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Asset Pricing and Dual Listing on Foreign Capital Markets: A Note

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INTERNATIONAL CAPITAL FLOWS CAN be hampered by a variety of barriers such as transaction costs, information costs, and legal restrictions. These barriers can be severe enough to produce segmentation of capital markets along national borders, thereby producing incentives for firms to adopt financial policies that can effectively reduce the associated negative effects. According to Stapleton and Subrahmanyam [6, p. 313], dual listing of the firm's securities on foreign capital markets is one such policy.[1] However, adoption of this policy will bring forth asset-pricing adjustments. The purpose of this note is to provide and analyze a closed-form solution to the equilibrium asset-pricing problem that arises in this situation.[2] Once the solution is obtained, comparative statics are provided.[3]

The model presented assumes that one of the domestic securities is dually listed on a foreign capital market, while none of the foreign securities is dually listed on the domestic capital market. This scenario often characterizes the initial stages of capital market integration, in which a country with relatively scarce capital or a relatively underdeveloped capital market allows a small number of domestic securities (or a fund of domestic securities) to be listed on a foreign capital market while simultaneously forbidding its citizens to invest in foreign securities. This point can be illustrated by the emergence of a variety of "country" funds in the U.S. capital market, such as the Japan Fund in the 1960's, the

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[1] Here, dual listing refers to the situation where the stock of a firm that is listed on a domestic exchange also becomes listed on a foreign exchange. A detailed case study of internationalizing a firm's capital source through dual listing is provided by Stonehill and Dullum [8]. Readers interested in examining a firm's motivation for dual listing are advised to see this case study as well as Stapleton and Subrahmanyam [6, 7].

[2] Previously, Stapleton and Subrahmanyam [6, 7] examined, among other things, the equilibrium asset-pricing problem arising from dual listing of securities by providing and analyzing numerical solutions to an eight-firm twenty-investor example. Unlike Stapleton and Subrahmanyam, in this paper a closed-form solution to the valuation problem under dual listing is analytically derived.

[3] This model complements the strand of literature such as that by Errunza and Losq [2] and Bodurtha [1], who examined international capital market equilibrium under partial segmentation. Errunza and Losq examined the so-called "mild" segmentation case in which foreign country investors have unlimited access to domestic country securities, whereas domestic country investors are completely precluded from investing in foreign country securities. Bodurtha, on the other hand, derived an asset-pricing model using a return-generating process that simultaneously allowed for investment restrictions, exchange risk, interest rate risk, and inflation risk. Other related works include those of Errunza and Senbet [3] and Lee and Sachdeva [4], who examined the role of multinational firms in completing the international capital market via direct foreign investment. None of the previous studies derived a closed-form asset-pricing model explicitly allowing for dual listing in otherwise segmented capital markets. This paper attempts to fill the gap.

Mexico Fund in the 1970's, and, more recently, the Korea Fund, the Australia Fund, the Italy Fund, and the Scandinavian Fund.

I. Investors' Choice Problem

Following Stapleton and Subrahmanyam (hereafter SS), it is assumed that there are two countries in the world, the domestic country and the foreign country. There are $(s_1 + 1)$ firms domiciled in the domestic country with securities numbered 0, 1, 2, $\cdots$, s_1. Security 0 is dually listed in the foreign country, and the remaining s_1 securities (referred to as "pure" domestic securities and indexed by i and j) are listed only in the domestic country. There are s_2 firms domiciled in the foreign country, but there are $(s_2 + 1)$ securities available for investment, numbered 0, 1, 2, $\cdots$, s_2; 0 is again the dually listed security, and the other s_2 securities (referred to as "pure" foreign securities and indexed by g and h) are listed only in the foreign country. In addition, there exists a riskless security in each country with the same rate of return. The capital markets, with the exception of the dually listed security, are otherwise completely segmented. Other assumptions are:

(A1) The capital markets are perfectly competitive in each country.
(A2) Neither transaction costs nor taxes exist within any country.
(A3) Investors have constant absolute risk aversion (CARA), so that the utility of investor k is given by

$$U^k(\tilde{W}_T^k) = -\exp(-A^k \tilde{W}_T^k), \qquad A^k > 0, \tag{1}$$

where $\tilde{W}_T^k$ is terminal wealth.[4]
(A4) Both foreign and domestic investors have homogeneous expectations.
(A5) Short sales with use of full proceeds are permitted in both countries.
(A6) Domestic and foreign security returns are joint-normally distributed.
(A7) The two countries maintain a fixed exchange rate.

A domestic country investor k will choose portfolio weights so as to maximize the expected utility of terminal wealth while not violating his or her budget constraint. The budget constraint is

$$\textstyle\sum_{i=0}^{s_1} x_i^k + x_f^k = 1, \tag{2}$$

where x_i^k is the proportion of wealth invested in risky security i and x_f^k is the proportion of wealth invested in the riskless security.

Since investor k's utility function is characterized by constant absolute risk aversion and asset returns are joint-normally distributed, the choice problem of investor k can be restated as choosing portfolio weights so that the certainty equivalent of wealth, CEQ^k, is maximized. In turn, CEQ^k equals

$$CEQ^k = \bar{W}_T^k - \frac{A^k}{2}\,\mathrm{Var}(\tilde{W}_T^k), \tag{3}$$

[4] The negative exponential utility function is used here for the sake of analytical simplicity. Actually, the results of the paper are more general since all that is needed is for utility to be a function of mean and variance of terminal wealth.

where $\bar{W}_T^k$ is expected terminal wealth and $\mathrm{Var}(\tilde{W}_T^k)$ is the variance of terminal wealth. The expected terminal wealth and variance of terminal wealth for investor k are, respectively,

$$\bar{W}_T^k = W_o^k\{\textstyle\sum_{i=0}^{s_1} x_i^k(\bar{R}_i - r)\} + W_o^k(1 + r) \tag{4}$$

and

$$\mathrm{Var}(\tilde{W}_T^k) = \textstyle\sum_{i=0}^{s_1} \sum_{j=0}^{s_1} (x_i^k W_o^k)(x_j^k W_o^k)\sigma_{ij}, \tag{5}$$

where $\bar{R}_i$ is the expected rate of return on security i, r is the riskless rate, W_o^k is the current wealth of investor k, and $\sigma_{ij} = \mathrm{Cov}(\tilde{R}_i, \tilde{R}_j)$. Thus, the problem of investor k is reduced to

$$\max_{\{x_i^k\}} \textstyle\sum_{i=0}^{s_1} W_o^k x_i^k(\bar{R}_i - r) + W_o^k(1 + r) - \dfrac{A^k}{2} \textstyle\sum_{i=0}^{s_1} \sum_{j=0}^{s_1} (x_i^k W_o^k)(x_j^k W_o^k)\sigma_{ij}. \tag{6}$$

Differentiating (6) with respect to x_i^k results in the following set of optimality conditions:

$$(\bar{R}_i - r) = A^k \textstyle\sum_{j=0}^{s_1} x_j^k W_o^k \sigma_{ij}, \qquad i = 0, 1, 2, \cdots, s_1. \tag{7}$$

Solving (7) for the dollar demand of investor k for security i ($d_i^k \equiv x_i^k W_o^k$, $i = 0, 1, 2, \cdots, s_1$) results in

$$d_o^k = \frac{1}{A^k}\{\textstyle\sum_{j=1}^{s_1} V_{oj}(\bar{R}_j - r) + V_{oo}(\bar{R}_o - r)\} \tag{8}$$

and

$$d_i^k = \frac{1}{A^k}\{\textstyle\sum_{j=1}^{s_1} V_{ij}(\bar{R}_j - r) + V_{io}(\bar{R}_o - r)\}, \qquad i = 1, 2, \cdots, s_1, \tag{9}$$

where V_{ij} is the element in cell (i, j) of the inverse of the variance-covariance matrix of returns, $[\sigma_{ij}]^{-1}$.

Similarly, the demand of a foreign investor q for the dually listed security 0 and pure foreign security g can be respectively written as

$$d_o^q = \frac{1}{A^q}\{\textstyle\sum_{h=1}^{s_2} \phi_{oh}(\bar{R}_h - r) + \phi_{oo}(\bar{R}_o - r)\} \tag{10}$$

and

$$d_g^q = \frac{1}{A^q}\{\textstyle\sum_{h=1}^{s_2} \phi_{gh}(\bar{R}_h - r) + \phi_{go}(\bar{R}_o - r)\}, \qquad g = 1, 2, \cdots, s_2, \tag{11}$$

where ϕ_{gh} is the element in cell (g, h) of the inverse of the variance-covariance matrix of returns, $[\sigma_{gh}]^{-1}$.

Since the pure domestic securities are held only by domestic investors, the aggregate demand for pure domestic security i (d_i) is obtained by summing the demand for this security as shown in (9) across all K domestic investors:

$$d_i = \sum_{k=1}^{K} d_i^k = \frac{1}{A^D} \{\sum_{j=0}^{s_1} V_{ij}(\bar{R}_j - r) + V_{io}(\bar{R}_o - r)\},$$

$$i = 1, 2, \cdots, s_1, \quad (12)$$

where $1/A^D = \sum_{k=1}^{K} (1/A^k)$. Letting $1/A^F = \sum_{q=1}^{Q} (1/A^q)$, the aggregate demand for the pure foreign security g (d_g) is similarly determined by summing the demand of all Q foreign investors as shown in (11):

$$d_g = \sum_{q=1}^{Q} d_g^q = \frac{1}{A^F} \{\sum_{h=1}^{s_2} \phi_{gh}(\bar{R}_h - r) + \phi_{go}(\bar{R}_o - r)\},$$

$$g = 1, 2, \cdots, s_2. \quad (13)$$

However, for the dually listed security, it is necessary to aggregate the demand across the investors of both countries, given (8) and (10):

$$\begin{aligned} d_o &= \sum_{k=1}^{K} d_o^k + \sum_{q=1}^{Q} d_o^q \\ &= \frac{1}{A^D} \sum_{j=1}^{s_1} V_{oj}(\bar{R}_j - r) + \left\{\frac{1}{A^D} V_{oo} + \frac{1}{A^F} \phi_{oo}\right\} (\bar{R}_o - r) \\ &\quad + \frac{1}{A^F} \sum_{h=1}^{s_2} \phi_{oh}(\bar{R}_h - r). \end{aligned} \quad (14)$$

From (14), it can be seen that the demand for the dually listed security depends on the covariance of its return with the returns of all the pure domestic securities as well as on the covariance of its return with the returns of all the pure foreign securities.

II. Equilibrium Asset-Pricing Relationships

In equilibrium, the aggregate dollar demand for any security should be equal to the market value of the security. Let D be the aggregate market value of all the domestic securities (including the dually listed security) and F be the aggregate market value of all the foreign securities. Then, in equilibrium,

$$d_i = x_i D, \qquad i = 0, 1, 2, \cdots, s_1, \quad (15)$$

$$d_g = x_g F, \qquad g = 1, 2, \cdots, s_2, \quad (16)$$

where x_i is the proportion of the market value of domestic security i to the aggregate market value of all domestic securities and x_g is the proportion of the market value of foreign security g to the aggregate market value of all foreign securities. It follows that the aggregate demand equations (12), (13), and (14) must, in equilibrium, respectively satisfy

$$x_i D = \frac{1}{A^D} \{\sum_{j=1}^{s_1} V_{ij}(\bar{R}_j - r) + V_{io}(\bar{R}_o - r)\}, \qquad i = 1, 2, \cdots, s_1, \quad (17)$$

$$x_g F = \frac{1}{A^F}\{\textstyle\sum_{h=1}^{s_2} \phi_{gh}(\bar{R}_h - r) + \phi_{go}(\bar{R}_o - r)\}, \qquad g = 1, 2, \cdots, s_2, \tag{18}$$

and

$$x_o D = \frac{1}{A^D}\textstyle\sum_{j=1}^{s_1} V_{oj}(\bar{R}_j - r) + \left(\frac{1}{A^D} V_{oo} + \frac{1}{A^F}\phi_{oo}\right)(\bar{R}_o - r) + \frac{1}{A^F}\textstyle\sum_{h=1}^{s_2} \phi_{oh}(\bar{R}_h - r). \tag{19}$$

The solution to this set of (s_1 + s_2 + 1) equations provides the following equilibrium asset-pricing relationships:

$$\bar{R}_i - r = A^D D \operatorname{Cov}(\tilde{R}_i, \tilde{R}_D) - (A^D - A^W) D \operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_D) + A^W F \operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_F), \qquad i = 1, 2, \cdots, s_1, \tag{20}$$

$$\bar{R}_g - r = A^F F \operatorname{Cov}(\tilde{R}_g, \tilde{R}_F) - (A^F - A^W) F \operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_F) + A^W D \operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_D), \qquad g = 1, 2, \cdots, s_2, \tag{21}$$

and

$$\bar{R}_o - r = A^W D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D) + A^W F \operatorname{Cov}(\tilde{R}_o, \tilde{R}_F), \tag{22}$$

where $1/A^W = 1/A^D + 1/A^F$; $\operatorname{Cov}(\tilde{R}_o, \tilde{R}_D) = \sum_{j=0}^{s_1} x_j \sigma_{jo}$; $\operatorname{Cov}(\tilde{R}_o, \tilde{R}_F) = \sum_{h=1}^{s_2} x_h \sigma_{ho}$; $\operatorname{Cov}(\tilde{R}_i, \tilde{R}_D) = \sum_{j=0}^{s_1} x_j \sigma_{ji}$; $\operatorname{Cov}(\tilde{R}_g, \tilde{R}_F) = \sum_{h=1}^{s_2} x_h \sigma_{hg}$; $\operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_D) = \sigma_i \sigma_D \rho_{io} \rho_{oD}$; $\operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_F) = \sigma_i \sigma_F \rho_{io} \rho_{oF}$; $\operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_F) = \sigma_g \sigma_F \rho_{go} \rho_{oF}$; and $\operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_D) = \sigma_g \sigma_D \rho_{go} \rho_{oD}$.[5] The last four terms can be thought of as "indirect" covariances since they reflect covariances between security and market returns that are "induced" by the dually listed security.

Equation (22) states that the expected return on the dually listed security depends on the covariances of its return with the returns on both the domestic and foreign market portfolios. This reflects the fact that all the investors, both domestic and foreign, hold the dually listed security. The expected return on a pure domestic security as shown in (20), on the other hand, depends on (a) its covariance with the return on the domestic market portfolio, (b) its indirect covariance with the return on the domestic market portfolio, and (c) its indirect covariance with the return on the foreign market portfolio. This peculiar pricing relationship is due to the fact that the markets for these securities are indirectly integrated via the dual listing. Dual listing of a security on the foreign capital market is thus found to produce an "externality effect" of indirectly integrating

[5] The method used to solve this set of (s_1 + s_2 + 1) equations begins by forming two portfolios, one consisting of pure domestic securities and the other consisting of pure foreign securities. Equations (17) and (18) can be expressed in terms of these two portfolios and, along with equation (19), form a set of three equations that can be solved through matrix inversion. The solution gives the asset-pricing relationships for both portfolios and the dually listed security and can subsequently be decomposed to arrive at the asset-pricing relationships for individual pure domestic and foreign securities, as shown in equations (20) and (21).

the market for pure domestic securities with the foreign security market. This externality effect is represented by the second and third terms on the RHS of (20).

The magnitude of the externality effect, however, varies among different domestic securities since it depends on the security's correlation with the dually listed security. The externality effect is at a maximum in the cases where the correlation is either perfectly positive or perfectly negative (i.e., $\rho_{io} = +1$ or -1). In these cases, the pure domestic security is a perfect substitute for the dually listed security. As a result, the security will be priced as if it were dually listed itself:

$$\bar{R}_i - r = A^W D \operatorname{Cov}(\tilde{R}_i, \tilde{R}_D) + A^W F \operatorname{Cov}(\tilde{R}_i, \tilde{R}_F). \tag{23}$$

In the case in which the pure domestic security is uncorrelated with the dually listed security (i.e., $\rho_{io} = 0$), dual listing would not produce any externality effect. Consequently, the security will be priced solely with reference to its domestic covariance risk:

$$\bar{R}_i - r = A^D D \operatorname{Cov}(\tilde{R}_i, \tilde{R}_D). \tag{24}$$

It is also noteworthy in equations (20) and (21) that the pricing relationships for the pure domestic and pure foreign securities are symmetrical in form. Thus, the basic pricing relationship is unaffected by which country dually lists the security, and a similar externality effect exists for pure foreign securities.[6]

III. Comparative Statics

In order to obtain additional insights into asset pricing with a dually listed security, the pricing of securities with a dual listing is compared with the pricing of securities without a dual listing.[7] Since the domestic and foreign markets are assumed to be completely segmented without the dual listing, the asset-pricing equations without a dual listing are given as follows:[8]

$$\bar{R}_i^s - r = A^D D \operatorname{Cov}(\tilde{R}_i, \tilde{R}_D), \qquad i = 1, 2, \cdots, s_1, \tag{25}$$

$$\bar{R}_g^s - r = A^F F \operatorname{Cov}(\tilde{R}_g, \tilde{R}_F), \qquad g = 1, 2, \cdots, s_2, \tag{26}$$

and

$$\bar{R}_o^s - r = A^D D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D). \tag{27}$$

From equations (20)–(22) and (25)–(27), the following comparative statics are

[6] The externality effect for pure foreign securities is represented by the second and third terms on the RHS of (21).

[7] See Lessard [5] for comparative statics of asset pricing under complete segmentation and complete integration.

[8] The magnitudes of D and F in equations (25)–(27) are not the same as indicated earlier in the dual-listing asset-pricing equations. However, assuming that the dually listed firm is atomistic, the differences in magnitudes will be so small that they can be safely ignored.

obtained:

$$\bar{R}_i = \bar{R}_i^s + A^W F \operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_F) - (A^D - A^W) D \operatorname{Cov}^*(\tilde{R}_i, \tilde{R}_D), \qquad i = 1, 2, \cdots, s_1, \tag{28}$$

$$\bar{R}_g = \bar{R}_g^s + A^W D \operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_D) - (A^F - A^W) F \operatorname{Cov}^*(\tilde{R}_g, \tilde{R}_F), \qquad g = 1, 2, \cdots, s_2, \tag{29}$$

and

$$\bar{R}_o = \bar{R}_o^s + A^W F \operatorname{Cov}(\tilde{R}_o, \tilde{R}_F) - (A^D + A^W) D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D). \tag{30}$$

Equation (28) indicates that the expected return of a pure domestic security with a dual listing can be greater than or less than the expected return of the same security without a dual listing, depending upon the net impact of the previously noted externality effect. A similar interpretation applies to the pricing of foreign securities, as shown in (29).

Equation (30) indicates that the expected return on the dually listed security is different from its expected return when it is not dually listed. This difference reflects two effects. First, when the security is dually listed, the risk represented by its return's covariance with the foreign market portfolio's return is introduced, resulting in a premium for this risk of $A^W F \operatorname{Cov}(\tilde{R}_o, \tilde{R}_F)$. Second, the domestic covariance risk is altered by the dual listing. Without the dual listing, the domestic investors alone bear this risk. But with dual listing, all investors, both domestic and foreign, share this risk. This leads to a change in the domestic covariance risk premium equal to $(A^D - A^W) D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D)$.

Specifically, equation (30) indicates that the required return will change from $\bar{R}_o^s$ to $\bar{R}_o$, as follows:

$$\bar{R}_o^s - \bar{R}_o = -A^W F \operatorname{Cov}(\tilde{R}_o, \tilde{R}_F) + (A^D - A^W) D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D). \tag{31}$$

Thus, the required return on the security will decrease (increase) upon dual listing if the RHS of (31) assumes a positive (negative) value. Noting that $A^D - A^W = A^D A^D/(A^D + A^F)$ and that $A^W = A^F A^D/(A^D + A^F)$, it can be seen that $\bar{R}_o^s$ will be higher (lower) than $\bar{R}_o$ if the "γ-ratio" is lower (higher) than unity:

$$\bar{R}_o^s > \bar{R}_o \quad \text{if} \quad \gamma < 1 \tag{32a}$$

and

$$\bar{R}_o^s < \bar{R}_o \quad \text{if} \quad \gamma > 1, \tag{32b}$$

where $\gamma \equiv [A^F F \operatorname{Cov}(\tilde{R}_o, \tilde{R}_F)]/[(A^D D \operatorname{Cov}(\tilde{R}_o, \tilde{R}_D)]$. The above result shows that the change in the required return, $\bar{R}_o^s - \bar{R}_o$, depends on the relative values of the aggregate risk-aversion coefficients, the market capitalization values in the two countries, and the covariances of the dually listed security with the domestic and foreign market portfolios. Assuming that $(A^F F/A^D D)$ is equal to unity, $\bar{R}_o^s$ will be greater than $\bar{R}_o$ if $\operatorname{Cov}(\tilde{R}_o, \tilde{R}_F)$ is less than $\operatorname{Cov}(\tilde{R}_o, \tilde{R}_D)$, a likely situation since, generally speaking, securities are known to be less positively correlated between countries than within a country. Accordingly, the required return on a security can be expected, in general, to be lower if it is dually listed when $(A^F F/A^D D) \approx 1$. Indeed, this is what was observed in the numerical analysis presented by SS.

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