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Partially segmented international capital markets and international capital budgeting

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Abstract

Evidence suggests that international capital markets are neither fully integrated nor completely segmented. There is, however, currently no general method available for computing the required return on corporate investments in such capital markets. This paper uses a model of partially integrated international capital markets to derive optimal international capital budgeting rules. We show how capital budgeting rules depend on the level of investor costs to cross-border investment, both directly and also indirectly through the portfolio specialization they induce. We explain how required returns differ for different companies raising capital in such markets and how these costs of capital may be estimated. We also explain how these differences in required returns can be consistent with general equilibrium and the effect they have on incentives for foreign direct investment. © 2000 Elsevier Science Ltd. All rights reserved.

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1. Introduction

If international capital markets are integrated it is a relatively straightforward step to extend to an international setting the standard analysis of domestic corporate financial decision rules given in Hamada (1969), Jensen and Long (1972) and Fama and Miller (1972). For instance, the Grauer, Litzenberger and Stehle (1976) model of equilibrium in a fully integrated international capital market would imply a set

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of corporate decision rules effectively identical to those for the domestic CAPM, with the domestic market portfolio replaced with the world market portfolio. Stulz (1995) discusses the application of a model of this type. There is, however, increasing evidence that integrated models of international capital markets cannot fully explain either the patterns of international portfolio holdings or the behavior of security returns (Errunza and Losq (1985), Jorion and Schwartz (1986), Cooper and Kaplanis (1986, 1994), Hietala (1989), French and Poterba (1991) and Tessar and Werner (1995)).

In light of this evidence it appears that some kind of costs to international investment must be invoked to give a realistic description of international capital market equilibrium.[1] Black (1974) and Stulz (1981) have developed models of international capital market equilibrium that incorporate such costs to international investment. Adler and Dumas (1975a,b) and Stapleton and Subrahmanyan (1977) show that models of this type imply that standard corporate finance rules must be modified to take account of the imperfections in the international capital market. Unfortunately, as Stulz (1996) notes: "We have little sense, however, how to compute the cost of capital for countries that are only partially integrated in international capital markets".

This lack of any satisfactory model has led to a variety of practical recommendations for computing the cost of capital for international real investments. (See, for example, Abuaf and Chu (1994), Godfrey and Espinosa (1996) and Stulz (1995).) The problem with these approaches is that they either assume complete market integration or segmentation or they are ad hoc.

The purpose of this paper is to give a clear foundation for international capital budgeting rules by deriving the optimal capital budgeting rules in the Stulz (1981) model of international capital market equilibrium. This model is rather restrictive in its assumptions, so we modify the original model by including an arbitrary number of countries (rather than two) and allowing the costs of cross-border equity holdings to depend on the identity of the issuer, the holder of the security and whether the position is long or short. This version of the model can, therefore, allow for the possibility that such costs are caused by factors that vary across companies and investors, and institutional features such as the higher cost of short-selling relative to long positions.

The optimal corporate decision rules we derive differ from those in integrated markets because all companies do not have access to capital on equal terms. This is not, however, because agents suffer from money illusion, nor is it because money and bond markets are segmented, implying different effective real interest rates for companies in different countries.[2] It is rather a consequence of the segmentation of equity markets generated by costs to cross-border portfolio investment. These costs cause investors' portfolios to differ because the net returns that different investors

[1] These costs can be direct costs such as taxes, or indirect costs such as the implied cost of information asymmetries.

[2] For a good critique of arguments of this type see Kester and Luehrman (1992).

receive from the same equity differ, and this leads to the well-known "home bias" in equity portfolios. Required returns for different companies investing in the same project consequently differ because the investment has different marginal risks and return for their investor clienteles. These different required returns for different companies undertaking the same project affect international competitiveness and incentives for foreign direct investment (see Lessard, 1991). We show how this can be incorporated into our model and made consistent with general equilibrium.

The paper is organized as follows. Section 2 gives the model of international capital market equilibrium and its implications for security prices. Section 3 uses this equilibrium to derive optimal capital budgeting rules. It also discusses how different required returns for different companies investing in the same project can be consistent with general equilibrium. Section 4 discusses a special case where assets fall into two types: global assets held by all investors and local assets held by only domestic investors. It also provides a numerical example. Section 5 discusses practical issues that arise in estimating required rates of return. In Section 6 we present a summary and our conclusions.

2. An international equilibrium with partially segmented markets

2.1. Assumptions

We make the following assumptions that are similar to Stulz (1981):[3]

A1. There are L countries and N risky assets. The ith asset has a return with an expectation equal to μ_i, and a covariance with asset j of σ_{ij}. Ω is the matrix of covariances of the returns to the risky assets.

A2. There are L investors, one for each country. Each maximizes a utility function that depends on the mean and variance of end-of-period wealth.[4]

A3. When investor i holds a long position in asset j, he experiences a dead-weight loss of cl_j^i. When he holds a short position he experiences a loss of cs_j^i. If asset j is a domestic asset for investor i, then $cl_j^i=0$.[5]

A4. All investors can hold costlessly a riskless asset with a return of r.

Our model is the Stulz (1981) model with multiple countries and a general structure of cross-border investment costs. We call this type of international capital market

[3] We do not include differences in investor behavior caused by different consumption baskets (see Adler and Dumas (1983)) as the evidence suggests that this is not an important source of international portfolio differences (Cooper and Kaplanis (1994)).

[4] Stulz (1981) demonstrates the important result that, in a model of this type, all investors facing the same investment costs will hold the same portfolio of risky assets. Our single investor in each country may, therefore, be thought of as the aggregate of investors in that country.

[5] This type of cost structure is discussed in Stulz (1981) and Cooper and Kaplanis (1986). It may represent direct costs, such as withholding taxes, or indirect costs, such as informational disadvantages.

segmentation "partial segmentation" to distinguish it from the "mild segmentation" in Errunza and Losq (1985). In the latter case, some investors are precluded from holding some securities. In our case, all investors may hold all securities; whether they choose to do so or not depends on how costly it is for them to do so. The effect of this is that the choice of specialization of investor portfolios is endogenous.

2.2. Optimal portfolios

The optimal portfolio choice of investor i is a simple extension of the Stulz result[6]:

$$\mu - r\mathbf{1} - \mathbf{cl}^i + \lambda\mathbf{l}^i = \alpha\Omega(\mathbf{xl}^i - \mathbf{xs}^i), \tag{1A}$$

$$\mu - r\mathbf{1} + \boldsymbol{cs}^i - \lambda\boldsymbol{s}^i = \alpha\Omega(\mathbf{xl}^i - \mathbf{xs}^i). \tag{1B}$$

Bold type denotes vectors, $\mathbf{1}$ is a vector of ones, α is the coefficient of risk aversion of all investors, xl_j^i is the proportion of investor i's portfolio held long in asset j, xs_j^i is the proportion held short, and λl_j^i and λs_j^i are shadow prices that satisfy the conditions:

$$xl_j^i \geq 0;\ \lambda l_j^i \geq 0;\ xs_j^i \geq 0;\ \lambda s_j^i \geq 0;\ xl_j^i \lambda l_j^i = 0;\ xs_j^i \lambda s_j^i = 0. \tag{2}$$

Eqs. (1A, 1B) and (2) say that any security held long or short has an excess return net of costs proportional to its beta with respect to each investor's optimal portfolio.

To solve for investor i's portfolio holdings, we adopt a slightly different procedure to Stulz. We note that an investor will not choose to be long and short the same asset, so that we can define without loss of information $x_j^i = (xl_j^i - xs_j^i)$ as the net holding by investor i of asset j. We delete from the system of Eqs. (1A) and (1B) all rows for which xl_j^i and xs_j^i are both equal to zero so that investor i has no holding in security j. We also delete the corresponding rows and columns of Ω. We denote the vector $\mathbf{x}^i$ and matrix Ω censored in this way by $\mathbf{X}^i$ and Ω^i. The censored system is then:

$$\mathbf{M}^i = \alpha\Omega^i\mathbf{X}^i, \tag{3}$$

where $\mathbf{M}^i$ is the vector of m_j^i for the assets held in non-zero amounts by investor i, m_j^i is the net excess return on asset j for the long or short position held by investor i:

$$m_j^i = \mu_j - r - c_j^i, \tag{4}$$

and $c_j^i = cl_j^i$ if investor i holds asset j long and $c_j^i = -cs_j^i$ if investor i holds asset j short. The vector $\mathbf{c}^i$ measures the losses to investor i resulting from the costs involved in the actual positions (long or short) he holds.

Denoting the inverse of Ω^i as P^i (the censored precision matrix for this investor) and premultiplying by $\alpha^{-1}P^i$ gives:

[6] We are mainly interested in the features of international finance caused by partial segmentation of markets, so we assume equality of risk aversion to avoid introducing differences caused by arbitrary assumptions about relative attitude to risk.

$$\mathbf{X}^i=\alpha^{-1}P^i\mathbf{M}^i. \tag{5}$$

This is the solution for the subset of assets held in the portfolio of investor i. To aggregate across investors, we now augment the matrix P^i by putting rows and columns of zeros back in the positions censored from the original covariance matrix. This matrix is called p^i and the resulting system is:

$$\mathbf{x}^i=\alpha^{-1}p^i\cdot\mathbf{m}^i, \tag{6}$$

where $\mathbf{x}^i$ and $\mathbf{m}^i$ are the vectors $\mathbf{X}^i$ and $\mathbf{M}^i$ augmented with zeros in the same way as p^i.

2.3. Equilibrium returns

The aggregation condition is:

$$\sum w^i\mathbf{x}^i=\mathbf{e}, \tag{7}$$

where w^i is investor i's share of world wealth and $\mathbf{e}$ is the vector of asset proportions of world market value. Aggregating Eq. (6) using Eq. (7) and substituting Eq. (4) gives:

$$\boldsymbol{\mu}=r\cdot\mathbf{1}+\hat{\boldsymbol{c}}+\alpha\hat{\beta}, \tag{8}$$

where $\hat{\boldsymbol{c}}=S[\Sigma w^ip^i\boldsymbol{c}^i]$, $\hat{\beta}=S\boldsymbol{e}$, $p=\Sigma w^ip^i$, $S=p^{-1}$. Eq. (8) is the asset pricing equation under our assumptions. It states that the excess return on a risky asset (μ_j-r) consists of a term reflecting a weighted average cost of holding the asset, $\hat{c}_j$, and a term, $\hat{\beta}_j$, that is similar to a beta.

The nature of the terms in Eq. (8) can be appreciated from their values for an asset that is held long by all investors (a "global" asset). In this case, using Eq. (1A) with $\lambda l_j^i=0$ for all investors and aggregating using Eq. (7) gives:

$$\mu=r+\overline{cl}_j+\alpha\beta_j^w, \tag{9}$$

where β_j^w is the jth element of $\Omega\mathbf{e}$, a vector proportional to the vector of betas with respect to the world market portfolio and $\overline{cl}_j=\Sigma_iw^icl_j^i$ is the wealth-weighted average of access costs for asset j. For such a global asset the excess return consists of the wealth-weighted average of capital market access costs for all investors $(\overline{cl}_j)$ plus a risk premium based on its world market beta (β_j^w).

To compare this with the returns on assets that are not held by all investors, compare Eq. (8) with Eq. (9). Note that a more complex average cost term, $\hat{\boldsymbol{c}}$ is used as the cost term in Eq. (8) rather than the wealth-weighted average $\bar{\boldsymbol{c}}$. The "covariance" term is $S\mathbf{e}$ rather than the global beta vector $\Omega\mathbf{e}$. Segmentation induced by costs to cross-border investment modifies expected returns on risky assets both directly through the costs themselves and also indirectly through their impact on portfolio segmentation and risk-sharing. If costs to cross-border investment are sufficiently low that all investors hold all assets, then S is equal to the market covariance matrix, Ω and $\hat{\boldsymbol{c}}$ is equal to $\bar{\boldsymbol{c}}$.[7] In this case, although there is home bias there is no segmentation of portfolios in the sense of some assets being omitted from some portfolios. Then the appropriate risk measure is the global beta, $\boldsymbol{\beta}^{\mathbf{w}}$, as in an integrated markets equilibrium. With higher costs, however, the covariance matrix is "inflated" by the partial segmentation of markets which does not allow complete risk-sharing (see Cooper and Kaplanis, 1996). With portfolio segmentation the cost vectors are also weighted by the censored precision matrices of investors (the p^i) to give the aggregate cost vector $\hat{\mathbf{c}}$. The effect of this is that investors who do not hold an asset receive no weight in its required return, and other investors receive weights that depend both on the covariance matrix of returns and the choice of assets that are excluded from their portfolios.

2.4. Investor portfolios

The portfolios of investors will tend to be specialized into those assets that have low costs for them relative to the average of investors. Using Eq. (1A) for two investors j and k who hold asset j:

$$\alpha(\beta_j^j-\beta_j^k)=(c_j^j-c_j^k), \tag{10}$$

where β^j is $\Omega\mathbf{x^j}$ the vector of covariances with respect to the portfolio of investor j and β_j^j is the jth element of $\boldsymbol{\beta}^{\mathbf{j}}$, the beta of asset j with respect to the portfolio of investor j. If we compare an investor j, for whom j is a domestic asset, with another investor, k, for whom it is a foreign asset, then the cost of a long position is lower for the domestic investor so the right-hand side of Eq. (10) is negative. So asset j must have a higher beta with respect to the portfolio of investor j than with respect to that of the foreign investor k for Eq. (10) to hold. This can be true, in general, only if investors tend to hold disproportionate amounts of their home assets. This leads to the "home bias" observed in equity portfolios whereby equities with low access costs for a particular investor, especially domestic equities, are held disproportionately.

Eq. (10) also shows the intimate relationship between the betas of assets with respect to investors' portfolios in equilibrium and the structure of costs. Portfolios adjust until the relative costs of holding assets are exactly offset by differences in marginal portfolio risks for any assets that investors choose to hold. So observing portfolios implicitly is equivalent to observing the costs. Because of this duality, many of the relationships we derive below can be stated either in terms of costs or betas with respect to particular portfolios. In some cases switching from one representation to another will give a more revealing analysis or provide a more practiced way of estimating required returns.

Note that, although investors in a country tend to hold more than the market portfolio weight of firms domiciled in that country, their cost of holding these assets

[7] This is also the equilibrium if short selling is permitted and rewarded by a rebate of the cost c_j^i. This is one case discussed in Adler and Dumas (1975b). Such an assumption is, however, rather unrealistic.

does not necessarily receive a disproportionate weight in setting the required return on these firms. This can be seen in Eq. (9), the required return on globally held equities, where the access costs of all investors receive weights equal to their wealth proportions, despite the fact that the equities are held disproportionately by home investors. This is because required returns are set by marginal portfolio effects and these do not receive weights proportional to portfolio holdings.

As an example, suppose that a particular investor faces very heavy costs to foreign investment. His portfolio will be heavily invested in his home market, so any foreign investment is likely to have a low beta with respect to this portfolio. Thus the required return on foreign assets would be low if it weren't for the impact of costs. The costs of foreign investment are, however, high for this investor so his required return for any foreign asset he holds is, in total, the same as the required return for an investor who faces a lower cost to holding this asset who also holds the asset. The latter has a higher beta relative to his portfolio for foreign investment, but a lower cost. At the margin they both affect the required return, and the low cost investor who holds a lot of the asset does not necessarily have a heavier weight in determining the return.

Another feature of portfolios is that each investor excludes certain assets from his portfolio. Focusing on long positions, these assets may be identified by the fact that they have $\lambda l_j^i > 0$ in equilibrium. To identify these assets, we aggregate Eq. (1A) using Eq. (7) and subtract it from Eqs. (1A) and (1B) to give:

$$\lambda\mathbf{l}^i = \overline{\lambda\mathbf{l}} + \alpha\Omega(\mathbf{x}^i - \mathbf{e}) + (\mathbf{c}^i - \overline{\mathbf{c}}). \tag{11}$$

The jth row of Eq. (11) gives the shadow price of the long position for investor i holding asset j. If it is positive, that holding is zero. It is clear from Eq. (11) that the asset is likely to be excluded from investor i's portfolio if c_j^i is large, $\overline{c_j}$ is small, and the jth row of $\Omega(\mathbf{x^i} - \mathbf{e})$ is large. The first of these says that high cost assets will be excluded, the second that assets that are cheap for other investors to hold will be excluded, and the third that assets with a high beta relative to the active portfolio of the investor will tend to be excluded. This active portfolio will tend to overweight the domestic assets of the investor, for which $cl_j^i = 0$, so that the excluded assets will tend to be those foreign assets that have high betas with respect to the domestic market portfolio of the investor.

2.5. The structure of the covariance matrix

The extent of the distortions of portfolios and returns relative to an integrated markets equilibrium depends upon the covariance matrix, Ω, and the cost vectors. The results in this section are quite general and do not rely on assumptions about the structure of the covariance matrix, except that it and relevant sub-matrices are non-singular. So the results hold for any set of activity choices by firms, including, for instance, the case where firms are highly internationally diversified. In that case, however, the covariance matrix of returns will be such that benefits to international portfolio diversification will be very limited, so that the deviation of the equilibrium returns from the integrated market equilibrium will be small. The way that activity choices by firms are determined in equilibrium is discussed in Section 3.5 below.

3. Optimal capital budgeting rules

3.1. Introduction

Hamada (1969) and Fama and Miller (1972) derive the optimal financing and capital budgeting rules for an integrated domestic capital market. The Hamada analysis shows that projects that are "small" relative to the size of the market can be treated as though they do not distort equilibrium returns. Their marginal required rates of return can, therefore, be computed given the current structure of equilibrium returns without including any effect of the project on the structure of these returns. In this section we use the Hamada result in partially segmented international capital markets to derive capital budgeting rules for international investment when international securities markets are segmented in the way modelled above.

The questions we address in this section are:

- What is the required return on a marginal project undertaken by firm *i*?
- If the project is in a different business or country to firm *i*'s existing assets, how does the marginal required return for firm *i* compare to the required return of competitors already operating in that business or country?
- How does the required return on a marginal project compare to firm *i*'s cost of capital on its existing projects?
- How do differences in the required returns of different international companies competing in the same industry interact with differences in their abilities to generate operating cash flows to give a general equilibrium?

To derive the capital budgeting rules in a partially segmented international equilibrium we assume that firm *i* is considering a project that pays a random return of δR_I. The stochastic part of the return, R_I, is a linear combination of returns from existing firms:

$$R_I = \sum_{j=1,N} I_j R_j - \sum_{j=1,N} I_j \theta_{ij}, \tag{12}$$

where the I_js are weights that sum to one and θ_{ij} are constants. These constants represent the difference between the marginal mean return that company *i* is able to earn on this project and the mean return being earned by existing companies that hold the investments that generate R_j. The "size" of the project is δ, which will be made small to give the required return for an infinitessimal project.

3.2. Required returns

Appendix A proves that the required return on this project undertaken by firm *i*, denoted by $\hat{\mu}_{iI}$, is given by the *i*th element of the vector:[8]

[8] Investors who hold the shares of company *i* are not unanimous about the incremental return they require from this project. The criterion that we use for the required rate of return on the marginal project is the return that is required for the project to increase the total value of the equity of the company, the

$$\hat{\mu}_{iI}=\boldsymbol{\mu}+K'\mu-S\sum_{l}w^{l}p^{l}K'(\mathbf{c}^{l}-\lambda^{l}), \tag{13}$$

where K is an $N\times N$ square matrix with zeros everywhere except the ith column. In the ith column the element in the ith row is (I_i-1) and in all other rows j it is I_j. Evaluating the ith element of Eq. (13) gives:

$$\hat{\mu}_{iI}=\Sigma I_j\mu_j-\left[S\sum_{l}w^{l}p^{l}K'(\mathbf{c}^{l}-\lambda^{l})\right] \tag{14}$$

The required return for a project in Eq. (14) is equal to the required return on the portfolio of shares that spans the project, $\Sigma I_j\mu_j$, plus an adjustment term. The second term in Eq. (14) adjusts for the deadweight costs of investing in the company undertaking the project relative to the deadweight cost of investing in the spanning portfolio. Note that the required return depends only on the stochastic structure of the returns to the project and not on the mean return that the company can actually earn. So the mean return, as determined by the constants $\{\theta\}$ does not enter Eq. (13). The mean return does, however, affect the NPV of the project as discussed in Section 3.5 below.

3.3. Required returns relative to foreign competitors

We derive the required return on a project relative to the required return of foreign competitors by considering firm i investing in a project that has the same return characteristics as a foreign firm. This would be the case, for instance, when a US firm makes an investment in a foreign industry. We denote by firm I the foreign firm that has return characteristics identical to the project being undertaken. In this case the matrix K' has zeros everywhere except position $\{i,i\}$ which has -1, and position $\{i,I\}$ which has +1. The required return on the marginal project for firm i is then:

$$\hat{\mu}_{iI}=\mu_I+\sum_{l}y^{l}[(c_i^{l}-c_I^{l})-(\lambda_i^{l}-\lambda_I^{l})], \tag{15}$$

where $y^l=w^l[Sp^1]_{ii}$ and $[Sp^1]_{ii}$ is the ith element of the matrix Sp^1, which is zero for any investor who does not hold firm i. So Eq. (15) becomes:

$$\hat{\mu}_{iI}=\mu_I+\sum_{l\varepsilon\{i\}}y^{l}[c_i^{l}-c_I^{l}+\lambda_I^{l}], \tag{16}$$

where $\{i\}$ is the set of investors who hold asset i.

most frequently used capital budgeting criterion. Jensen and Long (1972) discuss the conditions under which this corresponds to wealth and welfare maximisation.

Eq. (16) gives the required return when a company from country i (we refer to the country of residence of company i as country i) makes an investment in country I. This consists of two parts. The first is the cost of capital of a company from country I making this investment. The second is an adjustment for the relative costs of investors holding company i rather than company I. This cost term is, in fact, a weighted average of the cost differentials between investing in company i and company I for investors who hold firm i. The weights, y^l, sum to one.[9]

The nature of this weighted average can be seen if we look at two extreme cases. In the case where all investors choose to hold all assets, then Sp^l is the identity matrix, and Eq. (16) becomes:

$$\hat{\mu}_{iI}=\mu_I+\bar{c}_i-\bar{c}_I. \tag{17}$$

In this case, the cost adjustment for the location of the company making the investment is simply a global wealth-weighted average of the relative deadweight costs of portfolio investment in the two companies. In this case the companies that will have the lowest required return *for any project* will be those located in the country with the lowest value of $\bar{c}_i$, the wealth-weighted average cost of access to that capital market for investors.

In the case where costs of foreigners holding firm i are so high that only local investors hold it, then $c_i^l=0$ for the only investor holding the asset, and the value of Eq. (16) becomes:

$$\hat{\mu}_{iI}=\mu_I-(c_I^i-\lambda_I^i), \tag{18}$$

where c_I^i and λ_I^i are the cost and shadow price for the investor holding firm i making an investment in firm I. Here the required return for firm i investing in a project with the return characteristics of company I (a foreign firm) is unambiguously lower than the return required by I.[10] This is because the cost of foreign investment is so high that investors choose not to hold foreign assets directly. If they are given access to the return characteristics of those assets indirectly by a domestic corporation, then they benefit from the improved diversification. This benefit is directly related to the deadweight costs that are avoided by foreign direct investment, as Eq. (18) shows. Indeed, in the case where investor i already holds some of asset I, Eq. (18) becomes $(\mu_I-c_I^i)$, so that the required return is simply the required return on firm I minus the cost of holding foreign firm I for investor i. This investor now effectively holds an investment in firm I for zero deadweight portfolio cost via his domestic firm i rather than at the cost c_I^i of holding a foreign firm.

The two extreme cases of no portfolio specialization and complete specialization are illustrated by Eqs. (17) and (18). The general case, given by Eq. (16), lies somewhere between these two extremes. Thus the required return for a company investing in a foreign country will, in general, be lower than for a domestic company in that

[9] $\Sigma y^1=\Sigma w^1[Sp^1]_{ii}=\Sigma w^1\{[\Sigma w^1p^1]^{-1}p^1\}_{ii}=[I]_{ii}=1$.

[10] $(c_I^i-\lambda_I^i)$ is equal to $(\beta_I^I-\beta_I^i)$ where β_I^i is the beta of the asset with respect to the portfolio of the domestic investor for asset I. From Eq. (13) this is greater than β_I^i, the beta of the asset with respect to the portfolio of an investor who does not hold the asset, so $c_I^i>\lambda_I^i$.

country making the same investment. The degree of this advantage will depend on the level of portfolio specialisation induced by deadweight costs to foreign investment.[11] This lower required return for an investment that gives investors diversification which is costly to achieve via portfolios will not necessarily result in a net incentive for firms to make such investment. The expected return on such investment may be sufficiently low that, even compared with the low required return, the NPV is negative. This is analyzed in Section 3.5 below.

3.4. Adjusting the cost of capital of the investing firm

We can also derive the relationship between the required return on the project and the firm's existing cost of capital. If we rewrite Eq. (16) using Eqs. (1A) and (1B) as:

$$\hat{\mu}_{iI}=\mu_i+\alpha\sum_{l\varepsilon\{i\}}y^l(\beta_I^l-\beta_i^l), \tag{19}$$

the required return on the project is the return on firm i's existing assets adjusted by a weighted average of the project beta minus the existing asset beta. The weighted average is taken across the investors who hold shares in the company making the investment. These beta differences are measured relative to the portfolios of investors and are different for different investors. For a "scale expansion" project, which has the same structure of returns as the firm undertaking it, we get the familiar result that the required return on the project is the same as the equilibrium return on the investing firm's existing assets.

3.5. Net present value differences and foreign direct investment (FDI)

With integrated markets all companies should use the same discount rate to evaluate projects with identical risk characteristics. In that case differences in net present value (NPV) between companies come only from differences in the operating cash flows caused by different competitive positions, different corporate tax effects, or other corporate costs to cross-border investment. With partially segmented markets, projects will have a different required return for different companies, as shown in the previous sections. So differences in NPV come from different required returns as well as differences in operating cash flows. Thus the net value of an investment will be different for international companies as a result of three effects:

(a) deadweight costs to foreign portfolio investment, which are reflected in relative required returns;

[11] Note that, in any integrated international capital market equilibrium where investors with different nationalities have different preferences and this causes specialized portfolios but there are no costs to cross-border investment, the identity of the company making an investment does not affect the required return, as investor opportunity sets are not affected by the identity of the firm making a marginal investment.

(b) deadweight costs to corporate cash flows, which affect the level of expected cash flow;
(c) competitive advantages and disadvantages resulting from international ownership.

To compute the NPV of a marginal investment, we compare the required return with the expected return. The general expression for the required return for company i making an investment identical to the assets of company I is given by Eq. (16):

$$\hat{\mu}_{iI}=\mu_I+\sum_{l\varepsilon\{i\}}y^l[c_i^l-c_I^l+\lambda_I^l]. \tag{20}$$

The expected return is given by:

$$\mu_{iI}=\mu_I-\theta_{iI}, \tag{21}$$

where θ_{iI} reflects the competitive disadvantage of company i plus any deadweight costs to corporate investment. The project will have a positive NPV if $\mu_{iI}>\hat{\mu}_{iI}$, which implies:

$$\theta_{iI}+\sum_{l\varepsilon\{i\}}y^lc_i^l<\sum_{l\varepsilon\{i\}}y^l[c_I^l-\lambda_I^l]. \tag{22}$$

The left-hand side of Eq. (24) is the sum of two terms. The first is the competitive disadvantage and relative corporate cost for company i compared with company I of making the investment that corresponds to company I's assets. The second is the weighted deadweight cost to investors holding company i shares. The right-hand side is the weighted average cost for investors in company i holding company I's shares minus the weighted shadow price for investors in company i who do not yet hold company I's shares. So Eq. (24) says that project I will have a positive NPV for company i if the combination of investor costs, corporate costs, and corporate competitive disadvantage for company i is lower than for company I making the investment. The practical implication of this is that projects will have a positive NPV if the disadvantages of corporate costs and competitive disadvantage are less than the financing advantage.

3.6. Activity choices by firms and general equilibrium

A general equilibrium where there is no net incentive for companies to incrementally duplicate each other's activities can be obtained when there is no incremental investment for which Eq. (22) is satisfied. Although it is not the purpose of this paper to derive such general equilibrium, we can characterize the structure of the equilibrium by examining Eq. (22). The conditions for an equilibrium are that all investors are in equilibrium as described by Eq. (5); that returns satisfy the pricing condition given by Eq. (8) and that no incremental investment satisfies Eq. (22).

We can gain further insight into this equilibrium condition by restating the complement of Eq. (22) as:

$$\theta_{iI}+\sum_{l\varepsilon\{i\}} y^l c_i^l-\alpha\left[\beta_I^I-\sum_{l\varepsilon\{i\}} y^l\beta_I^l\right]\geq 0. \tag{23}$$

This is the condition for there to be no net incentive for firm i to invest in the activities that correspond to firm I. The first term is the relative competitive disadvantage and corporate costs of firm i. The second term is the weighted average portfolio costs of access to firm i's shares for its shareholders. The third term is the diversification benefit that firm i's shareholders obtain by the firm investing in the activities that correspond to firm I. This benefit is measured by the beta of the investment I relative to the portfolio of domestic investor I compared with the beta of the investment relative to the portfolios of the shareholders of firm i. This difference depends in turn, on the extent of the home bias induced by relative portfolio access costs. As long as there is a home bias, the term inside the square brackets is positive, so the effect of the last term is negative. Thus an equilibrium exists when the relative corporate cash flow cost of international diversification plus the portfolio access costs exceed the diversification benefits.

4. Global assets and local assets: a special case

To illustrate the model with a more specific example, we now consider a special case that is of particular interest. This is the case where some assets ("global" assets) are held by all investors and all others ("local" assets) are held only by the domestic investors in the home country of the firm. Global and local refer here to the scope of shareholdings in the companies rather than the scope of their real activities. Assets are split into two groups: those with low cross-border costs are held by all investors; those with high cross-border costs are held by only the domestic investor. In particular, this excludes the case where an asset is held by some, but not all, foreign investors.

In this case investor portfolios consist of holdings of global assets plus the entire ownership of their own local assets. We use the following notation: Ω_G is the covariance matrix of the global assets; v_i is the vector of covariances of country i's local assets with the global assets and c_G^i is the cost vector for investor i holding the global assets. The equilibrium returns for the global assets are determined, as before, by a combination of the global beta and wealth-weighted access costs:

$$\mu_j=r+\bar{c}_j+\alpha\beta_j^w. \tag{24}$$

The required return for a domestic asset also depends on the costs of global assets, but not the access costs for foreigners to the domestic asset as no foreigners hold the asset. For the domestic asset i of country i, the expected return is:[12]

$$\mu_i = r - \mathbf{q_i}'(\mathbf{c_G^i} - \bar{\mathbf{c}}_\mathbf{G}) + \alpha \mathbf{q_i}'\, \beta_G^w + \alpha d_{ii} e_i / w_i, \tag{25}$$

where: $\mathbf{q_i} = \Omega_G^{-1}\mathbf{v_i}$, $d_{ii} = \sigma_{ii} - \mathbf{v_i}'\Omega_G^{-1}\mathbf{v_i}$, β_G^w is the vector of betas for global assets, Ω_G is the covariance matrix for global assets, $\boldsymbol{c}_\mathbf{G}^\mathbf{i}$ is the vector of costs for the ith investor investing in global assets. To interpret this result note that $\mathbf{q_i}$ is the vector of multiple regression coefficients resulting from a regression of the return on the ith domestic asset on the returns to all global assets. The variable d_{ii} is the variance of the residual from this regression, that is the part of the variance of the return on domestic asset not explained by global asset returns.[13]

The required return on domestic asset i consists of a risk-premium for the part of its risk that is unrelated to global assets (d_{ii}), a premium for its return's projection into the betas of global assets, ($\mathbf{q}_i'\boldsymbol{\beta}_G^w$), and a cost term. The cost term does not depend on access costs to this asset (no foreigners hold it and domestic access costs are zero). The dependence on the access costs of global assets arises because the asset effectively gives the investor a position equivalent to the vector $\mathbf{q_i}$ of global assets. Global assets are effectively held at zero cost through the domestic asset rather than at the cost $\mathbf{q}_i'\mathbf{c}_G^i$ through the global assets themselves. This cost is saved by investor i, so the required return is lowered by that amount. On the other hand, the supply of global assets is effectively higher by the amount $\mathbf{q_i}'$, so costs of $\mathbf{q}_i'\bar{\mathbf{c}}_G$ are imposed on investors in general and this increases the required return.

In this equilibrium, the required return on a project depends on the type of company making the investment and the type of project. Table 1 shows the four possible cases. The required return on the project (indexed by I) is shown in three ways: as a total required return, as a return relative to the required return on the existing asset I, and relative to the required return on the company i making the investment. In the first and simplest case a global company makes an investment that has return characteristics identical to an existing global company. The total return shows that the components of the return are the interest rate, the deadweight cost of company i accessing funds, and the global beta of the project. Alternatively, the required return can be thought of as the required return on the company k that is identical to the project plus an adjustment for the fact that the funds are being raised by company i at a cost of $\bar{c}_i$ rather than company I at a cost $\bar{c}_I$. Finally, the return can be constructed starting from the required return on company i undertaking the project. In this case the adjustment that is required is for the global beta of the project relative to the beta of the exiting assets of the firm.

These three equivalent ways of estimating required returns have different potential

[12] This is the return on a composite local asset. Returns on individual local assets can be easily derived from this and have a similar form. A proof of Eq. (25) and the result for individual local assets is available from the authors.

[13] There are some similarities between this special case and the model of Errunza and Losq (1985). In their case, however, investors are segmented between those who hold all assets and those who hold only a subset, rather than securities being segmented into global and local by means of costs.

Table 1
Required return in an incremental investment[a]

Investor type (i)	Investment type (I)	Required return	Required returns minus company I return	Required return minus company i return
Global	Global	$r+\bar{c}_i+\alpha\beta_I^w$	$\bar{c}_i-\bar{c}_I$	$\alpha(\beta_I^w-\beta_i^W)$
Global	Local	$r+\bar{c}_I-c_i+\alpha\beta_I^w$	$\bar{c}_i-q_k{}'(\bar{c}_G-c_G^k)+\alpha(\Sigma d_{Il}e_l-d_{II}e_I/w_I)$	$\alpha(\beta_I^w-\beta_i^w)$
Local	Global	$r+\bar{c}_I-c_I^i+\alpha\beta_I^w$	$-c_I^i$	$\alpha(\beta_I^i-\beta_i^i)$
Local	Local	$r-q_I{}'(\bar{c}_G-c_G^i)+\alpha q_i{}'\beta_G^w+\alpha d_{iI}e_i/w_i$	$q_I{}'(c_G^I-c_G^w)+\alpha(d_{iI}e_i/w_i-d_{II}e_I/w_I)$	$\alpha(\beta_I^i-\beta_i^i)$

[a] The table shows the required return on an investment made by company i in a project I. The project has returns that are proportional to those of the existing company I. r is the riskfree rate, $\bar{c}_i$ is the wealth-weighted cost of holding security i, α is the coefficient of risk-aversion, β_G^w is a vector of global company betas whose Ith element is $\beta_I^w \cdot q_I{}'$ is the vector of regression coefficients of the Ith domestic asset on global assets, $\bar{c}_G$ is the vector of $\bar{c}_j$ for global assets, c_G^I is the vector of c_i^I for global assets, c_I^i is the cost for investor i of holding asset I, d_{Il} is the covariance between the residual risks from the regression against global assets, of domestic assets I and le_l is asset l's proportion of world market value, w_I is investor I's proportion of world wealth, and β_I^i is the beta of asset I with respect to investor i's portfolio.

uses. The last is generally the simplest and most observable and so is probably the best basis for actually estimating required returns, as discussed in Section 5 below. The second approach highlights the relative required returns on the same project for two different companies. This depends principally on their relative costs of access to funds. Such comparisons are important in examining questions of international competition and foreign direct investment, which we discussed in Section 3.5. As an example of this, the third row of Table 1 shows that a local firm investing in a project that is identical to a global firm has a required rate of return that is lower than that of the global firm by the cost that its local investor experiences in holding shares of the global firm. As the local investor already holds the global firm at this cost (c_I^i), an investment by the local firm in this asset gives the investor the same risky asset at a zero access cost, a saving of c_I^i with no incremental risk effects. Thus the required return is lower by this amount. In this case direct investment achieves international diversification with a cost lower than for portfolio investment, and this is reflected in the required return.

To illustrate the importance of the effects we are discussing, Tables 2 and 3 give numerical examples. There are two countries (1 and 2) and four assets (1 to 4). The assets are worth equal amounts and their countries have equal wealth. Assets 1 and 3 have very high costs to cross-border investment and are held only by the local investor. Asset 2 and 4 have lower costs and are held by both investors.

Table 2 shows the optimal portfolios and the required returns relative to these portfolios. Asset 1 has a required return of 9% for investor 1 and is held only by this investor and so has a return of 9%. Asset 2 is held by both investors. For this asset investor 1 has a required return of 8% and zero cost. Investor 2 has a required return of 7% and 1% cost. So a gross return of 8% satisfies both investors. This

Table 2
Numerical example A.[a] The optimal portfolios of investors facing costs to portfolio investment[b]

Asset	Cost to investor i		Optimal portfolio %		Required risk premia %		Expected premium %
	1	2	1	2	1	2	
1	0	Large	50	0	9.0	6.0	9.0
2	0	1%	33	17	8.0	7.0	8.0
3	Large	0	0	50	6.0	9.0	9.0
4	1%	0	17	33	7.0	8.0	8.0

[a] There are four assets and two investors. α=3. All assets have standard deviations of 20% and all correlations are 0.5.

[b] Given these portfolios the expected returns on assets are equal to the required risk premium for investors who face zero costs.

Table 3
Numerical example B.[a] The required returns for two types of companies making four types of investment[b]

Investment by Co. i	Type of investment I	Required return	Relative to company i WACC	Relative to company I WACC
1	1	9.0	0.0	0.0
1	2	8.0	−1.0	0.0
1	3	6.0	−3.0	−3.0
1	4	7.0	−2.0	−1.0
2	1	8.0	0.0	−1.0
2	2	8.0	0.0	0.0
2	3	8.0	0.0	−1.0
2	4	8.0	0.0	0.0

[a] There are four assets and two investors. α=3. All assets have standard deviations of 20% and all correlations are 0.5.

[b] Company 1 is funded locally and company 2 is funded globally. The required returns on the investments are shown and compared with the company's own WACC and the WACC of the company that is identical to the investment.

expected return of 8% for this global asset is also equal to the global beta times the price of risk (7.5%) plus the average access cost (0.5%).

Table 3 shows the required returns for the local company (1) and the global company (2) making incremental investments in assets that are like the four existing types of asset. The required return to the local company is lower than its own WACC for any investment that is not identical to its existing assets (penultimate column). For assets 3 and 4, the foreign assets, its required return is lower than for the existing companies that own those assets (last column). This is because the company achieves diversification benefits for its investors by owning these assets. For the global company, the required return is independent of the asset type as all assets have the same global beta and global access costs in this case. The global company does, however, have a lower required return than the local companies as it achieves better risk sharing. As can be seen from Tables 2 and 3, all the relative cost of capital effects are of a material size relative to the overall risk premia and of the same order of magnitude as the costs inducing them.

5. Estimating the cost of capital

Because the capital market equilibrium depends on the unobservable matrix S, and the unobservable cost structure $\{c_{ij}\}$, the cost of capital for any firm is not directly observable, and must be estimated. This estimation would appear to depend through Eq. (8) on the estimation of S and the cs, which requires the observation of all investors' portfolios and costs. There is, however, an alternative more direct approach to the problem.

To see this, first note that the gross required return on a share evaluated marginally with respect to the portfolio of *any* investor that holds that particular share is equal to the equilibrium expected return.[14] (This is obvious from Eq. (3).) This required return for each investor consists of three parts: the interest rate, the risk premium with respect to the particular investor's portfolio and the dead-weight costs of that investor. Although different investors have different portfolios and different dead-weight costs they choose their portfolios so that the sum of the last two effects is the same for all investors that hold the asset. This sum is equal to the price of risk, α, thus the global market pseudo-beta $\hat{\beta}$ plus an average dead-weight cost $\hat{c}$. Thus we can estimate the required return on a company either by knowing the pseudo covariance matrix S, the cost structure $\{c_{ij}\}$, and the capital market line Eq. (8), or by observing the portfolio of an individual investor that holds the asset and measuring the required return incremental to this portfolio and adding his access cost.

Following this latter approach, there is one particular investor for whom the required return to company i can be set without knowledge of dead-weight costs. This is the investor in the country of domicile of company i, for whom the dead-weight cost is zero. This investor is guaranteed to hold the asset, so the required return marginal to his portfolio is equal to the equilibrium required return. In many cases, the portfolio that this investor holds is also relatively easy to observe. The investor in our model is the consensus investor in the country, and there is considerable evidence that, because of the "home bias" in equity portfolios, the portfolio held is often close to the domestic market portfolio. This means that a commonly used procedure to estimate the cost of capital, to base it on the beta of the equity relative to the domestic market portfolio of the country of domicile of the company, may be close to being correct in many cases, even when it is recognized that capital markets are global, but partially segmented. To estimate the required return for an individual project that differs in risk to the existing assets of the firm, we may then

[14] Note that investors are not unanimous about the return they require on assets. Investors who do not hold the asset would require a higher return than the equilibrium return to do so. They have no influence on the required return, however, as short selling is not allowed.

start from the required return on the company making the investment and use the final column of Table 1 to adjust this to give the required return on the project.

6. Summary and conclusions

We have developed a model of international capital market equilibrium with partially segmented capital markets. Segmentation is generated by costs to cross-border investment and short-selling restrictions. This limits risk-sharing and raises the market risk-premium in a way similar to models with non-traded assets. In our model, however, all assets are traded, but costs induce portfolio specialization. The empirical implications of our model encompass the effect of segmentation on expected returns found by Jorion and Schwartz (1986) and Hietala (1989) and the "home-bias" in portfolio analysed by Cooper and Kaplanis (1986, 1994) and French and Poterba (1991).

Among the normative features of the model are implications for international cost of capital estimation and international capital budgeting. The expected returns on risky assets line up, in this equilibrium, along a single capital market line. The "betas" of assets are, however, unobservable. We have shown how, despite this, one could estimate the required returns on assets from portfolio holdings of domestic investors. The required returns on projects depend on the firm making the investments and we have related this to the motives for foreign direct investment and competition in product markets.

We illustrated the model with a special case with two classes of assets: global assets held by all investors and local assets held only by domestic investors. Expected returns in this special case depend on the factors generating global asset returns. A possible extension would be to analyze this equilibrium using an explicit factor model.

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Appendix A. Derivation of the required return for a marginal project

We consider a marginal project undertaken by firm i with return of δR_k, where:

$$R_k = \sum_{j=1,N} k_j R_j \tag{A1}$$

The covariance matrix for the market that results from adding this project to firm i is:

$$\hat{\Omega}=\Omega+\Delta\Omega \quad \text{(A2)}$$

where $\Delta\Omega=\delta\Omega K+\delta K'\Omega$. We denote the corresponding value of Ω^i as $\hat{\Omega}^i$, and of P^i as $\hat{P}^i$. We assume that the assets with zero holdings for each investor remain unchanged (we prove this below). Then:

$$I=\hat{\Omega}^i\cdot\hat{P}^i=\Omega^i\cdot P^i+\Omega^i\cdot\Delta P^i+\Delta\Omega^i P^i=I+\Omega_i\cdot\Delta P^i+\Delta\Omega^i\cdot P^i \quad \text{(A3)}$$

where $\Delta\Omega^i=\hat{\Omega}^i-\Omega^i$, $\Delta P^i=\hat{P}^i-P^i$, and the term $\Delta P^i\cdot\Delta\Omega^i$ has been omitted as it is $O(\delta^2)$. Thus:

$$\Delta P^i=-P^i\cdot\Delta\Omega^i\cdot P^i \quad \text{(A4)}$$

We augment $\hat{P}^i$ with zeros to give $\hat{p}^i$, and define Δp^i as $(\hat{p}^i-p^i)$, Δp as $\Sigma w^i\Delta p^i$, and ΔS as $(\hat{S}-S)$. Then:

$$\Delta p^i=-p^i\cdot\Delta\Omega\cdot p^i=-\delta p^i(\Omega K+K'\Omega)p^i \quad \text{(A5)}$$

$$\hat{p}=p+\Delta p \quad \text{(A6)}$$

$$\Delta S=-S\Delta pS \quad \text{(A7)}$$

Note that:

$$\mu-r\mathbf{1}=\alpha S\mathbf{e}+S\Sigma w^l p^l\mathbf{c^l} \quad \text{(A8)}$$

and

$$\hat{\mu}-r\mathbf{1}=\alpha\hat{S}\hat{\mathbf{e}}+\hat{S}\Sigma\hat{w}^l\hat{p}^l\mathbf{c^l} \quad \text{(A9)}$$

Subtracting Eq. (A8) from Eq. (A9):

$$\hat{\mu}-\mu=\alpha(\hat{S}\hat{\mathbf{e}}-S\mathbf{e})+(\hat{S}\Sigma\hat{w}^l\hat{p}^l\mathbf{c}^l-S\Sigma w^l p^l\mathbf{c}^l) \quad \text{(A10)}$$

Therefore:

$$\hat{\mu}-\mu=\alpha((S+\Delta S)(\mathbf{e}+\Delta\mathbf{e})-S\mathbf{e})+(S+\Delta S)\Sigma(w^l+\Delta w^l)(p^l+\Delta p^l)\mathbf{c^l} \quad \text{(A11)}$$
$$-S\Sigma w^l p^l\mathbf{c^l}$$

where: Δw^l is the change in the wealth of investor l; $\Delta\mathbf{e}$ is the change of the vector of market capitalisation proportions.

Ignoring any terms of $O(\delta^2)$ and using Eq. (8) we can rewrite Eq. (A11) as:

$$\hat{\mu}-\mu=-\Delta p(\mu-r\mathbf{1})+S\Sigma w^l\Delta p^l\mathbf{c^l}+\alpha S\Delta\mathbf{e}+S\Sigma\Delta w^l p^l\mathbf{c^l} \quad \text{(A12)}$$

From Eqs. (1A) and (1B) and Eq. (6) we have that:

$$p^l(\mu-r1-\mathbf{c}^l)=\Omega^{-1}(\mu-r\mathbf{1}-\mathbf{c}^l+\lambda^l)=\alpha x^l \quad \text{(A13)}$$

Substituting Eq. (A13) in Eq. (A12) gives:

$$(\hat{\mu}-\mu)=\delta K'(\mu-r\mathbf{1})-\delta S\Sigma w^l p^l K'(\mathbf{c}^l-\lambda^l)+\alpha\delta S\Sigma w^l p^l\Omega K\mathbf{x}^l+\alpha S\Delta e \quad \text{(A14)}$$

$$+S\Sigma\Delta w^{l}p^{l}\boldsymbol{c}^{l}$$

In the limit as δ tends to zero Eq. (A14) shows that the expected returns on existing assets are unchanged, justifying the assumption that the portfolio holdings of investors remain unchanged. The terms in Eq. (A14) may be interpreted as follows. The first is a weighted average of returns on existing equities that span the new project. The second takes into account the deadweight cost of channelling the investment through company i rather than the portfolio of existing companies that span the project. The third is caused by changes in betas due to the change in the market portfolio. The fourth is the effect of changed asset supply and the last is a wealth effect. Following Hamada (1969) we assume that the last three are negligible.

We can derive the required return on the marginal project by noting that:

$$\hat{\mu}_i=\mu_i(1-\delta)+\delta\hat{\mu}_{ik} \quad \text{(A15)}$$

where $\hat{\mu}_{ik}$ is the required return on the marginal project. This implies that:

$$\hat{\mu}_{ik}-\mu_i=(\hat{\mu}_i-\mu_i)/\delta \quad \text{(A16)}$$

Using Eq. (A14) and Eq. (A16) gives the required result.

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