DISCUSSION PAPER SERIES

No. 3062

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FINANCIAL ECONOMICS

Centre for Economic Policy Research

www.cepr.org

Available online at: www.cepr.org/pubs/dpsDP3062.asp

ISSN 0265-8003

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Discussion Paper No. 3062
November 2001

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CEPR Discussion Paper No. 3062

November 2001

ABSTRACT

The Cost of Capital in International Financial Markets: Local or Global*

This Paper analyses to what extent international and domestic asset pricing models lead to different estimates of the cost of capital for an individual firm. We distinguish between (i) the multifactor ICAPM of Solnik (1983) and Sercu (1980) including both the global market portfolio and exchange rate risk premiums, and (ii) the single factor domestic CAPM. We test for the significance of the cost of capital differential in a sample of 3,293 stocks from nine countries in the period 1980–99. We find that the domestic CAPM yields a different estimate of the cost of capital from the multifactor ICAPM for only 3% of the firms in our sample. The difference amounts to on average 50 basis points for the US, 75 basis points for Germany and Japan and similar differentials for the other countries. We attribute these findings to strong country factors in individual stock returns.

JEL Classification: F31, G15 and G30
Keywords: cost of capital, exchange rate exposure, ICAPM and pricing error

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* We thank Geert Bekaert, Frans de Roon, Casper de Vries, Bernard Dumas, Alex Lammertsma, Piet Sercu, René Stulz, Jean-Pierre Urbain, Tom Vinaimont and seminar participants at Indiana University (Bloomington), Washington University (St. Louis), Catholic University of Louvain (Belgium), University of Amsterdam, the Federal Reserve Bank of St. Louis, the 1999 Econometric Society European Meeting at Santiago de Compostela, the 1999 European Finance Association Meetings in Helsinki, the 1999 CEPR meeting on capital markets in Louvain-la-Neuve and the 2000 American Finance Association Meetings in Boston for helpful discussion and comments on previous versions of this Paper. We are solely responsible for any remaining errors.

Submitted 23 October 2001

NON-TECHNICAL SUMMARY

1 Introduction

Theory suggests the use of an international CAPM (ICAPM) for computing a firm's cost of capital in a financially integrated world. In practice, however, a wide variety of asset pricing models is used to compute the cost of capital.[1] This may, among other things, be related to the fact that even though the ICAPM is theoretically preferable to the domestic CAPM, a firm's beta calculated using the domestic CAPM does not necessarily provide a worse estimate of the cost of capital. The two asset pricing models could lead to the same cost of capital if the local stock market portfolio contains all the information that is relevant in order to price domestic assets internationally.[2]

The purpose of this paper is to examine whether international and domestic asset pricing models really lead to a different estimate of the cost of capital. A partial answer is given by Stulz (1995b), who derives an expression for the difference in the estimation of a firm's beta when computed with the domestic CAPM as compared to the single factor ICAPM of Grauer, Litzenberger and Stehle (1976). Stulz refers to this difference as the pricing error, which is linearly related to the computed cost of capital differential. Stulz uses data on the Swiss multinational Nestlé and finds a substantial pricing error.

We generalize the analysis of Stulz in three ways. First, we employ the multifactor ICAPM of Solnik (1983) and Sercu (1980) including both the global market portfolio and exchange rate risk premiums.3 Second, we derive statistical tests for the significance of the pricing error. Third, we use data on 3,293 stocks from nine different countries to investigate the difference between each of these models empirically.[4] We analyze the sample period 1980:02-1999:06.

We find that the pricing error in terms of the cost of capital computed with either the

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[1] This is indicated by a recent survey by Keck, Levengood and Longfield (1998), which shows that practitioners often perform cost of capital computations in a way that is inconsistent with the theoretical foundations of international valuation.

[2] See Stulz (1998) for an overview of the literature on globalization, asset pricing and the cost of capital.

[3] In the benchmark ICAPM that Stulz (1995b) uses, exchange rate factors are omitted, since PPP is assumed to hold. However, evidence abounds that substantial PPP-deviations exist at a monthly horizon, see e.g. Abuaf and Jorion (1990) and Frankel and Rose (1995).

[4] Such wide coverage of firms and countries stands in contrast to most of the empirical literature, see for example Harvey (1991), Ferson and Harvey (1933) and Dumas and Solnik (1995).

domestic CAPM or the multifactor ICAPM of Solnik-Sercu is marginal. Only for about 3 percent of all firms in our sample the domestic CAPM yields a significantly different cost of capital than the multifactor ICAPM at the 95% confidence level. We show that the absolute difference in the cost of capital amounts to about 50 basis points for the US, about 75 basis points for Germany and Japan and similar amounts for the other countries in our sample. We tentatively argue that our findings may be attributed to strong country factors in the individual stock returns, consistent with the evidence of Heston and Rouwenhorst (1994).

Testing for a pricing error turns out to be very similar to testing for foreign exchange rate exposure. We show how both methodologies are related and how pricing error tests can shed light on the well-known puzzle that firms from a variety of data sets show little exposure to foreign exchange rate fluctuations.[5]

The paper is set up as follows. In section 2 we review the international CAPM and the domestic CAPM and derive testable hypotheses. In section 3 the data are described and summary statistics are discussed. Empirical results are presented in section 4. Section 5 explores the results using a variance decomposition technique. We elaborate on the link between the pricing error tests and the foreign exchange rate exposure literature in section 6. Summary and conclusions are presented in section 7.

2 The International CAPM and the Domestic CAPM

In this section we develop tests to evaluate whether the domestic CAPM yields a significantly different cost of capital than the multifactor ICAPM. The starting point for the rest of the paper is the Solnik-Sercu version of the multifactor ICAPM. In this model, the systematic risk factors are the global market portfolio and exchange rate factors.[6] Assume a world with $N + 1$ countries (currencies). The model can be expressed as

$$E[R_i] = r_0 + E[R_G - r_0]\, d_{i1} + E[S + r - \iota r_0]'\, d_{i2}\,, \tag{1}$$

where R_i and R_G are the return of asset i and the global market, respectively, expressed in the

[5] See Jorion (1990), Amihud (1994), Bodnar and Gentry (1993), Bartov and Bodnar (1994), and He and Ng (1998).

[6] Differences between the international asset pricing models of Solnik (1974, 1983), Grauer, Litzenberger and Stehle (1976), Sercu (1980), Stulz (1981), and Adler and Dumas (1983) mainly arise from different assumptions with respect to the role of exchange rate factors and inflation differentials. See Stulz (1995a) for an overview of the literature.

numeraire currency. As the numeraire currency we choose the home currency *0* of asset *i*. *S* represents the vector of nominal exchange rate returns of the other l = 1, ..., *N* countries against currency *0*. The vector *r* denotes the nominal returns on the risk-free asset in country l (l = 1, ..., *N*). r_0 is the risk-free rate in the numeraire (home) country. For a derivation of equation (1) we refer to Sercu and Uppal (1995). The beta's are defined as d_{i1} and d_{i2} and can be estimated from the multiple regression

$$R_i = \alpha_{1i} + Z^{/} d_i + u_i = \alpha_{1i} + R_G\, d_{i1} + S^{/} d_{i2} + u_i\,, \tag{2}$$

where $Z^{/} = [R_G, S^{/}]$ and $\alpha_{1i} = r_0(1 - d_{i1}) + (r - \imath r_0)^{/} d_{i2}$ is taken as a constant. Under the maintained hypothesis that the ICAPM holds, *Z* is orthogonal to u_i.

We assume that the sensitivities d_i with respect to the global factors are constant over time. The risk premiums on the global market and the currency factors may be time varying though.[7] Our empirical tests will be formulated in terms of hypotheses on the factor loadings d_i for individual stocks relative to the global factors.

We follow Stulz (1995b) and consider the domestic CAPM as an alternative model

$$E[R_i] = r_0 + E[R_L - r_0]b_i\,, \tag{3}$$

where R_L is the return of the local market index expressed in the numeraire currency *0*. The beta of the CAPM can be estimated in the regression

$$R_i = \alpha_{2i} + R_L\, b_i + e_i\,, \tag{4}$$

The domestic CAPM posits a different decomposition into systematic and specific risk than the ICAPM. In order to compare the two models, we need to relate R_L to the global factors *Z*. To this purpose, we apply equation (2) to R_L and get

$$R_L = \alpha_L + Z^{/} d_L + u_L\,, \tag{5}$$

where u_L is orthogonal to *Z*. Substituting equation (5) into (4) yields

$$R_i = \alpha_{3i} + Z^{/} d_L\, b_i + u_L\, b_i + e_i\,, \tag{6}$$

where $\alpha_{3i} = \alpha_{2i} + b_i\alpha_L$. Equations (2) and (6) lead to the same decomposition of systematic and

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[7] See for example Dumas and Solnik (1995).

specific risk if the local specific risk e_i in equation (4) is orthogonal to Z. In that case, the composite specific risk term $u_L b_i + e_i$ is orthogonal to Z and equations (2) and (6) are identical. But then the parameters in equations (2) and (6) must be the same too, implying

$$d_i = d_L\, b_i \,. \tag{7}$$

If the restrictions in equation (7) hold, no pricing error results from using the domestic CAPM instead of the ICAPM.[8] A simple test of the pricing error restrictions is to run the augmented regression

$$R_i = \alpha_{4i} + R_L\ \beta_i + Z^{/}\delta_i + \zeta_i \ . \tag{8}$$

Under H_0: $\delta_i = 0$, we can see that $\alpha_{4i} = \alpha_{2i}$, $\beta_i = b_i$, and $\zeta_i = e_i$. The test for the null-hypothesis $\delta_i = 0$ is called the 'Pricing Error' test. It tests the orthogonality between the global factors and the residuals from the domestic CAPM regression (4). If the restriction holds, the risk that is diversifiable domestically is also diversifiable globally. Consequently, the domestic market portfolio contains all the information that is relevant to price assets. On the other hand, if risk that is diversifiable domestically contains risk that is systematic in the world market, the domestic CAPM incorrectly ignores such risk. The ICAPM will require a risk premium, however. In that case, the domestic CAPM leads to a different cost of capital than the ICAPM.

If exchange rate risk is not priced, the results from the Pricing Error test may overstate the pricing error.[9] If rejection occurs because of violation of the exchange rate restrictions $d_{i2} = d_{L2} b_i$, the impact on the estimated cost of capital will nevertheless be zero if required foreign exchange risk premiums $E[S + r - \iota\, r_0]$ are zero. Therefore, whether only the first restriction in equation (7) is rejected within the framework of the multifactor ICAPM is of interest under the assumption that exchange rate risk premiums are zero. In appendix A we show that the pricing error vector $p_i = d_L b_i - d_i$ can be expressed as a linear combination of the parameter δ_i in equation (8)

$$p_i = \left(\mathrm{I} + \frac{d_L d_L^{/}\Omega}{\sigma_L^2} \right)^{-1} \delta_i = \Lambda \delta_i \ , \tag{9}$$

where Ω is the covariance matrix of Z and σ_L^{2} is the variance of residuals u_L in equation (5). We test the null-hypothesis that the first element of p_i is equal to zero. We call this the 'Global Beta'

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8 We assume that the parameter restriction $\alpha_{1i} = \alpha_{2i} + b_i\alpha_L$ holds.

9 For an overview of the literature on exchange rate risk we refer to Dumas and Solnik (1995) and Engel (1996).

test. If the null-hypothesis is rejected, the direct ICAPM beta d_{i1} will differ significantly from the indirect beta $d_{L1}\, b_i$. Table 1 presents a brief summary of the hypotheses underlying the different tests.

3 Data

In the empirical analysis we use monthly data for nine industrialized countries: Australia, Canada, France, Germany, Japan, the Netherlands, Switzerland, United Kingdom, and the United States. Nominal exchange rates for all countries are taken from the International Financial Statistics (IFS) tape (line ae). In the empirical application we consider the period 1980:02-1999:06.

The market weighted local equity indices and the market weighted global market index are from Morgan Stanley Capital International (MSCI). Table 2 shows that the nine countries jointly account for approximately 91 percent of the MSCI market-weighted world index in July 1994. Australia, Canada, France, Germany, the Netherlands and Switzerland are each less than 4 percent of the MSCI market-weighted world index. The United States take approximately 36 percent of the index.

Data on individual stocks in this study are obtained from Datastream. We have downloaded stock prices, dividend yields and dividends of firms that are included in the Datastream equity lists. If dividends are unavailable, the dividend yield is used. If neither dividend data nor dividend yields are available, the stock is excluded from the sample. We also exclude stocks that have not been continuously listed over the whole period and stocks that are denominated in a currency different from the local currency of the country where they are listed. Furthermore, the data are filtered for data errors; stocks with outlier observations are excluded from the sample.[10]

The second column of Table 2 reports the number of stocks included for each country after the selection procedures. The total sample consists of 3,293 stocks with a complete series of returns for the period 1980:02-1999:06. The third column of Table 2 shows the weight of each country in our world sample. The weight is computed by dividing the number of stocks in the

[10] These are stocks with average annual returns larger than 200%, stocks with a local beta smaller than 0.1, and infrequently traded stocks which have a zero return for more than twenty percent of the observations.

country by the total number of stocks in the sample. Columns five and six of Table 2 show the number of stocks in our sample for two subperiods, 1980:02-1989:12 and 1990:01-1999:06.[11]

4 Empirical Results

In this section we discuss the main results we have obtained by applying the testing methodology introduced in section 2 to the sample of 3,293 stocks. Throughout, we assume that the MSCI world and local indexes are good proxies for the global and local market portfolios respectively. We apply the Pricing Error and Global Beta tests as discussed in section 2 to each individual firm in order to assess the magnitude and significance of the pricing error made by the domestic CAPM as compared to the multifactor ICAPM. A summary of the test results is reported country-wise in Table 3 for the full sample period. All tests in this paper are robust to heteroskedasticity.

Column 1 of Table 3 presents the rejection percentage of the Pricing Error test per country. That is, this column shows the percentage of stocks per country for which the CAPM yields a significant cost of capital differential with 95% confidence compared to the ICAPM. The hypothesis of a zero pricing error is rejected very infrequently for each country. The highest rejection percentage is 3.70 percent for Australia, while the lowest is 1.55 percent for Switzerland. For the total sample of 3,293 firms, the Pricing Error test rejects in only 3.1 percent of the cases.

The second column of Table 3 shows the rejection percentage of the Global Beta test per country. This test evaluates the significance of the first element of the pricing error vector $d_L b_i - d_i$. The total percentage of firms for which this hypothesis is rejected is 2.95 percent (97 firms). Individual countries such as Australia, the UK and the US show even lower percentages.

The evidence from Table 3 indicates that the domestic CAPM generally does not lead to a significantly different cost of capital than the multifactor ICAPM. On average, rejection of the null-hypothesis that this differential is equal to zero only occurs for about 3 percent of the firms in our sample. That is, the risk of a firm in our sample that is diversifiable locally does very rarely contain any additional systematic risk in the global market.

Figures 1 through 9 contain additional information on the pricing error tests for each

[11] Estimation results for subperiods are qualitatively similar. They are not reported in this paper but are available from the authors on request.

country. The figures provide a scatter plot of each firm's 'direct beta' versus its 'indirect beta'. The direct beta is the firm's multifactor ICAPM beta d_{i1}, while the indirect estimate of a firm's global beta can be calculated by multiplying the global beta of the local market as represented by the first element of the vector d_L and the firm's CAPM beta b_i. Summary statistics for the difference between the direct and the indirect beta are provided below the scatter plot. For each country, the dots in the graph are centered around the line with a slope of unity.[12] For firms on this line, the estimated cost of capital is invariant to the use of the CAPM or ICAPM, if exchange rate risk is not priced. Firms that plot below the line have a higher cost of capital using the ICAPM than using the CAPM. The difference reflects a premium for risks that are diversifiable locally but not internationally. On the other hand, firms that lie above the line have a lower cost of capital according to the ICAPM as compared to the CAPM, suggesting the presence of non-diversifiable local risk that can be diversified internationally. Although for each country several firms plot off the straight line, the differences are generally very small. [13]

This is supported by the summary statistics. They show that the equally weighted average of the differences between the direct and the indirect betas is close to zero for all countries, as expected (see footnote 11). The absolute pricing error in terms of betas within each country is more interesting. This number varies from 0.076 (Germany and the US) to 0.123 (France) and is thus relatively small in beta terms. The (discrete) return on the global market portfolio over the sample period 1980-1999 was 15.2 percent annually when expressed in US dollars. Over the same period, the average one-month risk free rate was 7.8 percent, resulting in an excess market return of 7.4 percent. Consequently, the implied cost of capital difference between the two models amounts to 0.56 percent on average for US firms. [14] For Germany the excess return on

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[12] The value-weighted sum of the ICAPM betas equals unity. Also, each local market is priced correctly by the ICAPM, according to the internationally undiversifiable risks of that portfolio. By construction the market weighted average pricing error is equal to zero. This means that for an individual firm the CAPM and the ICAPM might give different cost of capital but on average, (value-weighted) domestic pricing provides the correct cost of capital. Note that the above characteristics only hold in a world where both local and global market indexes are measured perfectly including all individual stocks. In our empirical work, non-zero average pricing errors arise first because we do not use all stocks included in the local and global MSCI-indices, and second because we present equally weighted averages.

[13] If exchange rate risk is priced, differences in the estimated cost of capital may be larger because of differences in the directly and indirectly estimated coefficients on the exchange rate factors.

[14] In the absence of currency risk premia (and in the absence of deviations from the restriction $\alpha_{1i}=\alpha_{2i}+ b_i\alpha_L$) the difference $(d_Lb_i - d_i)E[R_G - r_0]$ would give an estimate of the cost of capital difference between the domestic and the international CAPM.

the global market in local currency equals 9.4 percent, yielding a pricing error in terms of cost of capital of 0.71 percent. For Japan the implied cost of capital differential is equal to 0.78 percent, while for France the difference is equal to 1.01 percent per year in local currency.

Figures 1 through 9 show that the pricing error in terms of beta is not only not statistically significant but also small in economic terms. Most firms plot close to the line with a slope of unity in the scatter plots. The summary statistics show that the average of the absolute differences between the betas estimated by the CAPM and the multifactor ICAPM is relatively small for all countries. In cost of capital terms, these differences generally amount to less than one percent.

5 Local, Global and Currency Factors: A Decomposition

This section further explores our finding that the pricing error is rarely statistically significant in our sample of almost 3,300 international stocks. We investigate how much of the risk that is specific from a local country perspective is systematic from a global perspective. For this we use a variance decomposition metric that allows for an assessment of the respective contributions of the local market, the global market and the vector of exchange rate changes to an individual asset *i's* return.

The decomposition starts from the domestic CAPM and investigates how much global market and currency factors add to the local market index as a measure of systematic risk. We consider the regression

$$R_i = \alpha_{5i} + R_L\, b_i + \eta_Z{}' h_i + \xi_i\,, \tag{10}$$

where η_Z represents the residual vector from regressing Z on R_L. This way the marginal contribution of the global factors to the explanatory power of the regression conditional on the local market contribution can be measured. Under the null hypothesis of a zero cost of capital differential, all the global risk factors are accounted for by the local market index. Equation (10) is a simple reparametrization of equation (8). However, equation (10) immediately yields the actual contribution of the global factors Z. Taking the variance of both the left and the right hand side of equation (10), the variance decomposition of stock i can be expressed as

$$\omega_i^2 = b_i^2\, \omega_L^2 + h_i' (\Omega - \frac{\Omega\, d_L\, d_L'\, \Omega}{\omega_L^2}) h_i + \sigma_i^2\,. \tag{11}$$

In equation (11) the total variance of stock i (denoted by ω_i^2) is decomposed into systematic local market risk (related to the variance ω_L^2 of the local market return), additional global risk in Z that is orthogonal to the local market (related to the covariance matrix Ω of Z) and specific risk σ_i^2. Note that the contribution of the global factors should be zero under the null hypothesis that the domestic CAPM does not yield a different cost of capital than the multifactor ICAPM. That is, the estimate of h_i must equal zero under the null hypothesis.

In Figure 10 the variance decomposition according to equation (11) is given for each country. From the graph, it is clear that the marginal contribution of Z across firms in one country is negligible on average. Obviously, the choice between domestic CAPM and the multifactor ICAPM does not matter a great deal for the computation of the cost of capital.[15] Our results provide support for the existence of important country effects in asset pricing, consistent with Heston and Rouwenhorst (1994) and de Ménil (1999), who show that the cross-section of returns and their variations across international equity markets are caused by large country-specific components, and not industrial structure.[16]

Figure 10 suggests that most firms within one country share a common exposure to international currency and stock market factors. Since such average exposure is captured in the international pricing of the local stock market index, this index in turn is a sufficient statistic against which to measure an individual firm's sensitivity to global factors. This means that even in integrated markets the pricing error is very small for most firms, because the local market factor can serve as a proxy for the omitted global factors in the domestic CAPM. The domestic CAPM induces a pricing error only for firms that have significantly deviating exposure from the local market. Further research is required to examine the issue which firm characteristics determine the deviating exposure of a firm relative to the local market.

6 Foreign Exchange Rate Exposure

In section 2 we showed that in general testing for a pricing error can be implemented by

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[15] The extent to which formal rejection of a pricing error is possible, can be shown to depend on the overall explanatory power of the ICAPM. In other words, the power of the test depends on the performance of the model. Unreported results are available from the authors to illustrate this point.

[16] Along similar lines, Froot and Dabora (1999) find that the location of stock listing matters for pricing. Our results are also in line with Errunza, Hogan and Hung (1999) who find that gains from international asset diversification beyond domestic diversification are statistically and economically insignificant.

examining the statistical significance of a set of instrumental variables in a time series regression of the stock return of an individual firm on an intercept and the domestic market return (see equation (8)). These pricing error tests are very similar to the well-known tests for exchange rate exposure. In this section we perform several exchange rate exposure tests and show that the results of section 5 can shed light on the well-known puzzle that companies show hardly any exposure to foreign exchange rate fluctuations

Adler and Dumas (1984) define foreign exchange rate exposure as the impact of exchange rate movements on the value of a firm. Recent papers in the field, e.g. Jorion (1990), Bartov and Bodnar (1994), and He and Ng (1998) test for currency exposure of individual companies using a version of the time-series regression

$$R_i = \gamma_{0i} + R_L\, \gamma_{1i} + f(S)^{/}\, \gamma_{2i} + \varepsilon_i\,, \tag{12}$$

where $f(S)$ is a function of the nominal exchange rate returns expressed in the home currency of firm i. The null-hypothesis of the test for currency exposure can be formulated as H_0: $\gamma_{2i} = 0$. This test can also be interpreted as a pricing error test as it analyzes whether any systematic (currency) risk can be filtered out from the risk of a firm that is diversifiable domestically.

Several versions of regression (12) have been used in the literature. Most studies use a trade-weighted exchange rate index for $f(S)$. An alternative would be to define $f(\cdot)$ to be a linear projection. In this paper the latter test is called the ‘Exposure’ test. It uses a subset of the orthogonality conditions in equation (8). A brief description of the Exposure test is presented in Table 1.

We suspect that foreign currency exposure as estimated in equation (12) may (in part) be captured by the domestic market factor. In order to control for this effect we also run the alternative regression

$$R_i = c_{0i} + S^{/}\, c_{1i} + \eta_G\, c_{2i} + \eta_L\, c_{3i} + \nu_i\,, \tag{13}$$

where η_G is the residual vector from regressing R_G on an intercept and S. Similarly, η_L is the residual vector from regressing R_L on an intercept, R_G and S. By orthogonalizing R_L, we want to accomplish that the coefficient on S does not merely reflect the deviating exposure of firm i from the average currency exposure of all firms in the country. The test of $c_{1i} = 0$ is called the ‘Total Exposure’ test.

An alternative way to estimate foreign exchange rate exposure is in a regression of a stock return on the global market return and foreign exchange rate returns. It is unlikely that most of the joint currency exposure would also be captured by the global stock market, which contains a much more diverse population of firms. The appropriate regression to run is the following

$$R_i = \alpha_{1i} + R_G\, d_{i1} + S^{/} d_{i2} + u_i \qquad (14)$$

Note that equation (14) is the same as equation (2). This regression looks for significant 'Currency Beta's'. A short description of the hypotheses underlying the Total Exposure and the Currency Beta's tests is presented in Table 1.

The first column of Table 4 depicts the percentage of firms in each individual country for which the null-hypothesis of no currency exposure in regression (12) is rejected at the 5% confidence level. Several recent studies, e.g. Bartov and Bodnar (1994), and He and Ng (1998) report results that are consistent with the exchange rate exposure puzzle. Consistent with the literature we find that significant exposure exists on average for about 10 percent of the firms in our sample. As mentioned in section 5 the variance decomposition in Figure 10 shows that most firms within a country have a joint exposure to the global market and foreign exchange rates. Therefore, the evidence in column 1 of Table 4 does not necessarily imply that the value of a firm is not affected by changes in exchange rates. The exposure may at least partly be captured by the domestic market factor

The rejection percentages for the Total Exposure test as depicted in column 2 of Table 4 are considerably higher than those of the Exposure test. On average about 40 percent of the firms exhibit significant currency exposure. The highest rejection percentage is 68.52 percent for Australia, while the lowest is 30.45 percent for the UK. The results for the Currency Beta's test are very similar to these findings. This corroborates our results.

7 Conclusions

Theory suggests the use of an international CAPM for cost of capital calculations in an integrated world. This does not imply that the domestic CAPM does not provide an adequate estimate of a firm's cost of capital. In this paper, we examine to what extent international and domestic asset pricing models yield a different cost of capital for a sample of monthly data for 3,293 firms from nine major industrialized countries from 1980 to 1999. We distinguish between: (i) the multifactor ICAPM of Solnik-Sercu including both the global market portfolio and exchange rate risk premiums, and (ii) the single factor domestic CAPM. Our analysis allows for an assessment of what is important in cost of capital computations and what is not.

We find that difference in the cost of capital computed with the domestic CAPM and the multifactor ICAPM is significant at the 95% confidence level for only about 3 percent of the firms in our sample. For virtually all firms in our sample the risk that is diversifiable locally is also fully diversifiable in the global market. In a variance decomposition analysis we subsequently evaluate whether the domestic market, the global market, and the exchange rate factors can explain the variance of historical stock returns. We show that the marginal contribution of all global factors is very limited, which indicates strong country factors in our data. Firms within a country demonstrate a joint exposure to the global factors, which is captured in the international pricing of the domestic market index.

We show that the tests for a pricing error we developed are very similar to the tests used in the exchange rate exposure literature. The latter use a slightly different set of instrumental variables for finding additional risk factors in the unique risk of a firm as measured by the domestic CAPM. We were thus able to borrow the testing methodology in this paper from several recent studies in this literature. Our evidence on currency exposure is consistent with the findings in the literature that only a limited number of firms exhibit exchange rate exposure. As suggested above, however, at least part of the foreign exchange rate exposure of a firm may be absorbed by the domestic market index. If we correct for this effect the results are much stronger indeed. Currency exposure is significant for around 40% of the companies in our sample.

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Appendix A

In this appendix we show that the pricing error of the CAPM as compared to the multifactor ICAPM of Solnik-Sercu can be expressed as a linear combination of the parameter δ_i in the regression

$$R_i = \alpha_{4i} + R_L\, \beta_i + Z'\delta_i + \zeta_i\,. \tag{A1}$$

The moment conditions of equation (A1) can be written as

$$\begin{pmatrix} \omega_L^2 & d_L'\Omega \\ \Omega d_L & \Omega \end{pmatrix}\begin{pmatrix} \beta_i \\ \delta_i \end{pmatrix} = \begin{pmatrix} \omega_L^2 b_i \\ \Omega d_i \end{pmatrix}, \tag{A2}$$

where Ω is the $(N+1)\times(N+1)$ covariance matrix of Z, ω_L^2 is the variance of R_L, and d_L is the covariance between Z and R_L. Solving for δ_i from the second line of (A2) we get

$$\delta_i = d_i - d_L \beta_i\,. \tag{A3}$$

Substituting this expression into the first line of equation (A2) gives

$$\beta_i = \frac{\omega_L^2 b_i - d_L'\Omega d_i}{\omega_L^2 - d_L'\Omega d_L} = b_i - \frac{d_L'\Omega p_i}{\sigma_L^2}\,, \tag{A4}$$

where $p_i = d_L b_i - d_i$ is the pricing error and σ_L^2 is the variance of residuals u_L in equation (5). Substituting this expression for β_i back into equation (A3) yields

$$\delta_i = \left(\mathrm{I} + \frac{d_L d_L'\Omega}{\sigma_L^2} \right) p_i\,. \tag{A5}$$

Equation (A5) can be rewritten as

$$p_i = \left(\mathrm{I} + \frac{d_L d_L'\Omega}{\sigma_L^2} \right)^{-1} \delta_i\,. \tag{A6}$$

Note that d_L, Ω, and σ_L^2 are unrelated to asset i and are treated as exogenous.

Figure 1

Australia: the cross-section of alternative beta estimates

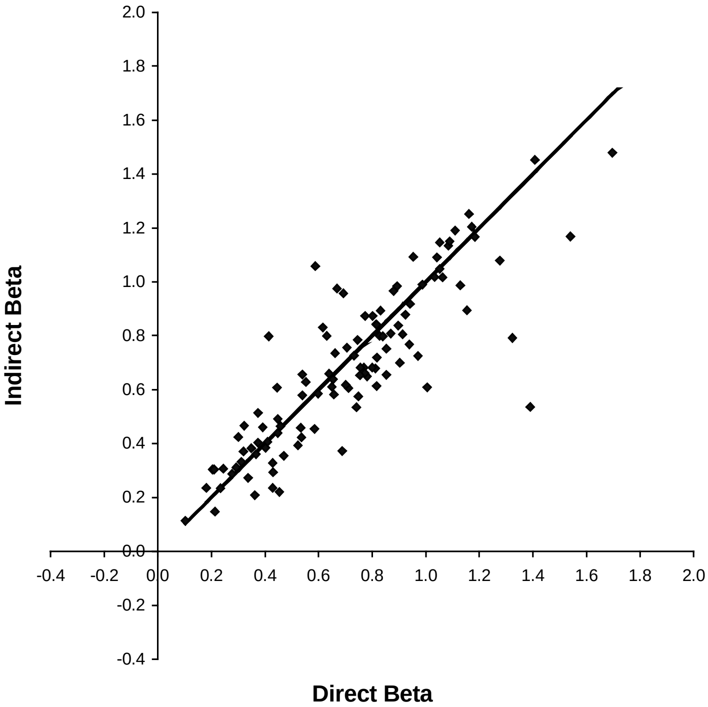
This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 108 companies. Direct betas are obtained from the multifactor ICAPM and are equal to the OLS estimate of d_{i1} in the regression

$$R_i = \alpha_{1i} + R_G\, d_{i1} + S^{/} d_{i2} + u_i \,.$$

Indirect betas are calculated as the product of b_i from the domestic CAPM ($R_i = \alpha_{2i} + R_L b_i + e_i$) and the estimate of d_{L1} of the domestic market portfolio priced with the multifactor ICAPM,

$$R_L = \alpha_L + R_G d_{L1} + S^{/} d_{L2} + u_L \,.$$

The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all Australian firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06. Data on domestic and global market indices are obtained from MSCI. Nominal exchange rates are taken from the International Financial Statistics (IFS) tape. Data on individual stocks are obtained from the Datastream equity lists. Stocks with incomplete price or dividend data, stocks with outlier observations and illiquid stocks have been removed from the dataset.



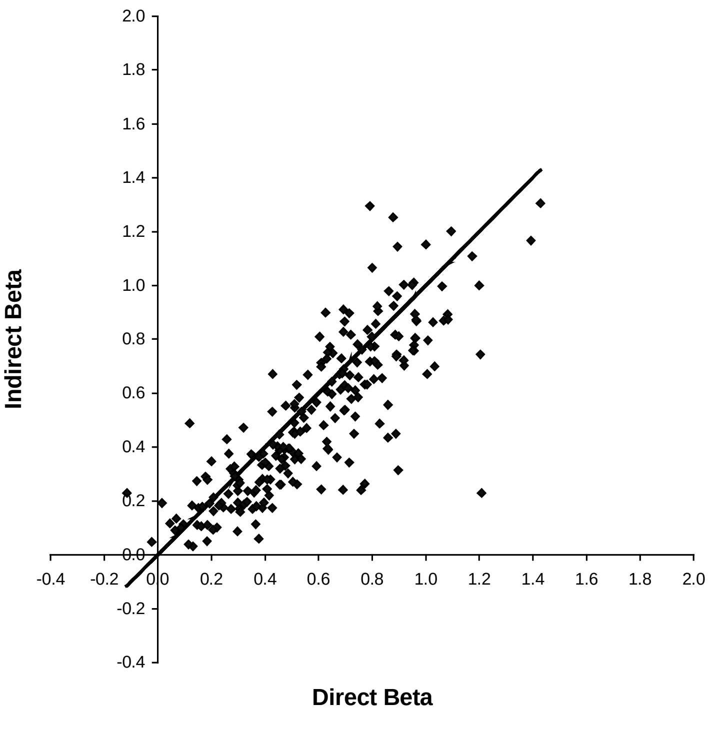
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.009	0.115	0.159	-0.490	0.693

Figure 2

Canada: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 219 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all Canadian firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



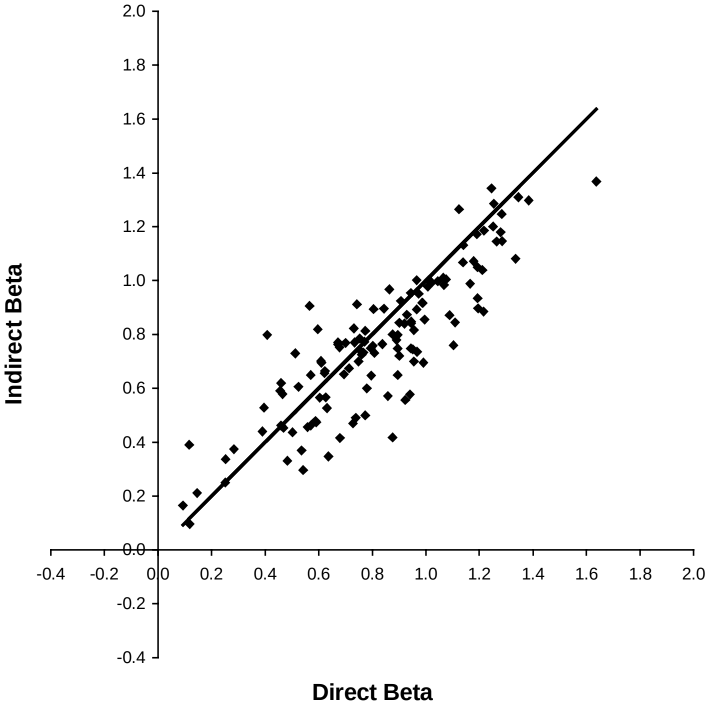
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.038	0.121	0.155	-0.617	0.492

Figure 3

France: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 127 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all French firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



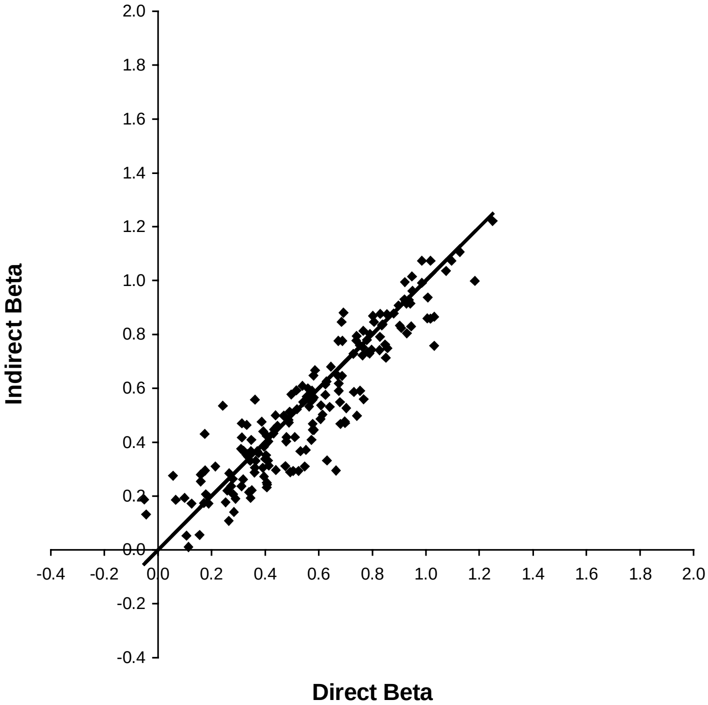
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.038	0.123	0.149	-0.384	0.512

Figure 4

Germany: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the ‘direct’ (x-axis) versus the ‘indirect’ beta (y-axis) for 178 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all German firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



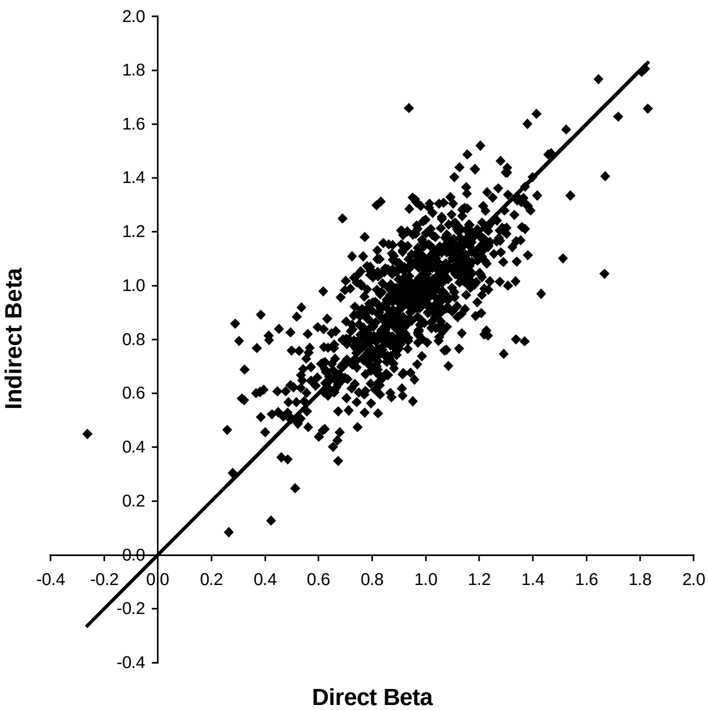
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.013	0.076	0.099	-0.303	0.307

Figure 5

Japan: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the ‘direct’ (x-axis) versus the ‘indirect’ beta (y-axis) for 829 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all Japanese firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



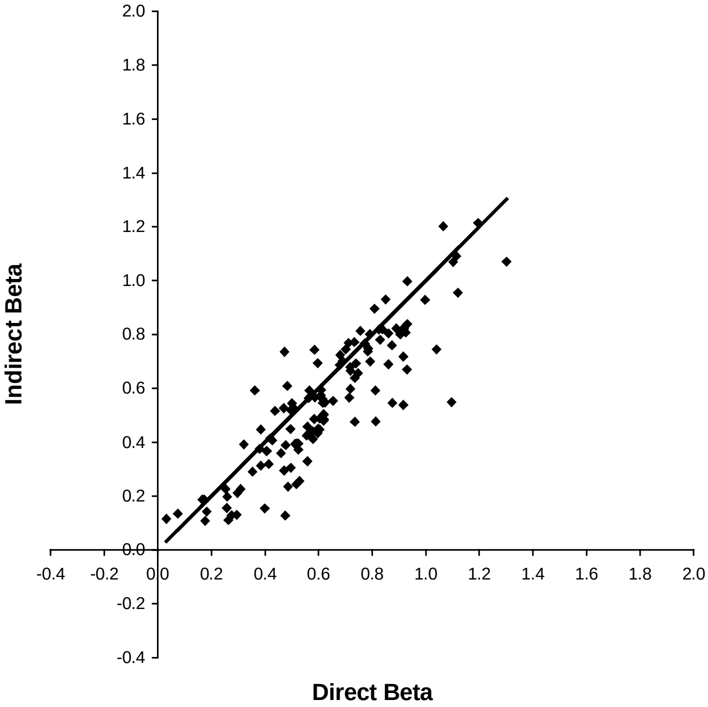
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	-0.020	0.118	0.156	-0.865	0.497

Figure 6

The Netherlands: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 123 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all Dutch firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.

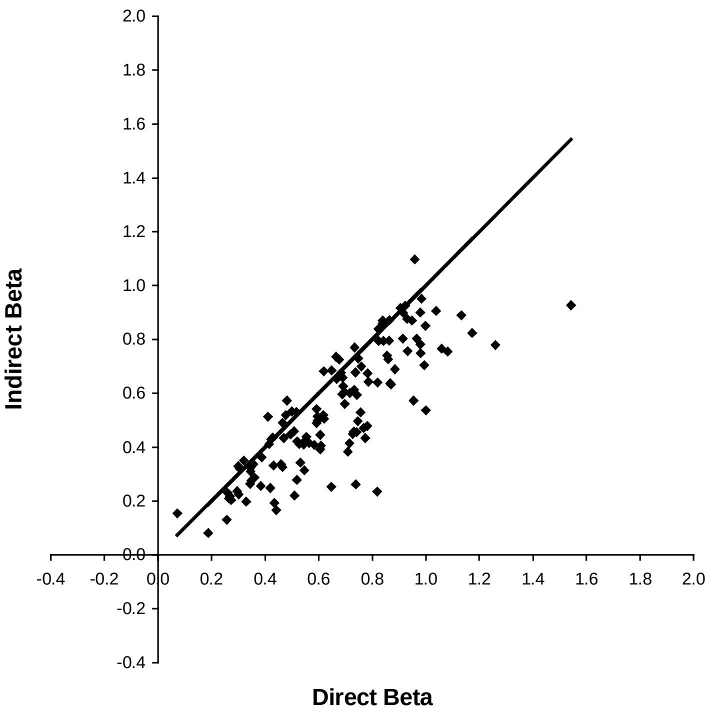


Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.056	0.096	0.110	-0.278	0.435

Figure 7
Switzerland: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 129 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all Swiss firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



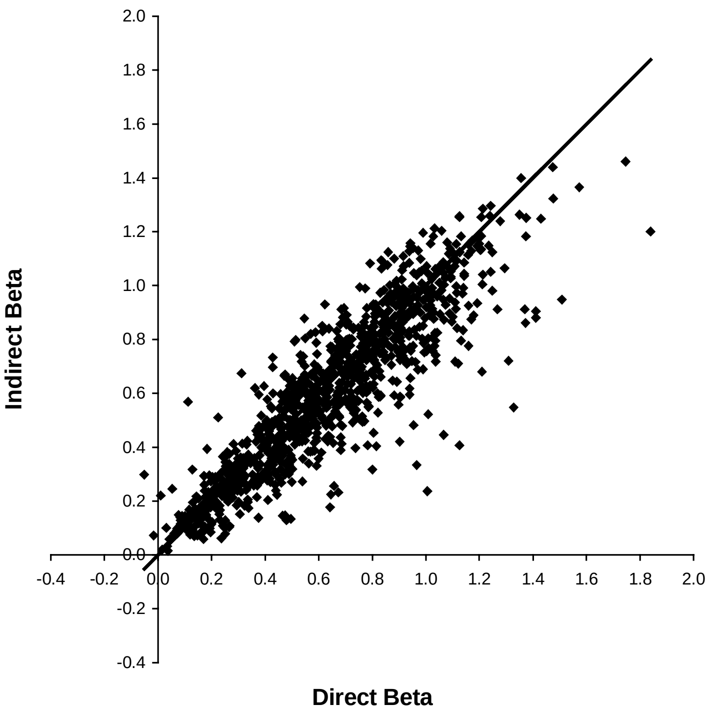
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.079	0.104	0.109	-0.160	0.420

Figure 8

United Kingdom: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the ‘direct’ (x-axis) versus the ‘indirect’ beta (y-axis) for 1,051 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all UK firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



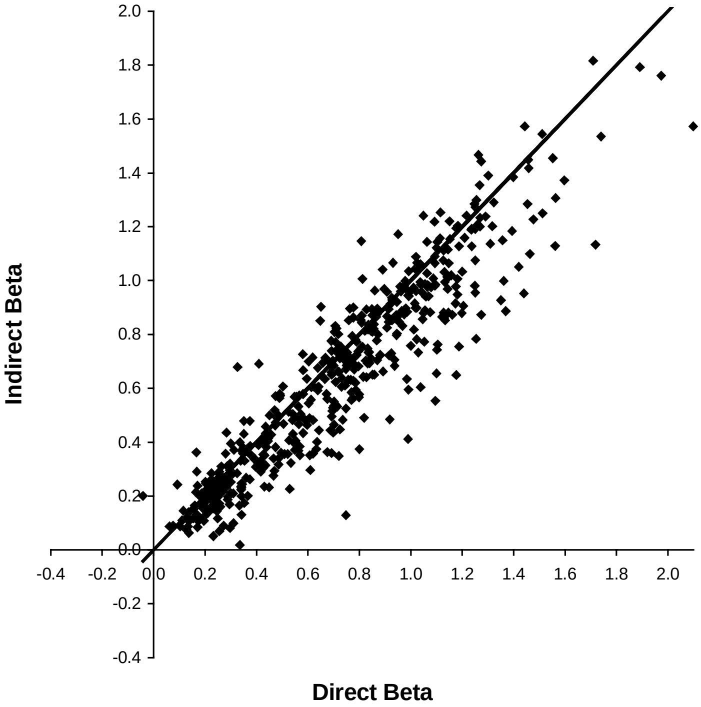
Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.003	0.090	0.122	-0.549	0.644

Figure 9

United States: the cross-section of alternative beta estimates

This figure depicts a scatter plot of the 'direct' (x-axis) versus the 'indirect' beta (y-axis) for 529 companies. Direct and indirect beta estimates can be estimated as described in Figure 1. The line in the graph reflects the 45° line. The table at the bottom of the page shows summary statistics of the difference between the direct and the indirect beta of all US firms. The columns present the mean, the mean of the absolute value, the standard deviation, the minimum and the maximum value of the beta errors, respectively. The sample period is 1980:02-1999:06.



Summary statistics

	Mean	Abs	StDv	Min	Max
Beta Error	0.037	0.076	0.105	-0.454	0.475

Figure 10

Average pricing error decomposition

This figure presents the variance decomposition desccribed in section 5. The general idea behind this decomposition is that the orthogonalized global market factor and the currency risk factors are added to the CAPM regression

$$Z = a + R_L\theta + \eta_Z$$
$$R_i = \alpha_{5i} + R_L\, b_i + \eta_Z{}' h_i + \xi_i\,.$$

The variance of firm *i* can then be expressed as

$$\omega_i^2 = b_i^2\, \omega_L^2 + h_i^{\prime}\,(\Omega - \frac{\Omega\, d_L\, d_L^{\prime}\, \Omega}{\omega_L^2})\, h_i + \sigma_i^2\,.$$

In this equation the total variance of stock *i* (denoted by ω_i^2) is decomposed into systematic local market risk (related to the variance ω_L^2 of the local market return), additional global risk in *Z* that is orthogonal to the local market (related to the covariance matrix Ω of *Z*) and specific risk σ_i^2. With this metric we are able to estimate to what extent the global market and the exchange rate risk factors add explanatory power to the domestic CAPM. Under the null-hypothesiss of no pricing error the global factors should have no contribution to the total variance. The variance decomposition for a country is equal to the weighted average of all decompositions of individual firms in that country with $(1/\sigma_i^2)/(\Sigma 1/\sigma_i^2)$ as weights. The sample period is 1980:02-1999:06.

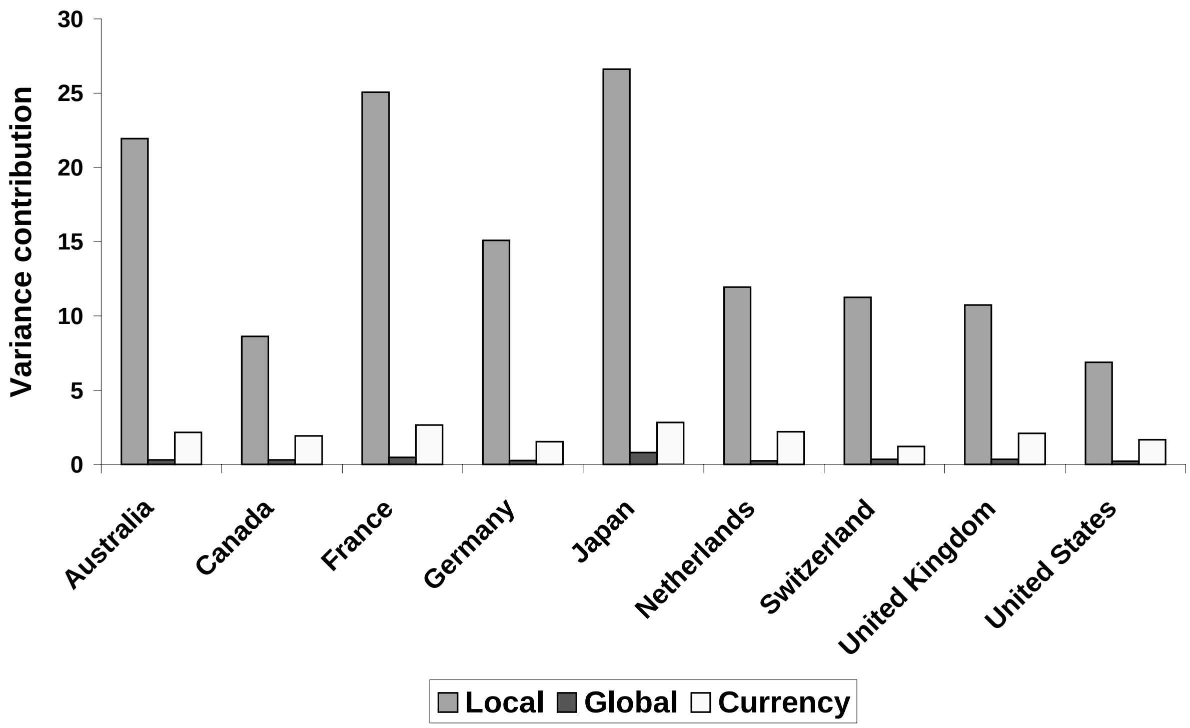


Table 1

Summary of null-hypotheses, purposes and underlying model structures of the test statistics

Test	Regression Model	H_0	Issue
Pricing Error	$R_i = \alpha_{4i} + R_L\,\beta_i + Z^{/}\delta_i + \zeta_i$	$\delta_i = 0$	pricing error of domestic CAPM vs. ICAPM
Global Beta	$R_i = \alpha_{4i} + R_L\,\beta_i + Z^{/}\delta_i + \zeta_i$	1st element of $\Lambda\delta_i = 0$	beta error of domestic CAPM vs. ICAPM
Exposure	$R_i = \gamma_{0i} + R_L\,\gamma_{1i} + S^{/}\gamma_{2i} + \varepsilon_i$	$\gamma_{2i} = 0$	e.r. exposure controlled for local market return
Total Exposure	$R_G = c_1 + S^{/} f_{GS} + \eta_G$ $R_L = c_2 + R_G\, f_{LG} + S^{/} f_{LS} + \eta_L$ $R_i = c_{0i} + S^{/} c_{1i} + \eta_G\, c_{2i} + \eta_L\, c_{3i} + v_i$	$c_{1i} = 0$	e.r. exposure controlled for orthogonalized local and global market return
Currency Beta's	$R_i = \alpha_{1i} + R_G\, d_{i1} + S^{/} d_{i2} + u_i$	$d_{i2} = 0$	e.r. exposure controlled for global market return

Table 2

Composition of MSCI index and sample

This table presents an overview of the composition of the MSCI World index on July 29, 1994 (source: Morgan Stanley Capital International Perspective Third Quarter 1994) and of the composition of our sample of individual stocks. The sample period is 1980:02-1999:06. The first subsample consists of the period 1980:02-1989:12. The second subsample is the period 1990:01-1999:06. Data on domestic and global market indices are obtained from MSCI.

Country	weight in MSCI world index	# stocks in sample	weight in sample	# stocks in 1st subsample	# stocks in 2nd subsample
Australia	2.3	108	3.3	118	244
Canada	2.2	219	6.7	231	345
France	3.7	127	3.9	130	500
Germany	3.8	178	5.4	181	432
Japan	28.7	829	25.2	734	1,755
Netherlands	2.1	123	3.7	126	160
Switzerland	2.7	129	3.9	136	264
United	9.4	1,051	31.9	1,118	1,245
United States	35.6	529	16.1	557	749
Total	90.5	3,293	100	3,331	5,694

Table 3

Pricing error test results

This table contains the rejection frequencies for two tests for each of the nine countries in our sample. The Pricing Error Test tests whether a pricing error exists between the domestic CAPM and the multifactor ICAPM. The Global Beta Test is similar to the Pricing Error Test but focusses on the beta error of the domestic CAPM versus the multifactor ICAPM. All tests are Chi-squared distributed and robust to heteroskedasticity. Rejection frequencies are defined as the percentage of firms in a country for which the null-hypothesis is rejected at the 5% significance level. 'Average' depicts a weighted average of the percentages of firms in each individual country for which the null-hypothesis is rejected. The weights of the rejection frequencies are the weights of each country in the sample as shown in the third column of Table 3. The sample period is 1980:02-1999:06. Data on domestic and global market indices are obtained from MSCI. Data on individual stocks are obtained from the Datastream equity lists. Nominal exchange rates are taken from the International Financial Statistics (IFS) tape. Stocks with incomplete price or dividend data, stocks with outlier observation and illiquid stocks have been removed from the dataset.

Country	Pricing Error Test percentage rejections	Global Beta Test percentage rejections
Australia	3.70	1.85
Canada	2.74	6.85
France	3.15	4.72
Germany	2.81	2.25
Japan	3.50	3.98
Netherlands	1.63	4.88
Switzerland	1.55	0.78
United Kingdom	3.05	1.43
United States	3.40	2.84
Average	3.10	2.95

Table 4

Foreign exchange rate exposure tests

This table presents rejection frequencies for three tests for each of the nine countries in our sample. The Exposure Test tests for foreign exchange rate exposure of individual stocks when controlled for the local market index. The Total Exposure Test tests for exchange rate exposure when controlled for fluctuations in the local market index that are orthogonal to all exchange rates. The Currency Beta's Test tests for exposure of individual firms when the global market return is included in the regression. All tests are Chi-squared distributed and robust to heteroskedasticity. Rejection frequencies are defined as the percentage of firms in a country for which the null-hypothesis is rejected at the 5% significance level. 'Average' depicts a weighted average of the percentages of firms in each individual country for which the null-hypothesis is rejected. The weights of the rejection frequencies are the weights of each country in the sample as shown in the third column of Table 2. The sample period is 1980:02-1999:06. Data on domestic and global market indices are obtained from MSCI. Data on individual stocks are obtained from the Datastream equity lists. Nominal exchange rates are taken from the International Financial Statistics (IFS) tape. Stocks with incomplete price or dividend data, stocks with outlier observation and illiquid stocks have been removed from the dataset.

Country	Exposure Test percentage rejections	Total Exposure Test percentage rejections	Currency Beta's Test percentage rejections
Australia	10.19	68.52	68.52
Canada	8.22	42.01	42.01
France	13.39	44.88	42.52
Germany	15.73	44.94	35.96
Japan	12.55	45.96	67.55
Netherlands	13.82	47.97	15.45
Switzerland	5.43	51.16	27.13
United Kingdom	7.90	30.45	21.69
United States	11.72	33.27	32.51
Average	10.55	39.63	39.42