's risk premium is the excess return on domestic investors' equilibrium portfolio, and the market risk of a stock is the stock's covariance with the return on the domestic investors' equilibrium portfolio relative to the variance of the return on the equilibrium portfolio.

For those stocks in the domestic investors' opportunity set, which domestic investors are not holding, the expected return is less[11] than the equilibrium return considered by domestic investors. These are the stocks in which domestic investors would have a short position if there were no legal restrictions against short selling. We know that domestic investors hold all the restricted stocks in positive amounts and so all the stocks in $G - G^*$ must be unrestricted stocks. The converse does not have to be true; i.e., domestic investors may hold some (or even all) unrestricted stocks in positive amounts.

Similarly, formula (18a) in the Appendix shows that foreign investors' security market plane for their investment opportunity set H is

$$E[\tilde{R}_h] \leq R_f + (E[\tilde{R}_{H^*}] - R_f)\text{var}^{-1}(\tilde{R}_{H^*})\text{cov}(\tilde{R}_h, \tilde{R}_{H^*}) \quad \forall h \in H, \tag{18a}$$

where H refers to foreign investors' investment opportunity set and H^* refers to the set of stocks which foreign investors hold in equilibrium. The interpretation of other variables is similar to the one in (17a).

Once again to emphasize the difference between sets H^* and $H - H^*$, we can split (18a) into two parts:

$$\begin{cases} E[\tilde{R}_{h^*}] = R_f + (E[\tilde{R}_{H^*}] - R_f)\text{var}^{-1}(\tilde{R}_{H^*})\text{cov}(\tilde{R}_{h^*}, \tilde{R}_{H^*}) & \forall h^* \in H^*. \\ E[\tilde{R}_h] \leq R_f + (E[\tilde{R}_{H^*}] - R_f)\text{var}^{-1}(\tilde{R}_{H^*})\text{cov}(\tilde{R}_h, \tilde{R}_{H^*}) & \forall h \in H - H^*. \end{cases} \tag{18b}$$

The stocks (in set $H - H^*$) which foreign investors do not hold in equilibrium

[11] Only in degenerate cases does the equality hold in the second equation in formula (17b).

are unrestricted stocks because foreign investors have a positive holding in all foreign stocks $c \in C$. Thus, formula (18b) implies that some unrestricted stocks may sell at prices which are too high from foreign investors' point of view. The prices of these unrestricted stocks are determined by the demand from domestic investors.

The most important conclusion from the equilibrium model presented above is the fact that for all stocks in sets A, B, and C there exist two separate risk premiums, one for each investor group evaluating the stock. This fact is not crucial for stocks in sets A and C because all stocks in set A are held in equilibrium by domestic investors and all stocks in set C by foreign investors. However, for unrestricted Finnish stocks (set B) both risk premiums are relevant because both domestic and foreign investors can hold these stocks. The equilibrium market prices for these stocks are determined by the demand from the investor group for which the required risk premium is lower. By coincidence, for some stocks the two risk premiums may be equal, and these stocks are held in equilibrium by both investor groups. The normal situation is, however, that the equilibrium price of a stock will be determined solely by the demand from one investor group and the stock will appear overpriced to the other investor group. Moreover, there will be no pressure toward price revisions because the legal restrictions prohibit investors from shorting these "mispriced" stocks.

Thus, this equilibrium model is able to explain the premiums seen in the Finnish stock market. More specifically, an unrestricted stock is traded at a premium if and only if the price of the unrestricted stock is determined by foreign investors.[12] This happens if foreign investors require a lower risk premium on this stock than domestic investors do.

Our model is also consistent with different premiums across stocks. The smaller the beta of the unrestricted stock calculated with respect to the foreign investors' optimal portfolio relative to the beta of the restricted stock calculated with respect to the domestic investors' optimal portfolio, the larger the equilibrium premium.

III. Empirical Evidence

Our model in Section II is able to explain the existence of price premiums on unrestricted stocks. More precisely, it predicts that the price premiums on unrestricted stocks can vary from 0% upwards depending on the risk premiums of the stock for domestic and foreign investors. In this section we will first look at possible reasons for observed discounts in some unrestricted stocks. Thereafter we will test whether the model is able to predict the cross-sectional variation in the price premiums across different stocks.

[12] The only reason why a domestic investor wants to hold an unrestricted stock which is traded at a premium is for speculative purposes. As our model is a one-period model it does not capture this behavior. On the other hand, those unrestricted stocks which have been traded at premiums have earned returns which are statistically significantly lower than the returns on the corresponding restricted stocks. Thus, this speculative behavior does not seem to be warranted by risk-averse investors.

A. Unrestricted Stocks Traded at Discounts

It is clear that rationally an unrestricted stock should always be traded at least at the same price as the restricted stock because for domestic investors these two stocks give exactly the same payoff stream and voting power. Our data in Figure 2 show that we have twenty-seven observations (out of 458 observations) where unrestricted stocks traded at discounts relative to the restricted stocks. These twenty-seven discount cases are calculated from real transaction prices,[13] and for all these cases the two transactions occurred on the same day.

A vast majority (90%) of these discount cases are, however, temporary discounts which vanished within one or two days. Thus, in these cases probably no real discounts existed and the apparent discounts simply reflected measurement errors caused by nonsynchronous data.[14]

Another reason for the discounts is that for several companies the unrestricted and restricted stocks are not perfect substitutes for domestic investors because of the differential transaction costs. The differential transaction costs are caused by extremely infrequent and thin trading in some unrestricted stocks.[15] Thus, it may well be optimal for the domestic investors to buy the restricted shares rather than place a purchase order for the unrestricted shares and not know whether and when this order will be fulfilled.[16] In the end of the following subsection we will test whether this illiquidity effect also affects the cross-sectional variation in the observed average premiums across different companies.

B. Price Premiums and the Betas of the Stocks

In this subsection we analyze the cause of the different price premiums across unrestricted stocks. In our equilibrium pricing model the price premiums originate solely from the differences in the excess returns required by domestic and foreign investors. The excess return on an unrestricted stock required by foreign investors is the beta of the unrestricted stock with respect to the foreign investors' equilibrium portfolio times the excess return on their equilibrium portfolio, i.e.,

$$E[R_I] - R_f = \beta_I \lambda_I, \tag{19}$$

where

R_I = the required rate of return on the unrestricted stock by foreign investors,
R_f = the riskless interest rate,
β_I = the beta of the unrestricted stock with respect to the foreign investors' equilibrium portfolio,
$\lambda_I = (E[\tilde{R}_{H^*}] - R_f)$ in equation (18a).

[13] See the Figure 2 legend for explanations of how the premiums are calculated.

[14] A trading day lasted approximately three hours on the HSE during our sample period. Unfortunately, we do not have time-stamped data from the HSE, so we do not know the exact time difference between the transactions.

[15] The case of *Suomen Trikoo* is an extreme example of this: The unrestricted stock was traded only once during the second quarter of 1985, and only 100 shares of the unrestricted stock were traded at that time. This example clearly shows that even high discounts do not necessarily imply that the domestic investors are behaving irrationally.

[16] See Amihud and Mendelson (1986) for a model of how illiquidity affects transaction costs.

Similarly, the excess return on a restricted stock required by domestic investors is

$$E[R_D] - R_f = \beta_D \lambda_D, \tag{20}$$

where

R_D = the required rate of return on the restricted stock by domestic investors,
β_D = the beta of the restricted stock with respect to the domestic investors' equilibrium portfolio,
$\lambda_D = (E[\tilde{R}_{G^*}] - R_f)$ in equation (17a).

We estimated the two betas for twenty-five stocks as follows:[17]

1. β_D's are estimated from the market model using monthly returns for the period 1979–1983:

$$R_{jt} = \alpha_{Dj} + \beta_{Dj} R_{Dt} + \epsilon_{Djt}, \tag{21}$$

where

R_{jt} = the return on stock j in month t,
α_{Dj} = the domestic "alpha" for stock j,
β_{Dj} = the domestic "beta" for stock j,
R_{Dt} = the return on the Finnish market portfolio in month t. R_{Dt} is estimated by the return on the WI-index which is a value-weighted market index consisting of all stocks listed on the HSE. The return on the WI-index is adjusted for dividends. During the period 1979–1983 restricted and unrestricted stocks were traded together on the HSE.

2. β_I's are estimated from the market model using monthly returns for the period 1979–1983:

$$R_{jt} = \alpha_{Ij} + \beta_{Ij} R_{It} + \epsilon_{Ijt}, \tag{22}$$

where

α_{Ij} = the international "alpha" for stock j,
β_{Ij} = the international "beta" for stock j,
R_{It} = the return on the world market portfolio in month t. R_{It} is estimated by the return on the world index used by Capital International Perspective. This index is a value-weighted average of the performance of some 1200 securities listed on the stock exchanges of the U.S., Europe, Canada, Mexico, Australia, and the Far East. No Finnish stocks are included in the index. The return on this index is calculated in U.S. dollars; thus, we also calculate R_{jt} in (22) in U.S. dollars.

Two major assumptions have been made in estimating the β_I's:

1) R_{jt} reflects the return on the restricted stock because during the 1979–1983 period unrestricted stocks were not listed separately. Thus, we assume that the betas of the unrestricted and restricted stocks are identical. We did not

[17] Four of the twenty-nine stocks in our sample have entered the HSE since 1981 and were omitted from the tests performed in this subsection.

try to calculate the betas of the unrestricted stocks on the one hand because we had data only for eighteen months and on the other hand because we would have had a serious nontrading problem with the data.

2) By using R_{It} in (22) we assume that the equilibrium portfolio of foreign investors, who invest in the unrestricted Finnish stocks, is well approximated by the Capital International Perspective index.

We first test whether the international betas of the twenty-five Finnish stocks are significantly different from zero. That is, we test whether we can reject the joint hypothesis $\beta_{I,1} = \beta_{I,2} = \cdots = \beta_{I,25} = 0$. This hypothesis is tested using multivariate regression model:

$$\begin{bmatrix} R_{1,1} & \cdots & R_{25,1} \\ \vdots & \ddots & \vdots \\ R_{1,60} & \cdots & R_{25,60} \end{bmatrix} = \begin{bmatrix} 1 & R_{I,1} \\ \vdots & \vdots \\ 1 & R_{I,60} \end{bmatrix} \begin{bmatrix} \alpha_1 & \cdots & \alpha_{25} \\ \beta_1 & \cdots & \beta_{25} \end{bmatrix} + \begin{bmatrix} \epsilon_{1,1} & \cdots & \epsilon_{25,1} \\ \vdots & \ddots & \vdots \\ \epsilon_{1,60} & \cdots & \epsilon_{25,60} \end{bmatrix}. \quad (23)$$

The disturbance terms are assumed to have the following properties:

$$\operatorname{cov}(\epsilon_{is}, \epsilon_{jt}) = \begin{cases} \sigma_{ij} & \forall s = t \\ 0 & \text{otherwise.} \end{cases} \quad (24)$$

The F-statistics for the constraint $\beta_j = 0\ \forall j$ is 0.648, which is insignificant at any conventional probability level. Thus, we cannot reject the hypothesis that the international betas for the stocks in our sample are zero. Also, none of the twenty-five individual β_I's was significantly different from zero at the 5% probability level using standard t-statistics.[18]

The result $\beta_j = 0\ \forall j$ implies that $E[R_{Ij}] = R_f\ \forall j$.[19] The correlation between the returns on Finnish stocks and on the world market portfolio is so minimal that foreign investors' required rate of return on Finnish stocks practically is the riskless interest rate. The rate of return on a Finnish stock required by domestic investors is determined by the domestic beta of the stock—the higher the beta, the higher the required rate of return. Thus, if the international betas of the Finnish stocks are zero, our model predicts that there exists a positive correlation

[18] The fact that the Finnish stocks' international betas are approximately zero is not very surprising. Lessard (1975) found similar evidence from two other small European stock markets, i.e., from Denmark and Spain.

[19] This result gives rise to the following test:
Using the realized returns on the unrestricted stocks we would test the hypothesis that $E[R_j] = k\ \forall j$, where k is a constant. The following multivariate regression model would be the appropriate way to test this hypothesis:

$$\begin{bmatrix} R_{1,1} & \cdots & R_{25,1} \\ \vdots & \ddots & \vdots \\ R_{1,T} & \cdots & R_{25,T} \end{bmatrix} = \begin{bmatrix} 1 \\ \vdots \\ 1 \end{bmatrix} [\alpha_1 \cdots \alpha_{25}] + \begin{bmatrix} \epsilon_{1,1} & \cdots & \epsilon_{25,1} \\ \vdots & \ddots & \vdots \\ \epsilon_{1,T} & \cdots & \epsilon_{25,T} \end{bmatrix}.$$

The disturbance terms have properties explained in (24). The hypothesis to be tested would be $\alpha_1 = \alpha_2 = \cdots = \alpha_{25} = k$. This test requires, however, that $T > 25$. Unfortunately, we only have returns on unrestricted stocks for eighteen months.

between the size of the premium and the domestic beta of the stock. This is, in fact, the case: the correlation between the average monthly premiums and domestic betas is 0.558 in our sample. Thus, our data are consistent with our model's hypothesis that the size of the premiums can be explained by the β_I's and β_D's of the stocks.

As the different required returns affect the prices of unrestricted and restricted stocks, we can also derive a testable hypothesis about the sizes of the premiums if we assume that the dividend-perpetuity model $\left(\text{i.e., } P = \frac{D}{r}\right)$ holds. In this case we get

$$P_a = \frac{D}{R_f + \beta_D \lambda_D} \quad \text{and} \quad P_b = \frac{D}{R_f},$$

and, thus,

$$\frac{P_b - P_a}{P_a} = \beta_D \cdot \frac{\lambda_D}{R_f}.$$

That is, the price premium of an unrestricted stock is a constant, $\frac{\lambda_D}{R_f}$, times the domestic beta of the corresponding restricted stock. We test this hypothesis by running the following regression:

$$Premium_j = a + b \cdot \beta_{Dj} + \epsilon,$$

where $Premium_j$ is the average monthly premium for stock j over the time period from January 1984 to June 1985 and β_{Dj} is estimated in (21). Our model predicts that $a = 0$ and $b = \frac{\lambda_D}{R_f} > 0$. The results of the regression are

$$\begin{array}{lccc} Premium_j = & 0.0227 & + 0.2491 & \cdot \beta_{Dj} + \epsilon. \\ & (0.306) & (3.221) & \end{array}$$

t-values are in parentheses.

The constant term of our regression is insignificantly different from zero and b is positive and significant as predicted by our model.[20] Thus, this test also supports our model's hypothesis that the premiums can be explained by the β_I's and β_D's of the stock. In particular, because the β_I's are insignificantly different from zero, the domestic beta of a stock solely determines the size of the price premium.

The value of b in our regression seems to be quite low; that is, we would expect the ratio $\frac{\lambda_D}{R_f}$ to be higher than ¼. For instance, if we reasonably assumed $R_f =$ 10% and $\lambda_D = 5\%$, we would get an average price premium across stocks to be

[20] Our t-values are not, however, adjusted to the fact that there exist measurement errors in β_{Dj}'s. Because of these measurement errors both the coefficient of β_{Dj} and the standard error of the coefficient are downward biased.

50%, while in our sample the average price premium exceeded 50% only for three out of twenty-nine unrestricted stocks. That is, if the β_I's are zero, our model predicts the price premiums to be larger than they are in the Finnish stock market.

Footnote 20 explains one reason why the value of b turns out to be so low. That is, the measurement errors in β_{Dj}'s cause a downward bias in the coefficient of β_{Dj} in the regression.

There also exists another reason why our model's predictions exceed the observed premiums. There are many kinds of barriers to international investments in reality, e.g., legal barriers, informational barriers, and barriers arising from the dislike for illiquid markets. In our model we focused only on the legal restrictions prevailing in the Finnish stock market. The second assumption of our model particularly precludes any informational asymmetries from our model. It is very plausible that in reality the information acquisition process is more costly for foreign investors than for domestic investors. This may happen, e.g., because of the language barrier (only the largest Finnish companies publish English editions of their annual reports) and the different accounting standards used in Finland. In this case we would expect the realized premiums to be lower than the premiums predicted by the model and the premium size to be positively correlated with the firm size as foreign investors are at a smaller informational disadvantage in large firms.

Furthermore, many unrestricted stocks are very illiquid. Thus, it may be difficult for large foreign investors to make quick portfolio changes without causing large shifts in stock prices.[21] Thus, we would once again expect the model to overestimate the price premiums.[22]

[21] For the evidence on the price pressure effect in the U.S. stock markets, see, for example, Scholes (1972), Kraus and Stoll (1972), and Dann, Mayers, and Raab (1977).

[22] In this case we would expect to see a negative correlation between the average monthly premium and the illiquidity of the unrestricted stock. This assumes that all restricted stocks are liquid. For the companies having their unrestricted stocks listed, this is not an unreasonable assumption. To see whether illiquidity can explain some of the variation in price premiums, we ran the following regression:

$$\frac{P_b - P_a}{P_a} = a + b \cdot \beta_D + c \cdot \textit{illiquidity} + \epsilon,$$

where the illiquidity of a stock is estimated by the average interval (in trading days) between two transactions in the unrestricted stock. The same regression can also be used to test the hypothesis that the size of the premium is correlated with the firm size as the firm size and the liquidity of the unrestricted stock are almost perfectly correlated. We would expect to see $b > 0$ and $c < 0$. Since we do not have any theory of how illiquidity should affect the premiums, we do not have any predictions of the magnitude of c (or b). The results of the regression were

$$\underset{}{\frac{P_b - P_a}{P_a}} = \underset{(1.59)}{0.1528} + \underset{(2.79)}{0.2102} \cdot \beta_D - \underset{(-1.98)}{0.0401} \cdot \textit{illiquidity} + \epsilon.$$

T-values are in parentheses. The signs of both b and c are as predicted. It seems that, while the domestic beta of a stock is the most important factor to determine the size of the premium, also other factors affect the premiums—both their average magnitude and their cross-sectional variation.

IV. Conclusion

In this paper we have analyzed implications of the legal restriction that at most 20% of the stocks of many Finnish companies can be owned by foreign investors. Our main interest has been in explaining the observed cross-sectional variation in the price premiums in the Finnish stock market, i.e., why some unrestricted stocks are traded at huge premiums relative to the restricted stocks while for some other unrestricted stocks no price premiums exist. Besides the 20%-rule, a restriction concerning short-selling and a restriction concerning Finnish investors' possibilities to invest abroad are incorporated into an asset pricing model developed in the paper. According to the model, an unrestricted stock is traded at a price premium relative to the corresponding restricted stock if foreign investors require a lower rate of return on this stock than domestic investors do. If the rate required by foreign investors is higher than or the same as the rate required by domestic investors, the unrestricted and restricted stocks are traded at identical prices. Moreover, the size of the premium is determined by the international and domestic beta of the stock.

In the empirical part we observe that the international betas of Finnish stocks are insignificantly different from zero. Our model coupled with this result predicts that the price premiums are positively correlated with the domestic betas of the stocks. Our empirical data are consistent with this implication. We also present some evidence that factors omitted in our model—such as the foreign investors' informational disadvantage relative to the domestic investors—may also affect the size of the premiums. In particular, given the domestic beta of a stock, the price premium is positively correlated with the firm size and the liquidity of the unrestricted stock.

Appendix I: Important Facts about Finnish Tax Law

General

In Finland individuals have to pay taxes on both income and property. An average income tax bracket is about 30%, but the highest income tax brackets are around 70%. Property tax is much more moderate.

Corporations pay taxes only on income, and the tax rate is approximately 50%. (The tax rate increases from 0% to 50% as corporate income increases from \$0 to \$20,000 and thereafter is 50%.)

Tax on Interest and Dividend Income

Individuals

For individuals income from bonds (issued by the government or by mortgage banks) and from normal bank accounts (normal bank accounts are defined to mean those accounts whose interest rate do not exceed the rate imposed by regulations ($\approx 8\%$)) are nontaxable.

All other investment income (e.g., interest on debentures, interest on special

bank accounts, dividends, and rents) is taxable after an investment income deduction. This deduction was 3,800 FIM (≈$750) in 1986. (A corresponding deduction of $100 exists in the U.S.)

Corporations

All interest income (including interest income from bonds) is taxable for all corporations.

Dividend income is always taxable for banks, insurance companies, and stockbrokers. For other corporations dividend income is nontaxable (i.e., the dividend deduction, which is 85% in the U.S., is 100% in Finland). However, for holding companies dividend income is taxable unless they distribute it directly to their stockholders.

Foreign Investors

Foreign investors have to pay a withholding tax of 25% on all investment income.

Tax on Capital Gains

Realized capital gains are taxed at the same rate as dividends and interest in Finland (ordinary income tax rate). For banks, insurance companies, and stockbrokers, capital gains are always taxable and capital losses always tax-deductible. For individuals and other companies capital gains (losses) are taxable (tax-deductible) only if a security is held for less than five years. For individuals and other companies capital losses can be deducted, however, only from capital gains occurring in the same year.

Conclusions

It is extremely difficult to assess whether the total taxation on stocks is heavier for domestic or foreign investors in Finland. Foreign investors have to pay at least a 25% tax on dividends, whereas domestic corporations, tax-exempt foundations, and small investors get their dividends tax-free. On the other hand, wealthy domestic individuals have to pay effective taxes on dividends which can exceed the received dividends (because of the property tax). Depending on the investment period (whether it is less or more than five years) and on the institutional form of the investor, capital gains taxes may be higher or lower for foreign investors than for domestic investors.

Appendix II: Derivation of the Equilibrium Asset Pricing Model

In this Appendix we derive the equilibrium relations for the capital market described in Section I using assumptions laid down in Section II. The following terms and notations are used in the model:

Investors:

$d \in D$	[domestic investors]
$f \in F$	[foreign investors]

Securities:

$a \in A$	[restricted Finnish stocks]
$b \in B$	[unrestricted Finnish stocks]
$c \in C$	[foreign stocks]
ff	[the riskless security]

Portfolio variables:

$\tilde{W}_i$	[investor i's end of period wealth]
W_i^0	[the market value of investor i's endowment]
$X_{i,x}$	[the number of units of security x (a, b, c, or ff) held by investor i]
$X_{i,x}^0$	[investor i's endowed holding of security s (a, b, c, or ff)]

Security characteristics:[23]

P_x^0	[the price of security x at the beginning of the period]
$\tilde{P}_x^1$	[the end-of-period value of security x]
r_{ff}	[one plus the riskless rate of interest]

The equations describing the pure exchange model of capital market equilibrium are as follows:

Wealth constraints for investors in both investor groups:[24]

$$X_{\text{ff}} + \sum_a P_a^0 X_a + \sum_b P_b^0 X_b + \sum_c P_c^0 X_c = X_{\text{ff}}^0 + \sum_a P_a^0 X_a^0 + \sum_b P_b^0 X_b^0 + \sum_c P_c^0 X_c^0 = W^0. \tag{1}$$

End-of-period wealth for investors in both investor groups:

$$\tilde{W} = X_{\text{ff}} r_{\text{ff}} + \sum_a \tilde{P}_a^1 X_a + \sum_b \tilde{P}_b^1 X_b + \sum_c \tilde{P}_c^1 X_c. \tag{2a}$$

Solving (1) for X_{ff} and substituting in (2a) gives

$$\tilde{W} = r_{\text{ff}} W^0 + \sum_a X_a(\tilde{P}_a^1 - r_{\text{ff}} P_a^0) + \sum_b X_b(\tilde{P}_b^1 - r_{\text{ff}} P_b^0) + \sum_c X_c(\tilde{P}_c^1 - r_{\text{ff}} P_c^0). \tag{2b}$$

In formula (2b) the first term represents the end-of-period wealth of an investor who invests all his or her endowment in the riskless security, and the terms $(\tilde{P}^1 - r_{\text{ff}} P^0)$ are the excess returns (per stock) for securities in sets A, B, and C.

Utility functions for investors in both investor groups:

The only utility function satisyfing our first assumption is the quadratic utility function:

$$U(\tilde{W}) = \tilde{W} - e_i \tilde{W}^2, \tag{3}$$

where e_i is a positive constant which may differ across investors.

[23] All prices are expressed in domestic currency. This assumption is not crucial because our model does not attack the problem of exchange risk (see footnote 8).

[24] Investor subscripts are omitted when they are not necessary.

Legal restrictions for domestic investors:

$$X_{d,c} = 0 \quad \forall d \in D \quad \text{and} \quad \forall c \in C. \tag{4}$$

Legal restrictions for foreign investors:

$$X_{f,a} = 0 \quad \forall f \in F \quad \text{and} \quad \forall a \in A. \tag{5}$$

Legal restrictions concerning short-selling:

$$X_{d,a},\ X_{d,b},\ X_{f,b} \geq 0, \quad \forall d \in D, f \in F, a \in A, \quad \text{and} \quad b \in B. \tag{6}$$

We now determine investors' optimal portfolios: first the optimal portfolio for a domestic investor and then for a foreign investor.

Optimality Conditions for Domestic Investors

Domestic investors try to maximize the expected value of their end-of-period utility taking into account the legal restrictions[25] that $X_{d,b} \geq 0$ and $X_{d,c} = 0$.[26] A domestic investor's choice problem may be expressed as the maximization of the Lagrangian L formed by appending the short-selling constraint to the investor's expected utility:

$$\max_{X_a, X_b} L = E[U(\tilde{W})] - \textstyle\sum_b \lambda_b X_b, \tag{7}$$

where

$$\tilde{W} = r_{\text{ff}} W^0 + \textstyle\sum_a X_a(\tilde{P}_a^1 - r_{\text{ff}} P_a^0) + \sum_b X_b(\tilde{P}_b^1 - r_{\text{ff}} P_b^0),$$

and the λ_b are nonpositive Lagrangian multipliers corresponding to the short-selling restrictions.

The first-order conditions are

$$\frac{\partial L}{X_a} = E[U'(\tilde{W})(\tilde{P}_a^1 - r_{\text{ff}} P_a^0)] = 0, \quad \forall a \in A, \tag{8a}$$

$$\frac{\partial L}{X_b} = E[U'(\tilde{W})(\tilde{P}_b^1 - r_{\text{ff}} P_b^0)] - \lambda_b = 0, \quad \forall b \in B, \tag{8b}$$

$$\frac{\partial L}{\lambda_b} = X_b \geq 0, \quad \forall b \in B. \tag{8c}$$

In addition, the complementary slackness condition requires that $\lambda_b X_b = 0\ \forall b \in B$. If $X_b > 0$ then the corresponding Lagrangian multiplier is zero and the barrier against short-selling is nonbinding for this particular stock. If $\lambda_b < 0$ the marginal expected utility from the stock is negative. The investor would like to

[25] The risk tolerance functions of the domestic investors are linear in wealth, and the wealth coefficient is identical for all domestic investors. Moreover, domestic investors have identical expectations and portfolio opportunity sets. Cass and Stiglitz (1970) have shown that these conditions, coupled with the existence of a riskless asset, are sufficient for domestic investors' stock portfolios to be identical. Because domestic investors are the only investors who can hold stocks from set A, this implies directly that $X_{d,a} > 0$, $\forall a \in A$, $d \in D$. Because of this restriction $X_{d,a} \geq 0$ is dropped as redundant.

[26] A natural extension of our model is to a multiperiod setting. This task is left for future research.

take a short position in that stock but it precluded from doing so by the legal restriction, and $X_b = 0$.

It will be advantageous to refer to domestic investors' opportunity set as G, the union of A and B. The set of stocks which domestic investors hold in equilibrium will be referred to as G^*, which is a subset (not necessarily proper) of G.

Because we know that $\lambda_b \leq 0 \ \forall b \in B$, we can combine (8a) and (8b) to get

$$E[U'(\tilde{W})(\tilde{P}_g^1 - r_{\text{ff}} P_g^0)] \leq 0 \quad \forall g \in G. \tag{8ab}$$

Condition (8ab) states that the equilibrium marginal expected utility from a portfolio shift does not have to be identical for all stocks in the opportunity set of the domestic investors. In particular, the marginal expected utility to the domestic investors for some stocks $b \in B$ may be negative. However, for stocks actually held in the equilibrium portfolios of domestic investors, by definition elements of set G^*, the expected marginal utility of the excess returns at equilibrium prices will be identically equal to zero for all domestic investors.

Optimality Conditions for Foreign Investors

Optimality conditions for foreign investors are very similar to those for domestic investors. We will henceforth refer to the foreign investors' opportunity set as H, the union of sets B and C. The set of stocks which foreign investors hold in equilibrium will be referred to as H^*, which is a subset (not necessarily proper) of H. Then we can derive the counterparty for equation (8ab):

$$E[U'(\tilde{W})(\tilde{P}_h^1 - r_{\text{ff}} P_h^0)] \leq 0 \quad \forall h \in H. \tag{9ab}$$

The interpretation of condition (9ab) is identical to that of condition (8ab).

Capital Market Equilibrium

In addition to the optimality conditions given above, equilibrium requires that markets clear.

Conservation equations:[27]

$$\sum_d X_{d,x}^0 + \sum_f X_{f,x}^0 = \sum_d X_{d,x} + \sum_f X_{f,x} \quad \forall x \in A \cup B \cup C, \tag{10abc}$$

$$\sum_d X_{d,ff}^0 + \sum_f X_{f,ff}^0 = \sum_d X_{d,ff} + \sum_f X_{f,ff}. \tag{10d}$$

Now our capital market equilibrium model is complete. Properties and implications of the solution to this system of simultaneous equations are now analyzed.

The optimality conditions (8a) and (8b) for domestic investors can be combined by noticing that $\lambda_b = 0$ for all stocks b held in positive amounts by domestic investors. By definition domestic investors hold positive amounts of the stock in set G^*, and thus

$$[E(\tilde{P}_g^1) - r_{\text{ff}} P_g^0]\left[\frac{1}{2e_d} - r_{\text{ff}} W_d^0\right]$$

$$= \sum_{k \in G^*} X_k \{\sigma_{gk} + [E(\tilde{P}_g^1) - r_{\text{ff}} P_g^0][E(\tilde{P}_k^1) - r_{\text{ff}} P_k^0]\} \quad \forall g \in G^*, \tag{11}$$

where σ_{gk} = the covariance between the end-of-period values of assets g and k.

[27] One of these equations is, of course, redundant.

For any domestic investor d, the $|G^*|$ equations[28] in (11) describe the equilibrium conditions for the $|G^*|$ stocks in his or her equilibrium portfolio. For all other stocks in either C or $G - G^*$, domestic investors' equilibrium position is zero.

Investor-specific characteristics only affect the equilibrium quantities through the term

$$\left[\frac{1}{2e_d} - r_{\text{ff}} W_d^0\right].$$

This implies that, if the vector $\bar{X}_{G^*}$ is the solution of

$$[E(\tilde{P}_g^1) - r_{\text{ff}} P_g^0] = \sum_{k \in G^*} X_k \{\sigma_{kg} + [E(\tilde{P}_g^1) - r_{\text{ff}} P_g^0][E(\tilde{P}_k^1) - r_{\text{ff}} P_k^0]\}, \quad (12)$$

then

$$\bar{X}_{d,g}^* = \bar{X}_G^* \left[\frac{1}{2e_d} - r_{\text{ff}} W_d^0\right] \quad \forall d \in D. \quad (13)$$

The equilibrium portfolio of stocks is identical up to a scaling factor across domestic investors. Summing (13) over all domestic investors $d \in D$ gives the aggregate amount of stocks held in domestic investors' optimal portfolios:

$$\sum_{d \in D} \bar{X}_{d,g}^* = \bar{X}_{G^*} \left(\sum_d \frac{1}{2e_d} - r_{\text{ff}} \sum_d W_d^0\right) = \bar{X}_{D,G^*}, \quad (14)$$

where $\bar{X}_{D,G^*}$ is the aggregate equilibrium amount of the stock in set G^* held by domestic investors.

Combining (13) and (14), we get the following expression for $\bar{X}_{d,g}^*$:

$$\bar{X}_{d,g}^* = \left[\frac{1}{2e_d} - r_{\text{ff}} W_d^0\right]\left(\sum_d \frac{1}{2e_d} - r_{\text{ff}} \sum_d W_d^0\right)^{-1} \bar{X}_{D,G^*}.$$

The domestic investors' security market line for the stock in set G^* is now obtained by substituting this result into (11) by noticing that X_k in (11) is an element of $\bar{X}_{d,g}^*$. After simplifications we obtain

$$\frac{E[\tilde{P}_g^1]}{P_g^0} = r_{\text{ff}} + \left[\sum_d \frac{1}{2e_d} - E(\sum_d \tilde{W}_d)\right]^{-1} W_{G^*}^0 \operatorname{cov}\left(\frac{\tilde{P}_g^1}{P_g^0}, \frac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \quad \forall g \in G^*, \quad (15)$$

where $\tilde{W}_{G^*} = \sum_g \tilde{P}_g^1 X_{D,G^*}$ and the X_{D,G^*} are the elements of $\bar{X}_{G^*}$ and where $W_{G^*}^0 = \sum_g P_g^0 X_{D,G^*}$.

This security market line holds for all stocks in G^* and, hence, must hold for the domestic investors' equilibrium portfolio, which is characterized by the vector $\bar{X}_{D,G^*}$. The beginning and ending values of this portfolio are $W_{G^*}^0$ and $\tilde{W}_{G^*}$, respectively.

Substituting $W_{G^*}^0$ and $\tilde{W}_{G^*}$ for P_g^0 and $\tilde{P}_g^1$ in (15), solving for

$$\left[\sum_d \frac{1}{2e_d} - E(\sum_d \tilde{W}_d)\right]^{-1} W_{G^*}^0,$$

[28] $|G^*|$ refers to the number of stocks in set G^*.

and substituting this value into (15) gives

$$\frac{E[\tilde{P}_g^1]}{P_g^0} = r_{\text{ff}} + \left[\frac{E(\tilde{W}_{G^*})}{W_{G^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\frac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \text{cov}\left(\frac{\tilde{P}_g^1}{P_g^0}, \frac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \quad \forall g \in G^*. \tag{16}$$

To extend this security market line to include also stocks $g \in G$ but $\notin G^*$, we have to notice that for these stocks $X_{d,g} = 0$ and that λ_b in (8b) is nonpositive. Taking these two facts into account, we finally get domestic investors' security market plane for their whole opportunity set G:

$$\frac{E[\tilde{P}_g^1]}{P_g^0} \leq r_{\text{ff}} + \left[\frac{E(\tilde{W}_{G^*})}{W_{G^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\frac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \text{cov}\left(\frac{\tilde{P}_g^1}{P_g^0}, \frac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \quad \forall g \in G, \tag{17a}$$

or, to emphasize the difference between the sets G^* and $G - G^*$,

$$\begin{cases} \dfrac{E[\tilde{P}_{g^*}^1]}{P_{g^*}^0} = r_{\text{ff}} + \left[\dfrac{E(\tilde{W}_{G^*})}{W_{G^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\dfrac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \text{cov}\left(\dfrac{\tilde{P}_{g^*}^1}{P_{g^*}^0}, \dfrac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) & \forall g^* \in G^*, \\ \dfrac{E[\tilde{P}_g^1]}{P_g^0} \leq r_{\text{ff}} + \left[\dfrac{E(\tilde{W}_{G^*})}{W_{G^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\dfrac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) \text{cov}\left(\dfrac{\tilde{P}_g^1}{P_g^0}, \dfrac{\tilde{W}_{G^*}}{W_{G^*}^0}\right) & \forall g \in G - G^*. \end{cases} \tag{17b}$$

Similarly, we obtain the foreign investors' security market plane for their opportunity set H:

$$\frac{E[\tilde{P}_h^1]}{P_h^0} \leq r_{\text{ff}} + \left[\frac{E(\tilde{W}_{H^*})}{W_{H^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\frac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) \text{cov}\left(\frac{\tilde{P}_h^1}{P_h^0}, \frac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) \quad \forall h \in H, \tag{18a}$$

where

$\tilde{W}_{H^*} = \sum_h \tilde{P}_h^1 X_{F,H^*}$,
$W_{H^*}^0 = \sum_h P_h^0 X_{F,H^*}$,
X_{F,H^*} is an element of $\bar{X}_{F,H^*}$, and
$\bar{X}_{F,H^*} = \sum_{f \in F} \bar{X}_{f,h}^*$ = the aggregate equilibrium amount of stocks in set H^* held by foreign investors,

or, to emphasize the difference between the sets H^* and $H - H^*$,

$$\begin{cases} \dfrac{E[\tilde{P}_{h^*}^1]}{P_{h^*}^0} = r_{\text{ff}} + \left[\dfrac{E(\tilde{W}_{H^*})}{W_{H^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\dfrac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) \text{cov}\left(\dfrac{\tilde{P}_{h^*}^1}{P_{h^*}^0}, \dfrac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) & \forall h^* \in H^* \\ \dfrac{E[\tilde{P}_h^1]}{P_h^0} \leq r_{\text{ff}} + \left[\dfrac{E(\tilde{W}_{H^*})}{W_{H^*}^0} - r_{\text{ff}}\right] \text{var}^{-1}\left(\dfrac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) \text{cov}\left(\dfrac{\tilde{P}_h^1}{P_h^0}, \dfrac{\tilde{W}_{H^*}}{W_{H^*}^0}\right) & \forall h^* \in H - H^*. \end{cases} \tag{18b}$$

REFERENCES

Adler, Michael and David Simon, 1986, Exchange rate surprises in international portfolios, *Journal of Portfolio Management* 12, 44–53.

Amihud, Yakov and Haim Mendelson, 1986, Asset pricing and the bid-ask spread, *Journal of Financial Economics* 16, 223–249.

Black, Fischer, 1974, International capital market equilibrium with investment barriers, *Journal of Financial Economics* 1, 337–352.

Capital International Perspective, 1979–85.

Cass, David and Joseph Stiglitz, 1970, A contribution to the pure theory of mutual funds, *Journal of Economic Theory* 4, 122–160.

Dann, Larry Y., David Mayers, and Robert J. Raab, Jr., 1977, Trading rules, large blocks, and the speed of adjustment, *Journal of Financial Economics* 4, 3–22.

Errunza, Vihang and Etienne Losq, 1985, International asset pricing under mild segmentation: Theory and tests, *Journal of Finance* 40, 105–124.

Eun, Cheoul S. and S. Janakiramanan, 1986, A model of international asset pricing with a constraint on the foreign equity ownership, *Journal of Finance* 41, 897–914.

Grauer, Robert R. and Nils H. Hakansson, 1987, Gains from international diversification: 1968–1985 returns on portfolios of stocks and bonds, *Journal of Finance* 42, 721–741.

Jorion, Phillippe and Eduardo Schwartz, 1986, Integration vs. segmentation in the Canadian stock market, *Journal of Finance* 41, 603–614.

Kraus, Alan and Hans R. Stoll, 1972, Price impacts of block trading on the New York Stock Exchange, *Journal of Finance* 27, 569–588.

Lessard, Donald, 1975, World, country and industry: Relationships in equity returns, Working Paper, Sloan School of Management.

Lintner, John, 1965, Valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics* 47, 13–37.

Mossin, Jan, 1966, Equilibrium in a capital asset market, *Econometrica* 34, 768–783.

Scholes, Myron, 1972, The market for securities: Substitution vs. price pressure and the effects of information on share prices, *Journal of Business* 25, 179–211.

Sharpe, William F., 1964, Capital asset prices: A theory of market equilibrium under conditions of risk, *Journal of Finance* 19, 425–442.

Solnik, Bruno H., 1974a, The international pricing of risk: An empirical investigation of the world capital market structure, *Journal of Finance* 29, 365–378.

———, 1974b, An equilibrium model of the international capital market, *Journal of Economic Theory* 8, 500–524.

———, 1977, Testing international asset pricing: Some pessimistic views, *Journal of Finance* 32, 503–512.

———, 1984, Capital markets and international monetary variables, *Financial Analysts Journal* 40, 69–73.

Stehle, Richard E., 1976, The valuation of risk assets in an international capital market: Theory and tests, Ph.D. thesis, Stanford University.

Stulz, René M., 1981, On the effects of barriers to international investment, *Journal of Finance* 36, 923–34.