Testing international asset pricing models using implied costs of capital

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Abstract

This paper tests international asset pricing models using firm-level expected returns estimated from an implied cost of capital approach. We show that the implied approach provides clear evidence of economic relations that would otherwise be obscured by the noise in realized returns. Among G-7 countries, expected returns based on implied costs of capital have less than one-tenth the volatility of those based on realized returns. Our tests show that firm-level expected returns increase with world market beta, idiosyncratic volatility, financial leverage, and book-to-market ratios, and decrease with currency beta and firm size.

I. Introduction

Empirical asset pricing is plagued by a major problem: the fact that realized returns are extremely noisy proxies of expected returns.[1] This problem is exacerbated in international settings, where data availability often limits the time period of examination. As a result, financial researchers testing international asset pricing models face the risk that, during the time period of investigation, economically significant relations can be rendered statistically insignificant by the noise in realized returns.

The international asset pricing literature has traditionally dealt with this problem by focusing on the right hand side of the asset pricing equation – e.g., by introducing conditional asset pricing models, or more sophisticated econometric specifications of factor risk premia and factor loadings.[2] In this paper, we re-examine the left hand side of the asset pricing equation, and use an approach based on the implied cost of capital to estimate expected returns for the firms in G-7 countries (Canada, France, Germany, Italy, Japan, the U.K., and the U.S.).[3]

The implied cost of capital approach estimates firm-level expected return as the internal rate of return that equates the current stock price to the present value of forecasted free cash flows to equity holders. We use these expected return measures to test international asset pricing models, and to contrast the results with those based on realized returns. The key objectives of our paper are (a) to introduce the implied cost of capital approach to international asset pricing, and (b) to examine whether the implied approach leads to sharper inferences, particularly in economic relations that may be difficult to detect with realized returns.

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[1] See Elton (1999), Gebhardt, Lee, and Swaminathan (2001), and Pastor, Sinha, and Swaminathan (2007) for a more detailed discussion of the problem.

[2] For example, Merton (1980), Harvey (1991), Chan, Karolyi and Stulz (1992), Dumas and Solnik (1995), De Santis and Gerard (1998), Fama and French (1998), Ferson and Harvey (1993), Griffin (2002), and Hou, Karolyi, and Kho (2006). See the next section and Karolyi and Stulz (2003) for a more detailed discussion.

[3] Gebhardt, Lee, and Swaminathan (2001) use a similar approach to examine asset pricing models using the U.S. data. Pastor, Sinha, and Swaminathan (2007) use this approach to examine the inter-temporal asset pricing relationship between market-wide conditional expected returns and conditional volatility. Other papers that have used this approach include Claus and Thomas (2001), Fama and French (2002), Gode and Mohanram (2003), Easton (2004), Hail and Leuz (2006), Botosan and Plumlee (2005), and Ohlson and Juettner-Nauroth (2005). We discuss these studies in detail later in this paper.

To our knowledge, this is the first study to conduct formal international asset pricing tests using implied expected return estimates.[4] We show that expected returns based on implied costs of capital are much less noisy than those based on realized returns. In our sample, expected returns based on the implied approach have less than one-tenth of the volatility of the estimates computed using realized returns (see Table 1). Our main analyses exploit this feature of the implied expected return measures to test a number of international asset pricing models.

Opinions vary widely as to the "right" model for international asset pricing. One central issue is whether risks are priced locally or globally – i.e., whether local market returns should be included as a risk factor (see Karolyi and Stulz (2002) for a summary). Another point of contention is the existence of a currency risk factor. While many theoretical models (e.g., Solnik (1974), Sercu (1980), Stulz (1981), and Adler and Dumas (1983)) suggest that a currency factor should be included, empirical support for this factor is mixed.[5]

In this study, we estimate factor loadings for a three-factor asset pricing model consisting of a world market factor, a country-specific local market factor, and a currency factor.[6] In addition, we include several firm characteristics that have been shown in prior literature to be significantly related to the cross-section of realized returns (i.e., idiosyncratic volatility, size, book-to-market, and financial leverage).[7] For completeness, we also evaluate a model that features Fama-French 3-Factor Betas (see Table 8).

We find that implied expected returns are significantly related to a number of these factor loadings and characteristics. First, we show that world market betas and currency betas are reliably related to firm-level expected returns (local betas do not

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[4] Hail and Leuz (2006) use implied cost of capital in an international setting but they emphasize country-level factors. Specifically, they explore legal institutions and regulations that may affect country-level cost of capital, and do not address international asset pricing issues.

[5] Some empirical studies (e.g. Dumas and Solnik (1995) and De Santis and Gerard (1998)) find that currency risk is priced, but others do not (e.g., Jorion (1991)).

[6] We follow Chan, Karolyi, and Stulz (1992) and Bekaert and Harvey (1995) in including a local market factor. See also Errunza and Losq (1986). Additionally, we include a currency risk factor as suggested in Solnik (1974), Sercu (1980), and Adler and Dumas (1983).

[7] Stocks with high book-to-market ratios are found to earn higher realized returns (Fama and French (1998) and Griffin (2002)); small stocks outperform large stocks (Banz (1981) and Heston and Rouwenhorst (1995)); highly levered firms tend to earn higher returns (Bhandari (1988)), although Fama and French (1992) find that leverage is dominated by book-to-market and size; finally, Ang et al. (2006, 2007) , Spiegel and Wang (2006) and Malkiel and Xu (2002) examine the relation between volatility and realized returns, with mixed findings.

exhibit the same statistical reliability, perhaps not surprisingly given our sample of G-7 firms). Second, we document a clear positive relation between idiosyncratic volatility and expected returns (contrary to the mixed results in prior studies).[8] Third, we find a reliably positive relation between leverage and expected returns (again, contrary to the weak results in prior studies). Finally, we show that both size and book-to-market are strongly related to expected returns among G-7 firms (i.e., smaller and higher book-to-market firms are associated with higher expected returns).

These findings are robust to a variety of modifications to the primary research approach used in this paper. We show that these relations hold in both univariate sorts and multivariate regressions. They are insensitive to adjustments for country-level analyst forecast biases, alternative exchange rate forecasts, as well as for a range of reasonable perturbations in growth rate assumptions, fade rates, and forecast horizons. They are also robust across four different measures of implied costs of capital.[9] An empirical asset pricing model that includes three betas (world, local and currency) and four characteristics (volatility, leverage, B/M and size) consistently explains about 20 percent of the cross-sectional variation in firm-level risk premia across G-7 countries.

For comparison purposes, we show that results from identical tests are much weaker when realized returns are used as proxies for expected returns. We find that both realized and implied risk premia are positively related to world beta, local beta, idiosyncratic volatility, leverage, and book-to-market; and that both are negatively related to currency beta and size. However, in tests using realized returns, only the currency beta is uniformly significant. In contrast, results based on implied expected returns are significant for all seven variables.

In sum, the main conclusion of our paper is that the implied cost of capital approach can provide important new insights into the cross-sectional determinants of firm-level expected returns in the international context. We recognize that our study is limited in scope, particularly with respect to country membership. However, we view

[8] Empirical evidence with realized returns is mixed. For example, Spiegel and Wang (2006) find that at the monthly horizon, stocks with higher idiosyncratic risk have lower liquidity and higher returns, while Ang, et al. (2006, 2007) find that stocks with higher idiosyncratic volatility have lower subsequent returns.

[9] We conduct our tests using valuation models featured in four prior studies: Gebhardt, Lee, and Swaminathan (2001), Claus and Thomas (2001), Gode and Mohanram (2003), and Easton (2004).

these findings as a significant first step toward a broader investigation of the role of implied risk premia across international borders.

The rest of the paper proceeds as follows. Section II reviews the international asset pricing literature and the existing evidence. Section III outlines the methodology for computing cost of capital. Section IV describes the data and motivates the firm characteristics and factor model used to estimate betas. Section V discusses the summary statistics. Section VI discusses the cross-sectional findings and Section VII concludes.

II. International Asset Pricing Models

Asset pricing models call for the use of expected returns. The use of realized returns rests on the assumption that, over a long period, realized returns equal expected returns. However, in international markets, the time period of examination is substantially shorter than in the U.S. Thus researchers run the risk that, during the period under consideration, tests based on realized returns may obscure the true relation between time-varying risk and expected returns.

To circumvent these problems with realized returns, the international asset pricing literature has followed the domestic asset pricing literature in using conditional asset pricing models (e.g. Harvey (1991), Chan, Karolyi, and Stulz (1992), and Ferson and Harvey (1993)). Many of these tests follow Harvey (1991) in modeling time-varying expected returns as a function of instrumental variables. These conditional pricing models have been a source of much debate and controversy in the literature. A major problem with this approach is that forecasts of expected returns are only as good as the predictive power of the instruments used. For instance, Bossaerts and Hillion (1999) fail to find out-of-sample predictability in the commonly used instrumental variables in 14 countries.[10]

Other main points of contention in international asset pricing revolve around: (a) whether the risks are priced locally or globally, and (b) whether currency risk is priced. Using unconditional asset pricing models, Griffin (2002) finds that risks are local, while papers using conditional asset pricing models (see Harvey (1991) and Ferson and Harvey

[10] Goyal and Welch (2003) fail to find evidence of predictability in the U.S. but these findings are contested by Ang and Bekaert (2007).

(1993)) largely support global models. Additionally, while unconditional models (Jorion (1991)) find little evidence for priced currency risk, conditional models (Dumas and Solnik (1995), De Santis and Gerard (1998)) find the opposite. Thus, just as in the domestic asset pricing literature, the conclusions reached in the international asset pricing literature appear specific to the asset pricing methodology adopted.

As discussed in the introduction, the purpose of this paper is not to critique the various asset pricing methodologies but rather to present an alternate approach to estimating expected returns. Our focus is on the left hand side of the asset pricing equation as opposed to the right hand side, and we hope to present new evidence on some of the key issues discussed above. In the next section, we describe the methodology for computing the implied cost of capital.

III. The Methodology for Computing Implied Cost of Capital

We compute our main measure of cost of equity capital for each firm as the internal rate of return that equates the present value of future free cash flows to equity (FCFE) to current stock price where the numeraire currency is U.S. dollar. The free cash flow model, in infinite horizon form, can be written as follows:

$$P_t = \sum_{k=1}^{\infty} \frac{E_t\left(FCFE_{t+k}\right)}{\left(1+r_e\right)^k} \qquad (1)$$

where P_t is the current stock price in U.S. dollars, $E_t(FCFE_{t+k})$ is the expected future free cash flow to equity for period t+k conditional on information available at time t in U.S. dollars, and r_e is the cost of equity capital also denominated in U.S. dollars based on the information set at time t. All units are expressed in nominal terms. This definition assumes a flat term-structure of discount rates.

Clean surplus accounting requires that all gains and losses affecting book value are also included in earnings; that is, the change in book value from period to period is equal to earnings minus free cash flows to equity or net dividends (b_t equals $b_{t-1} + NI_t - FCFE_t$). The model in equation (1) can be written in terms of economic profits or residual income earned by a firm, if the clean surplus relationship holds:

(2) $$P_t = B_t + \sum_{k=1}^{\infty} \frac{E_t\left[NI_{t+k} - r_e\ B_{t+k-1}\right]}{\left(1+r_e\right)^k}$$

where B_t is the book value of equity at time t, NI_{t+k} equals net income for period t+k, and the term inside the expectation operator is the economic profit/residual income for period t+k. Equation (2) is commonly referred to as the residual income model.

Gebhardt, Lee, and Swaminathan (2001) compute the implied cost of equity using the residual income model. They forecast earnings by assuming that the return on equity of each firm reverts to an industry median ROE by the terminal period. This paper adopts a modified version of their approach, in which individual firms' earnings growth rates are assumed to revert to the long-run nominal world gross domestic product (GDP) growth rate. This alternate approach imposes less stringent data requirements and hence is easier to implement in the international context. We describe this approach in detail below.

A. Empirical Implementation of the Free Cash Flow Model

Equation (2) expresses stock price in terms of an infinite series, but in actual implementation free cash flows are only explicitly forecasted for a finite horizon. The present value of free cash flows beyond the last explicit forecast period is captured in the "terminal value" estimation. In other words, free cash flow models estimate firm value in two parts: (a) the present value of free cash flows up to a terminal period t+T, and (b) a continuing value that captures free cash flows beyond the terminal period. We derive future free cash flows up to year t+T as the product of annual earnings forecasts and one minus the plowback rate:

(3) $$E_t\left(FCFE_{t+k}\right) = FE_{t+k} \times (1 - b_{t+k})$$

where FE_{t+k} and b_{t+k} are the earnings forecasts in U.S. dollars and plowback rate forecasts for year t+k. To obtain equation (3), define net new equity investment as capital expenditures plus change in working capital minus depreciation and amortization minus net new issues of debt and preferred stock. Thus, FCFE is net income minus net new equity investment. Defining plowback rate as net new equity investment divided by net income we obtain equation (3).

We forecast earnings up to year t+T in three stages: (a) we explicitly forecast earnings (in dollars) for years t+1 and t+2; (b) we then use the growth rate implicit in the forecasts in years t+1 and t+2 to forecast earnings in year t+3; and, finally, (c) we forecast earnings from year t+4 to year t+T+1 implicitly by assuming that the year t+3 earnings growth rate (g_3) reverts to steady-state values by year t+T+2.

We use the world average real GDP growth rate (g) over the last ten years plus the average U.S. inflation rate over the same period as the nominal steady-state growth rate starting in year t+T+2.[11] We further impose an exponential rate of decline by allowing the year t+3 growth to revert to the steady-state growth.[12] Specifically, earnings growth rates and earnings forecasts using the exponential decline are computed as follows for years t+4 to t+T+1 (k equals 4…T+1):

(4)
$$
\begin{aligned}
g_{t+k} &= g_{t+k-1} \times \exp\left[\log\left(g / g_3\right) / \left(T-1\right)\right] \\
FE_{t+k} &= FE_{t+k-1} \times (1 + g_{t+k})
\end{aligned}
$$

We forecast plowback rates using a two-stage approach: (a) we explicitly forecast plowback rates for years t+1 and t+2 (see Section III.D below) and (b) we assume that the plowback rate in year t+2, b_2 reverts linearly to a steady-state value by year t+T+1 computed from the sustainable growth rate formula.[13] This formula assumes that, in the steady-state, the product of the steady-state return on new investments, ROI, and the steady-state plow back rate (ROI*b) is equal to the steady-state growth rate in earnings (g).[14] We further impose the condition that, in the steady-state, ROI equals r_e for new

[11] We use the average real GDP growth rates across the G-7 countries as our proxies for world real GDP growth. By reverting to world average GDP growth rates in US dollar terms, we implicitly assume that, in the long-run, purchasing power parity (PPP) holds.
[12] The exponential rate of decline reverses high growth rates faster to mean than a simple linear rate of decline. We chose this rate of decline because prior studies such as Nissim and Penman (2001) and Chan, Karceski, and Lakonishok (2003) show that high earnings growth rates decay rapidly.
[13] We assume that year t+k plowback affects year t+k+1 earnings growth. We assume a linear decline in plowback rate and an exponential decline in growth rate because empirically growth rates revert much faster than plowback rates and ROI (for example, see Nissim and Penman (2001)).
[14] See Brealey and Myers (2000).

investments, because competition will drive returns on these investments down to the cost of equity. Thus, there are two major assumptions underlying our model: (a) growth rate is assumed to revert to long-run GDP growth rate and (b) return on new investment, ROI, is assumed to revert to cost of equity, r_e.

Substituting return on new investment (ROI) with cost of equity (r_e) in the sustainable growth rate formula and solving for plowback rate (b) provides the steady-state value for the plowback rate, which equals steady-state growth rate divided by cost of equity (g/r_e). The intermediate plowback rates from t+3 to t+T (k equals 3…T) are computed as follows:

(5) $$b_{t+k} = b_{t+k-1} - \frac{b_2 - b}{T-1}$$

The terminal value (TV) is computed as the present value of a perpetuity equal to the ratio of the year t+T+1 earnings forecast divided by the cost of equity:

(6) $$TV_{t+T+1} = \frac{FE_{t+T+1}}{r_e}$$

where FE_{t+T+1} is the earnings forecast for year t+T+1. Note that the use of the no-growth perpetuity formula does not imply that earnings or cash flows do not grow after period t+T. Rather, it simply means that any new investments after year t+T earn zero economic profits. In other words, any growth in earnings or cash flows after year T is value irrelevant. It is easy to show that the Gordon growth model for terminal value will simplify to equation (6) when ROI equals r_e.

Substituting equations (3) to (6) into the infinite horizon free cash flow valuation model in equation (2) provides the following empirically tractable finite-horizon model:

(7) $$P_t = \sum_{k=1}^{T} \frac{FE_{t+k} \times (1 - b_{t+k})}{(1+r_e)^k} + \frac{FE_{t+T+1}}{r_e(1+r_e)^T}$$

In this paper, we implement the model in equation (7) using a fifteen-year horizon (T equals 15), and compute r_e as the rate of return that equates the present value of free cash flows to the current stock price in U.S. dollars.[15] We subtract the yield on a 10-year U.S. government bond from r_e to compute the implied risk premia. Our empirical tests are based on the implied risk premia.

B. Explicit Earnings Forecasts over the First Two Years

We obtain explicit earnings forecasts in the respective currencies for year t+1 and year t+2 for each firm from the I/B/E/S domestic and international databases. I/B/E/S analysts supply a one-year-ahead (FY1) and a two-year-ahead (FY2) EPS forecast in the local currency for each firm in the I/B/E/S database. These forecasts are aggregated across analysts monthly and a consensus (or mean) forecast is computed. We use the consensus one- and two-year-ahead EPS forecasts. We translate these EPS forecasts into dollar terms using one- and two-year-ahead forecast exchange rates and denote these dollar forecasts as FE_{t+1} and FE_{t+2}.

$$(8) \qquad \begin{aligned} FE_{t+1} &= FY1 \times FS_{t+1} \\ FE_{t+2} &= FY2 \times FS_{t+2} \end{aligned}$$

where FY1 and FY2 are local currency consensus EPS forecasts and FS_{t+1} and FS_{t+2} are one- and two-year ahead exchange rate forecasts expressed in units of dollars per foreign currency. In using dollar earnings forecasts, we are essentially invoking long run purchasing power parity. Exchange rate forecasts are described in the next sub-section.

We then estimate the growth rate for year 3 (g_3) from the consensus forecasts in years 1 and 2 by assuming g_3 equal FE_{t+2}/FE_{t+1}-1, and use this growth rate to compute a three-year ahead earnings forecast, as given by FE_{t+2} (1+ g_3). Firms with growth rates above 100% (below zero) are given values of 100% (zero).[16] These earnings forecasts,

[15] For simplicity, we assume the same number of years on the forecast horizon before the terminal period for all firms. We conduct robustness checks in Section VI which show that the forecast horizon assumption has little effect on our results. It is possible that results can be further improved by allowing the forecast horizon to vary for firms in different industries or growth stages. This is left for future research.

[16] We have relaxed this assumption to allow growth rates above 100% and repeated our cross-section tests. All of the major results remain unchanged.

combined with the plowback rates, allow us to generate explicit forecasts of free cash flows to equity.

C. Exchange Rate Forecasts

To compute implied cost of capital in U.S. dollars for firms in different countries, we use exchange rate forecasts to convert local currency earning forecasts into U.S. dollars. The exchange rate forecasts are obtained from the Economist Intelligence Unit (EIU). All of our reported results are based on risk premia computed in U.S. dollars using the EIU forecasts.[17]

D. Plowback Rates

We compute the plowback rate for each firm as one minus that firm's dividend payout ratio. We estimate the dividend payout ratio by dividing actual dividends from the most recent fiscal year by earnings over the same time period. We exclude share repurchases due to the practical problems associated with determining the likelihood of their recurrence in future periods and the limited availability of this data for international firms. For firms with negative earnings, we estimate the normalized earnings as the product of the firm's total assets and the median return-on-total-asset ratio (ROA) of the industry-size portfolio (based on three market cap portfolios in each industry group) to which the firm belongs.[18] The industry-size portfolio is constructed by sorting firms into 3 size portfolios within each industry. Payout ratios of less than zero (greater than one) are assigned a value of zero (one).

E. Measurement Error

One source of measurement error in calculating the implied cost of capital is associated with slow updating of analyst forecasts in the face of big price moves. As Guay, Kothari and Shu (2005) show, when there is a large upward movement in stock

[17] We also conduct our analysis using our own exchange rate forecasts based on a transfer function, i.e. a multivariate ARMA model of past exchange rate changes with uncovered interest parity variables. As a further robustness check, we also redo all the analysis based on risk premia computed completely in local currency terms, thus eliminating the need to forecast exchange rates. All the main results remain the same.

[18] As a robustness check, we also use six percent of total assets as a proxy for normal earnings levels when current earnings are negative (six percent is the average long-run return-on-total asset in the United States). None of our results change significantly.

price prior to estimating the cost of capital, the change in stock price reflects the market's revision of future firm earnings. Because analysts do not update their earning forecasts instantaneously, the valuation model will be based on downwardly biased cash flow forecasts, yielding an artificially low cost of capital to equate. Similarly, if there is a large drop in stock price, the cost of capital will be artificially high. Guay, Kothari and Shu (2005) recommend a simple correction for this effect, which we incorporate in all of our implied cost of capital measures.[19]

F. Three Alternative Implied Costs of Capital

While the main results in our paper use the implied cost of capital that we feature, we check the robustness of our results using three other implied costs of capital: Ohlson and Juettner-Nauroth (2005), the Modified-PEG model by Easton (2004), and Claus and Thomas (2001). Our computation of these three implied costs of capital $r_{MPEG,}$ r_{OJ} and r_{CT} follows closely the implementation in Hail and Leuz (2006). The implied risk premia for these three models are denoted by $rp_{MPEG,}$ rp_{OJ} and rp_{CT} and are computed as the respective implied costs of capital minus the U.S. 10-year interest rate. r_{MPEG} is based on the modified PEG ratio model by Easton (2004):

(9)
$$P_t = (\frac{FE_{t+2} + r_{MPEG} d_{t+1} - FE_{t+1}}{r_{MPEG}^2})$$

r_{OJ} is based on Ohlson and Juettner-Nauroth (2005) and Gode and Mohanram (2003):

(10)
$$P_t = (\frac{FE_{t+1}}{r_{OJ}}) \cdot \left(\frac{g_{ST} + r_{OJ} \dfrac{d_{t+1}}{FE_{t+1}} - g_{LT}}{r_{OJ} - g_{LT}} \right)$$

[19] To correct for the sluggish earnings revisions, Guay, Kothari and Shu (2005) explicitly adjust analyst earnings forecasts by the expected forecast error. We apply this technique in our paper. Specifically, we sort firms into twelve portfolios based on stock returns each year. In each portfolio, we calculate the time-series median of portfolio median forecast errors and subtract these portfolio median forecast errors from each firm's FE1 and FE2 to adjust for near-term analyst sluggishness.

where d_{t+1} is the dividend which is set as a constant fraction of forecast earnings following the current payout ratio of the firm, the short-term growth rate g_{ST} is estimated as the I/B/E/S forecast percentage change in earnings, and the long-term earnings growth rate g_{LT} is the historical mean GDP growth rate in the G-7 countries plus the historical mean U.S. inflation rate.[20] Finally, r_{CT} is based on Claus and Thomas (2001):

$$P_t = B_t + \sum_{k=1}^{T} \frac{(FE_{t+k} - r_C B_{t+k-1})}{(1+r_C)^k} + \frac{(FE_{t+k} - r_C B_{t+k-1})(1+g)}{(r_C - g)(1+r_C)^T} \tag{11}$$

where actual book value B_t and I/B/E/S forecast earnings up to three years ahead are used to derive the expected future residual income sequence.[21] Future book value is derived through clean surplus accounting. Each residual income in the future equals the forecast earnings minus the book value times the implied cost of capital.

IV. Data Description

Our sample of international firms is derived from the Worldscope database. To ensure that we have a reasonable number of firm-level observations in each country, we focus our analysis on the 1990 to 2000 time period, which has the widest coverage in the Worldscope database. Each firm's home country (both country of origin and country of domicile) is required to be clearly identified in the Worldscope database. Due to data limitations, we confine our analysis to firms in the G-7 countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States). Data for U.S. firms are obtained from the Compustat. Together, there are 118,244 firm-year observations.

We obtain international stock returns data from Datastream and the U.S. returns data from CRSP. We require our firms to have enough return observations available

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[20] As in Hail and Leuz (2006), this model requires a positive change in earnings forecasts in order to obtain a solution.

[21] Beyond the third year, the nominal residual income is assumed to grow at the historical mean GDP growth rate in the G-7 countries plus the historical mean US inflation rate. As in our main implied cost of capital measure, we estimate the growth rate for year 3 (g_3) from the consensus forecasts in years 1 and 2: g_3 equals FE_{t+2}/FE_{t+1}-1, and use this growth rate to compute a three-year ahead earnings forecast: FE_{t+3} equals FE_{t+2} (1+ g_3).

from Datastream and CRSP that we can estimate their betas and compare their one-year ahead realized returns. The data sample includes 83,678 firm-year observations.

We obtain total market capitalization for each firm based on the closing market price as of June 30 of each year. We require the availability of the following data items, measured as of the most recent fiscal year ending at least six months prior to June 30: common dividend, net income, book value of common equity, fiscal year-end date, and currency denomination. In addition, each firm needs to have a one-year-ahead and a two-year-ahead consensus earnings forecast (in local currencies) and one-year-ahead and two-year-ahead actual earnings in the I/B/E/S International database in June of each year. The stock price P_t as of June 30 is also obtained from I/B/E/S. We make adjustments for measurement errors in the forecast earnings based on the methodology of Guay, Kothari and Shu (2005). After these screens, there are 30,486 firm-year observations.

Only firms from the largest exchange in each country are included, except in Japan (where stocks from both the Osaka and Tokyo exchanges are included) and in the United States (where NYSE, AMEX, and NASDAQ stocks are all included).[22] To reduce errors in Datastream, we follow Hou, Karolyi, and Kho (2006) in applying a similar screening procedure for international stock returns.[23] Firms with negative common equity and negative one-year and two-year ahead earnings forecasts are excluded. After these screens, there are 28,124 firm-year observations.

We obtain country level data from the International Country Risk Guide (ICRG) and idiosyncratic volatility data from Ang et al. (2006, 2007). These include inflation and real GDP growth. The 10-year interest rates we use are the yields-to-maturity on 10-year U.S. Treasury government bonds as of the end of June, obtained from Datastream. The inflation rates are calculated from the Consumer Price Index (CPI) series of different countries from the Conference Board. To eliminate the influence of outliers, we rank firms in each country annually by their estimated risk premia and exclude observations in

[22] Because they are not domestic firms, depositary receipts are excluded. There are two main ways by which we exclude depositary receipts. First, Worldscope marks some firms with a depositary receipt indicator. Second, the names of some firms are clearly labeled as depositary receipts.

[23] We require a minimum price of \$5 in the previous month for a valid monthly return. Any return above 300% that is reversed within one month is set to missing. That is, if R_t or R_{t-1} is greater than 300% and $(1+R_t)(1+R_{t-1}) - 1 < 50\%$, then both R_t and R_{t-1} are considered missing. In order to exclude other outliers, we treat as missing the monthly returns that fall out of the 0.5% and 99.5% percentile ranges in each country.

the top and bottom 1%. We also exclude observations at the top and bottom 1% of book-to-market ratio and leverage.

After these filters, there are 24,913 firm-year observations across the G-7 countries. The number of firms per year is listed in Table 1. For each firm, we estimate the cost of equity, r_e, as the IRR from equation (2) at the end of June for each year from 1990 to 2000. We then subtract the end-of-June yield on the long-term (10-year) U.S. government bonds from the IRR to obtain an (annualized) implied risk premium for each firm in the sample.

Next, we describe our systematic risk measures (betas) as well as various firm-specific characteristics used in our analysis. As discussed earlier, we take a partial segmentation approach and adopt the following three-factor model as our primary specification for measuring systematic risk:[24]

$$r_t - r_{ft} = a + b_W\,(r_{Wmt} - r_{ft}) + b_L\,(r_{Lmt} - r_{ft}) + b_E\,e_t + u_t \tag{12}$$

where b_W is the world market beta, b_L is the local market beta, and b_E is the currency beta; r_{Wmt} represents the monthly dollar return on the world market portfolio, r_{Lmt} represents the monthly dollar return on the local market portfolio, e_t is the monthly trade-weighted exchange rate return index, and r_{ft} is the monthly one-month U.S. Treasury-bill return. Note that all returns are measured in U.S. dollars. The exchange risk is approximated by a single currency risk factor using the approach of Ferson and Harvey (1993).[25] Specifically, our currency risk factor is the return on a trade-weighted exchange rate index against major trading partners of the U.S., as provided by the Federal Reserve Board.[26] The exchange rate index represents the dollar value of the basket of

[24] We have also estimated a two-factor model excluding the local factors and our cross-sectional findings are similar.

[25] In a model featuring currency risk, the number of exchange risk factors can be as high as the number of currencies other than the numeraire currency, because, theoretically, investors bear exchange rate risk from all currencies. This, of course, is difficult to implement empirically as the number of factors could easily exceed the number of time-series observations used in the estimation of the factor model.

[26] We use a nominal exchange rate in most specifications but we test the robustness of our findings using real exchange rates as well. The nominal exchange rate index we adopt is a trade-weighted exchange index vis-à-vis currencies of major trading partners including the Euro area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index is obtained from the Federal Reserve Board at the following website: http://research.stlouisfed.org/fred2/series/TWEXBMTH/15.

currencies. An increase in the value of the index represents a depreciation of the value of the dollar.

To make the results easier to interpret, we orthogonalize local market returns relative to the world market returns, following Jorion and Schwartz (1986). Using ordinary least square regression, the local market returns are regressed upon the world market returns. The error term of the regression is the new local market return. This regression is conducted every two to five years to allow for time-varying factor loadings.

For each firm, in June of each year, we estimate the factor model in equation (12) using at least 24 months of data over the prior 60 months. The three estimated betas are then used in cross-sectional regression tests to be discussed later in this paper. For U.S. firms, individual stock returns are obtained from CRSP. For firms in other countries, returns data are obtained from Datastream. Returns on value-weighted local and world stock market indices are from Morgan Stanley Capital International (MSCI).

In addition to the betas, we include size, book-to-market ratio, leverage and idiosyncratic volatility as explanatory variables in some of our regression specifications. Based on average realized returns, Fama and French (1992) suggest that smaller and higher B/M firms might be riskier.[27] To reduce the impact of outliers, we use the natural log of market capitalization (LnSZE) and the natural log of book-to-market ratios (LnBM) in our empirical analysis.

We also investigate whether financial leverage (leverage) affects the cost of equity. Modigliani and Miller (1958) predict that a firm's cost-of-equity should be increasing in its financial leverage. Since we already include B/M ratio in the regression, we use a measure of book leverage in our cross-sectional regression tests. The book leverage ratio is defined as the ratio of total debt to total book value of equity from the most recent fiscal year end. Firms with no reported total debt are assigned a value of zero. To avoid any spurious relationship, we use lagged firm characteristics from the previous year in the regression.

[27] An alternative interpretation is that B/M ratios are proxies of mispricing, whereby high B/M ratios reflect undervaluation and low B/M ratios reflect overvaluation (see Lakonishok, Shleifer, and Vishny (1994)).

Finally, we include the idiosyncratic volatility (annualized standard deviation based on the last twelve months' daily stock returns) as a measure of total risk.[28] Firms with higher volatilities are found to have lower subsequent returns in Ang et al. (2006, 2007) but higher subsequent returns in other studies (Spiegel and Wang (2006) and Malkiel and Xu (2002)). Given these mixed results, we are interested in understanding the relationship between implied risk premia and idiosyncratic volatility.

V. Summary Statistics

In this section, we present risk premia computed for country portfolios. Our main goal in this section is to provide a benchmark comparison of the implied risk premium observed in each country to its historical risk premium computed using realized returns. In Section VI, we present the results of cross-sectional asset pricing tests.

Table 1 reports the equal-weighted and value-weighted average risk premia in percentage for each G-7 country each year from 1991 to 2000. As noted earlier, the implied risk premia are computed as the difference between the dollar cost of equity obtained from the discounted cash flow model in equation (7) as of the end of June each year and the end of June-yield on the 10-year U.S. Treasury bond. The realized risk premia are computed as the 1-year ahead ex post excess returns. The third-to-last and second-to-last columns of the table report the time-series averages and standard deviations across the implied and realized risk premia. The average implied risk premium ranges from 2.6% in Japan to 9.2% in Canada. In comparison, the average equal-weighted realized risk premium ranges from -0.8% in Japan to 13.1% in the U.S..

The most striking finding in this table is the difference in volatility between the realized risk premium and the implied risk premium. The time-series standard deviation of the realized risk premium for each firm is substantially larger than that of the implied risk premium. To facilitate the comparison, we compute a standard deviation ratio (SD ratio), which is the ratio of the standard deviation of the realized risk premium to the

[28] Professor Xiaoyan Zhang has kindly provided us with the monthly volatility data from Ang, et al. (2006, 2007). We also test the robustness of our results using the standard deviation of monthly returns computed using at least 24 months of data over the prior 60 months as a measure of total risk. The results are very similar.

standard deviation of the implied risk premium. We calculate the SD ratio for each firm and report the average of the SD ratios across all firms in each country.[29]

Table 1 shows that the standard deviation ratio (in bold) ranges from a low of 12.13 (Canada) to a high of 18.33 (U.S.). To put these numbers in context, an SD ratio of 12.13 for Canada means that the standard deviation of realized risk premium is 12.13 times that of the implied risk premium for Canadian firms. For every country in our sample, the standard deviation of the realized risk premia is more than ten times the standard deviation of the implied risk premia. The cross-country average of the SD ratios is 15.

Table 2 reports the summary statistics for risk premia based on alternate implied cost of capital measures (see Section III) and various firm characteristics. Panel A provides means and standard deviations and Panel B provides correlations across alternate risk premia measures. The mean implied risk premia across G-7 countries for our risk premium measure rp and the alternate measures rp_{MPEG}, rp_{OJ}, and rp_{CT} are 5.8%, 4.83%, 7.57% and 5.08% respectively. While the means are comparable across rp, rp_{MPEG} and rp_{CT}, the Ohlson-Juettner-Nauroth measure rp_{OJ} is substantially higher, suggesting a possible overestimation of long-term growth in estimating the implied cost of capital. Perhaps more importantly, the standard deviations of all four measures are narrowly distributed, ranging from 1.28% to 1.69%. In contrast, the realized risk premium is more than ten times as volatile as the implied risk premium, irrespective of the valuation model. We also report summary statistics for the error spread, which is the difference between realized risk premium and rp. The volatility of the error spread is comparable to that of the realized risk premium.

In additional (untabulated) analyses, we also compute the pairwise correlation among the four implied risk premia and with the realized risk premium. Although the implied risk premia are derived under different assumptions, the correlations among them are quite high, ranging from 0.45 to 0.94. The measure that is least correlated with the other three measures is rp_{CT}, with correlations ranging from 0.44 to 0.49. None of these four implied measures, however, are highly correlated with the realized risk premia –

[29] To limit the effect of outliers, we windsorize these SD ratios at the top and bottom 1%-level.

realized returns exhibit correlations of only 0.04 to 0.06 with the implied measures. This is perhaps not surprising, as we know that realized returns are quite noisy.

To further examine this issue, Table 3 provides evidence of the positive relation between the implied risk premium and ex post realized returns using a portfolio approach. Specifically, this table reports the average implied and realized risk premia for firms sorted into quintiles based upon their implied risk premia as of June 30 of each year. The results show that firms with higher implied risk premium (Q5) earn higher average excess returns than firms with lower implied risk premium (Q1) in each of the next two years. This relation is monotonic across the quintiles, with the difference between Q5 and Q1 statistically significant at the 5% level.[30] Evidently the implied risk premium is positively related to the realized risk premium, although the relationship is fraught with noise.

VI. Cross-Sectional Tests

A. Univariate Portfolio Tests

Table 4 provides evidence of the univariate relationship between factor betas, firm characteristics and the implied risk premium. To construct this table, we sort firms into quintiles based upon each factor beta or firm characteristic as of June 30 in each year and compute the mean implied risk premium for firms in each portfolio. We compute the implied risk premium as of June next year. The one-year gap between firm characteristics and the implied risk premium serve to minimize spurious correlations between these characteristics and the dependent variable. We compute time-series averages of cross-sectional means and report the Newey-West autocorrelation-adjusted t-statistics for the difference in risk premia across the extreme quintiles (Q1 and Q5).

Panel A presents results for the factor betas and Panel B presents results for the firm characteristics. These results show that firms with high world market betas have higher implied risk premium, although the positive relation is not monotonic across quintiles. The difference between Q5 and Q1 mean implied risk premia is 1.38% per annum. This difference is statistically significant with a t-statistic of 2.97. The difference between Q5 and Q1 mean realized risk premia is also positive and is comparable in

[30] We have also examined deciles instead of quintiles. The results are similar.

magnitude (1.22%). However, this difference is not statistically significant (t-statistic of only 0.28), illustrating the difference in the power of the two tests.

Local beta (based on the local market return orthogonalized to the world market return) is also positively related to the implied risk premium. Panel A shows that the spread in implied risk premia between the extreme quintiles is 0.60% which is significant at the 10% level. However, as with the world market beta, the correlation between the local beta and the realized risk premium is not statistically significant.

Panel A also shows that firms with high currency betas have reliably lower implied risk premium. The risk premium spread between extreme quintiles (Q5-Q1) is -1.87%, which is statistically significant at the 1% level. Economically, a negative risk premium implies that investors view stocks with positive currency betas (stocks that perform well when the dollar depreciates) as a hedge against currency risk (the risk of dollar depreciation). The results in Panel A suggest that investors are willing to accept a lower risk premium for such stocks.

Panel B reports the results for firm characteristics. Interestingly, stocks with higher idiosyncratic volatility have significantly higher implied risk premium. This supports the results in Spiegel and Wang (2006), who find that at the monthly horizon, stocks with higher idiosyncratic risk have lower liquidity and higher returns. Our findings differ from the result in Ang, et al. (2006, 2007), who report that stocks with higher idiosyncratic volatility have lower subsequent returns.

Consistent with Modigliani-Miller (1958), we find that firms with higher financial leverage face higher costs of capital. This is also consistent with Bhandari (1988)'s findings that leverage increases expected returns. Finally, we find that firms with smaller size and higher book-to-market ratio tend to have higher implied risk premia, which is consistent with previous empirical work using U.S. data.

B. Multivariate cross-sectional regressions

In this section, we estimate the cross-sectional relationship among factor loadings, firm characteristics and the implied risk premia in a multivariate context.[31] This

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[31] We estimated cross-sectional regressions with value-weighted average industry-country portfolio risk premia as the dependent variable (not reported), because portfolio risk premia might be estimated more

approach allows us to evaluate the incremental explanatory power of each beta or firm characteristic while controlling for the other variables. Specifically, we estimate the following Fama-MacBeth regression for year ‘t’ with K factor loadings and M characteristics:

$$r_{it} - r_{ft} = a + \sum_{k=1}^{K} \gamma_{kt} \beta_{ikt} + \sum_{m=1}^{M} \gamma_{mt} C_{imt} + u_{it} \tag{13}$$

where r_{it}–r_{ft} is the dollar risk premium estimate (relative to long-term U.S. treasury yields) for firm i in year t, β_{ikt} is the factor loading, or beta, corresponding to risk factor F_k, C_{imt} is the firm characteristic m for firm i in year t, and γ_{kt} and γ_{mt} are the slope coefficients corresponding to betas and characteristics from the cross-sectional regressions in year t.

In our empirical implementation, we make sure that all explanatory variables, except betas and idiosyncratic volatility, are from the year prior to that of the risk premium estimates. The cross-sectional regression in equation (13) is estimated each year from 1990 to 2000, with betas and characteristics as independent variables. The time-series averages and t-statistics of the estimated slope coefficients are then used to examine the cross-sectional asset pricing implications. Because the risk premia are autocorrelated over time, we use a Newey-West autocorrelation correction with two moving average lags to compute the t-statistics. We also report the time-series average of adjusted R-squares of each regression specification over the sample period.

In Table 5, we report the results of six different regression specifications. The first specification (S1) estimates a pure beta model in which the only independent variables are betas from the factor model in equation (12). The second specification (S2) adds idiosyncratic volatility to the betas. The third specification (S3) adds leverage to the betas. The fourth specification (S4) includes size. The fifth specification (S5) adds B/M

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precisely than individual firm risk premia. The result is similar to the firm-level result. We also estimated regressions involving only the country or only the industry risk premia. These regressions suffer from a lack of power because there are few cross-sectional observations. As expected, these regressions have very low R-squares and insignificant t-statistics.

ratio. The sixth specification (S6) includes all variables. In all six models, the dependent variable is the individual firm risk premium.

In the pure beta specification (S1), the coefficient with respect to the world beta, b_W, is marginally significant with a t-statistic of 1.72. The local market beta is not significant. The currency beta, b_E, has a negative sign and is statistically significant. These results suggest that currency beta is an important determinant of international risk premia. In particular, the regression confirms the univariate finding that firms with high currency beta tend to have lower risk premia.

Regression specification (S2) examines the effect of the total risk variable, idiosyncratic volatility, on the cost of capital. We find that idiosyncratic volatility is highly significant, and that its introduction reduces the importance of both the currency beta and the world market beta (which now becomes insignificant). When idiosyncratic volatility is added to the model, the adjusted R-square increases from 3% to 11%. In fact, idiosyncratic volatility continues to be one of the most significant determinants of the cross-sectional variation in international risk premia even with the inclusion of all of the other firm characteristics.

Specification (S3) evaluates the relation between leverage and cost of capital, controlling for other variables. Just as in the univariate case, higher leverage corresponds to higher implied cost of capital. Specifications (S4) and (S5) show that, as in the univariate tests, Size and B/M play a significant role in explaining cross-sectional implied risk premia. Smaller firms face a higher cost of capital, as do firms that have higher B/M ratios (perhaps due to greater distress risk).

In specification (S6), all seven explanatory variables are included. This specification shows that the most significant cross-sectional determinants of firm-level risk premium are world market beta, currency beta, idiosyncratic volatility, leverage, B/M ratio, and size. Interestingly, once firm characteristics are introduced, the world beta becomes more significant. The currency beta is significant in most specifications although it becomes marginal in the specification that includes all variables.[32] The firm characteristics (B/M ratio, size, leverage, and idiosyncratic volatility) are generally more

[32] See Griffin (2002) for similar conclusions on the noisy nature of beta estimates and the importance of local factors in an international context.

significant than the betas. Overall, a model that includes the betas, idiosyncratic volatility, leverage, B/M and size can explain approximately 20% (19.5%) of the cross-sectional variation in individual firm risk premia.

C. Regressions based on alternate measures of implied cost of capital

In this section, we examine the robustness of our cross-sectional findings to the risk premia based on the three alternate implied risk premia: rp_{MPEG}, rp_{OJ} and rp_{CT}. Table 6 presents the results from cross-sectional regressions involving these three measures. To conserve space, we only report results for the pure beta specification and the complete specification (models S1 and S6 from Table 5). The main finding in Table 6 is that the key results in Table 5 are not sensitive to the use of alternate measures of implied costs of capital. The currency beta, idiosyncratic volatility, leverage and B/M are all important in determining the implied risk premia. The only difference relates to the world market beta, which is in the right direction for all six specifications, but is significant only for the rp_{OJ} measure.

The fact that our results are invariant to different measures of implied cost of capital is encouraging because it shows that the results are not driven by spurious effects such as measurement errors specific to any particular implementation. However, we hasten to point out that all four models are based on similar theoretical constructs and could be vulnerable to similar problems.[33] Moreover, it is possible that commonality in the way that we handled model implementation or noise filtering could have induced a greater degree of commonality in results across these models. Despite these caveats, Table 6 provides an additional measure of assurance that the earlier results are not due to particular quirks of any given valuation model.

D. Regressions using Realized Returns

Table 7 presents results from cross-sectional regressions that use realized excess returns in place of implied risk premia. Our goal in constructing this table is to compare

[33] For example, Pastor, Sinha, and Swaminathan (2007) use simulation analysis to show that even crude measures of implied cost of capital with no information about future cash flow growth should be correlated with conditional expected returns as long as some of the stock price changes are driven by changes in expected returns.

and contrast these findings with those obtained earlier using the implied cost of capital. If the noise in realized returns is the primary culprit in traditional asset pricing tests, then we would hope to see similar regression coefficients in the realized return regressions, but with lower statistical significance. This is, in general, what we find in Table 7.

Panel A of this table reports the results for the full sample, and Panel B reports the results for the sub-sample for which I/B/E/S analysts' earnings forecasts are available. The results in both panels show that only the currency beta is uniformly significant. While idiosyncratic volatility has a positive sign in Panel A, it has a negative sign in Panel B. The local beta loads more significantly than the world market beta, which is consistent with Griffin (2002), who finds that the local beta is more important than the world beta. Book-to-market and size are significant in some specifications but not in others. Leverage has the right sign but is not statistically significant. Even under the best model (S6), only 5% of the cross-sectional variation in realized returns is captured by the betas and the characteristics.

These findings illustrate the difficulty underlying the use of realized returns as proxies for expected returns. Notice that the sample of firms with analyst coverage (Panel B) is much smaller than the sample of firms in broad cross-sectional studies such as Hou, Karolyi, and Kho (2006) and De Moor and Sercu (2006). This is because I/B/E/S analysts tend to cover only the larger, more liquid firms in each market. The fact that both samples provide similar results with respect to realized returns alleviates concerns that our results might be specific to our more restricted sample.[34]

Panel C of Table 7 examines the relation between the difference in realized returns and the implied cost of capital, i.e. the "error spread", and betas and firm characteristics. The error spread can be interpreted as the news or the expectation error in realized returns. The error spread, however, is also dominated by the noise in realized returns because the implied expected returns vary little while the realized returns vary to a considerable extent. As a result, the standard deviations of the error spreads are indistinguishable from the standard deviations of realized returns. For the overall sample,

[34] De Moor and Sercu (2006) show that a data sample including ultra-small firms can have a large impact on the Fama and French (1993) results. Unfortunately, in any measure of implied cost of capital, I/B/E/S earning forecasts are a crucial input to construct expected cash flows. Hence, we are limited to the I/B/E/S sample.

the standard deviation of annual realized excess returns is 19.70%, while the standard deviation of the error spread is 19.94%.

Empirically, we expect the error spread results to be similar to those based on realized returns. This is what we observe in Panel C of Table 7. The error spread results are quite similar to the I/B/E/S sample results in Panel B with the local beta, the exchange beta and firm size registering statistical significance, and the other variables registering insignificance. The slope coefficients from the error spread regression are almost exactly equal to the difference between the slope coefficients corresponding to the implied risk premium in Table 5 and those corresponding to realized returns in Panel B. The differences are not statistically significant even if they might be economically significant. The R-square of the error spread regression in Panel C is 5%, which is much lower than the R-square of the implied risk premium regressions in Tables 5 and 6, but is comparable to the R-square of the realized excess returns in Panels A and B. Collectively, these findings show that few systematic components of the error spreads can be extracted by the model.

We also conducted robustness checks of our results of error spread regressions by re-estimating regressions for our three alternate measures of implied cost of capital and for each country, based on our risk premium measure. The results, unreported, are quite similar to those in panel C of Table 7. For each alternate measure of implied cost of capital, only the local beta, currency beta, and firm size are statistically significant. The results for individual countries are even noisier because of reduced sample size. Finally, we have also estimated error-spread regressions as of December year-end, i.e., measuring annual returns from January to December as opposed to July to June as in Panel A, and find that under this formulation none of the slope coefficients are statistically significant. Overall, these results indicate that the divergence in the results between implied cost of capital and realized excess returns is not specific to one country, one measure of implied cost of capital, or seasonal effects. As we discussed earlier, the reason for the divergence is the noise in realized returns.

E. Robustness Tests on Forecast Horizon, Sample, and Model

We further conducted a number of robustness checks on forecast horizon, data sample and model. First, we have re-estimated our main implied cost of capital model for a 10-year forecast horizon and a 20-year forecast horizon, instead of a 15-year horizon. The cross-sectional results are essentially unchanged.

Second, we are concerned that our sample of firms is dominated by firms in U.S. U.K. and Japan. To address this, we re-estimate our cross-sectional regressions using only the 100 largest companies from each of the G-7 countries. The results are virtually unchanged.

Third, we re-estimate our results using alternate year-end dates. One concern about our findings is that they may be dependent upon our arbitrary choice of June 30 as the date for the estimation of implied cost of capital. As Chan, Karceski and Lakonishok (1998) show, there may be seasonal patterns in the returns for different B/M, momentum, size and other portfolios. To ensure that such seasonalities do not affect our cross-sectional findings, we estimate the implied cost of capital using market closing prices as of three different calendar months (January, March, and December). The results show that our key findings are robust to the use of alternate year-end dates.

Fourth, since asset pricing tests typically use monthly data, we re-estimate the implied cost of capital on a monthly basis and re-estimate Fama-MacBeth cross-sectional regressions using the monthly data. The results show that our key findings are robust to the use of monthly estimation.

Finally, we examine the cross-sectional relationship between betas estimated from an international version of the Fama and French (1993) three-factor model used by Zhang (2003). Zhang extends Fama and French (1998) by adding a size factor:

$$r_t - r_{ft} = a + b_{WMKT} WMKT_t + b_{WSMB} WSMB_t + b_{WHML} WHML_t + u_t \tag{14}$$

where WMKT is the excess return on the world market portfolio, defined as the return on the Datastream Value-weighted Global Index less the one-month Euro-dollar deposit rate, WSMB is the return on a zero-investment portfolio designed to capture small firm risks, and WHML is the return on a zero-investment portfolio designed to capture book-to-market risks.[35] We use the model in equation (14) to estimate betas for each firm.

The results in Table 8 indicate that size and book-to-market betas are significantly positively related to the cross-section of implied risk premia even after controlling for different characteristics. The world market beta turns insignificant in the presence of size and book-to-market betas while leverage, idiosyncratic volatility and book-to-market ratio continue to be significant.[36] These results suggest a possible role for size and book-to-market factors in international asset pricing. The challenge, however, is to understand why these factors might be important in international asset pricing, since the theoretical basis for these factors in international asset pricing is unclear.

F. Robustness Test on Analyst Forecast Errors

One potential concern with the use of analyst forecasts is the degree of bias in them. It is well known that analyst forecasts are biased (i.e., tend to be optimistic). If the bias in these forecasts differs significantly across countries, our implied risk premium estimates could be affected. We have taken several steps to handle this potential problem.

First, prior studies show that while analyst forecasts tend to be over-optimistic, the severity of the bias is quite similar across countries. For example, Frankel and Lee (1999) report that the average bias (forecast minus actual scaled by the forecast) in one-year-ahead forecasts is between 1% and 13% across the G-7 countries with the largest bias of 13% being observed for U.S. analysts, while the bias for everyone else is less than 10%. Similarly, Ang and Ciccone (2001) report standard deviation of analyst forecast error (but not the bias) across the G-7 countries. Their estimates range between 6% and

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[35] Zhang (2003) follows Fama and French (1993, 1998) closely in her portfolio construction. Zhang (2003) constructs the WHML and WSMB factors using firm-level returns, B/M ratios and market capitalizations from the U.S., the U.K., and Japan as obtained from Datastream. Within each country, the high and low B/M portfolios and small and large size portfolios are first formed. These country value and size portfolios are formed using value weights. The world value and size portfolios are formed by aggregating across countries' value and size portfolios using the countries' market capitalizations. The WHML factor represents the difference in returns of the high and low world value portfolios, while the WSMB factor represents the difference in returns of world small and big size portfolios.

[36] We have also estimated cross-sectional regressions involving realized returns and the error spread based on the three factor model in (14) and we find that these regressions are noisy compared to those based on the implied cost of capital presented in Table 9.

19% suggesting once again that the magnitude of the forecast errors is comparable across our sample countries.

To investigate this issue further, we explicitly adjust for ex post country-level forecast biases. The ex post forecast biases are computed using subsequent realized earnings of firms in each country. We then subtract these ex post country-mean forecast biases from each firm's earnings forecasts before the implied cost of capital is computed. We find that our cross-sectional results (available upon request) remain similar to the main results.

Second, in order to minimize the effect of these biases in long-run cash flows, we use an exponential rate of mean-reversion to forecast long-run growth rates, thus ensuring that the biases in short-run forecasts have minimal effect on the long-run growth rates.

Third, we conduct a Monte Carlo simulation that examines the potential effect of analyst forecast errors on our cost of capital estimates. The results (available upon request) show that the risk premium estimates vary from –1.0% to +1.0%, on average, based on the most extreme 5% and 95% forecasts (drawn from a simulated bivariate normal distribution of FY1 and FY2 estimates). These results suggest that analyst forecast errors are not likely to be a major factor in our results.

VII. Conclusions

This paper uses a new approach based on discounted cash flow models to estimate cost of equity capital for firms in the G-7 countries. The results show that firm characteristics such as idiosyncratic volatility, leverage, B/M and size are important in explaining the risk premia. Currency betas and, to a smaller extent, world market betas, as suggested by international asset pricing theory, also have power to explain the estimated risk premia. Together, the betas and the characteristics explain approximately 20% of the cross-sectional variation in risk premia in G-7 countries.

Our results are subject to a few caveats. First, we acknowledge that this study is limited in scope, particularly with respect to country membership. Second, we acknowledge that any large scale estimation of valuation models across many firms involves simplifying assumptions. Although we have done extensive robustness checks, including the use of four different valuation models, it is still possible that commonality in the way we handled model implementation or noise filtering could have induced a greater degree of commonality in results across these models. However, we see no reason that these design issues should result in the systematic relationships with betas and firm characteristics that we document.

Collectively, our findings support a broader use of the implied cost of capital in the finance literature, particularly in international asset pricing. Our findings should also be of interest to financial practitioners who wish to estimate the cost of equity capital for their international investments. The consistency of our regression results suggests that the relations we document can potentially be used to estimate cross-sectional costs of capital in an international context. We view this as a promising venue for future research.

The fact that the firm characteristics are priced also highlights the need to develop alternate asset pricing models that might accommodate these empirical findings. For example, Daniel, Hirshleifer, and Subrahmanyam (2001) entertain a behavioral asset pricing model in which expected returns are linearly related to both systematic risk and mispricing measures. Their model implies that the book-to-market ratios should be priced. Daniel and Titman (1997) and Daniel, Titman and Wei (2001) find that characteristics rather than covariances drive the cross-sectional expected returns in the U.S. and Japan.[37] Our results involving the role of B/M and size are consistent with these findings

In summary, our main message is that the implied cost of capital approach can provide important new insights into the cross-sectional determinants of firm-level expected returns in the international context. We view these results as encouraging, and hope that they will serve as catalysts toward a broader acceptance of implied expected returns in the asset pricing literature.

[37] Davis, Fama, and French (2000) object to this interpretation.

REFERENCES

Adler, M. and B. Dumas. "International Portfolio Choice and Corporation Finance: A Synthesis." *Journal of Finance,* 38 (1983), 925-984.

Ang, A., and G. Bekaert. "Stock Return Predictability: Is it There?" *Review of Financial Studies*, 20 (2007), 651-707.

Ang, A., R. Hodrick, Y. Xing and X. Zhang. "The Cross-Section of Volatility and Expected Returns." *Journal of Finance*, 61 (2006), 259-299.

______________. "High Idiosyncratic Volatility and Low Returns: International and Further U.S. Evidence." Columbia University Working paper (2007).

Ang, J. and S. J. Ciccone. "International Differences in Analyst Forecast Properties." Florida State University Working paper (2001).

Banz, R., "The Relationship Between Return and Market Value of Common Stocks." *Journal of Financial Economics* 9, (1981), 3-18.

Bekaert, G. and C. R. Harvey. "Time-Varying World Market Integration." *Journal of Finance,* 50 (1995), 403-444.

Bhandari, L. C. "Debt/Equity Ratio and Expected Common Stock Returns: Empirical Evidence." *Journal of Finance,* 43 (1988), 507-528.

Bossaerts, P. and P. Hillion. "Implementing Statistical Criteria to Select Return Forecasting models: What Do We Learn?" *Review of Financial Studies*, 12 (1999), 405-428.

Botosan, C. and Plumlee M. "Assessing Alternative Proxies for the Expected Risk Premium." *Accounting Review*, 80 (2005), 21-52.

Brealey, R. and S. Myers. *Principles of Corporate Finance,* Irwin McGraw-Hill (2000).

Chan, L. K.; J. Karceski; and J. Lakonishok. "The Risk and Return from Factors." *Journal of Financial and Quantitative Analysis*, 33 (1998), 159-188.

Chan, L. K.; J. Karceski; and J. Lakonishok. "The Level and Persistence of Growth Rates." *Journal of Finance*, 58 (2003), 643-684.

Chan, K. C.; G. A. Karolyi; and R. M. Stulz. "Global Financial Markets and The Risk Premium On U.S. Equity." *Journal of Financial Economics*, 32 (1992), 137-168.

Claus, J. and J. Thomas. "Equity Premia as Low as Three Percent? Evidence from Analysts' Earnings Forecasts for Domestic and International Stock Markets." *Journal of Finance*, 56 (2001), 1629-1666.

Davis, J; E. Fama; and K. French. "Characteristics, Covariances, and Average Returns: 1929 to 1997." *Journal of Finance,* 55 (2000), 389-406.

Daniel, K; S. Titman. "Evidence on the Characteristics of Cross Sectional Variation in Stock Returns." *Journal of Finance,* 52 (1997), 1-34.

Daniel, K; S. Titman; and K. Wei. "Explaining the Cross-Section of Stock Returns in Japan: Factors or Characteristics." *Journal of Finance,* 56 (2001), 743-766.

Daniel, K.; D. Hirshleifer; and A. Subrahmanyam. "Overconfidence, Arbitrage, and Equilibrium Asset Pricing." *Journal of Finance,* 56 (2001), 921-965.

De Moor, L. and P. Sercu. "The Small Firm Anomaly: US and International Evidence." KU Leuven Working paper (2006).

De Santis, G. and B. Gerard. "How Big is the Premium for Currency Risk?" *Journal of Financial Economics*, 49 (1998), 375-412.

Dumas, B. and B. Solnik. "The World Price of Foreign Exchange Risk." *Journal of Finance,* 50 (1995), 445-479.

Easton, P. "PE Ratios, PEG Ratios, and Estimating the Implied Expected Rate of Return on Equity Capital." *Accounting Review*, 79 (2004), 73-95.

Elton, E. J. "Expected Return, Realized Return, and Asset Pricing Tests." *Journal of Finance,* 54 (1999), 1199-1220.

Errunza, V. and E. Losq. "International Asset Pricing under Mild Segmentation: Theory and Test." *Journal of Finance,* 40 (1985), 105-124.

Fama, E. and K. R. French. "The Cross-Section of Expected Stock Returns." *Journal of Finance,* 47 (1992), 427-465.

______________. "Common Risk Factors in the Returns on Stocks and Bonds." *Journal of Financial Economics*, 33 (1993), 3-56.

______________. "Value versus Growth: The International Evidence." *Journal of Finance,* 53 (1998), 1975-1999.

______________. "The Equity Premium." *Journal of Finance,* 57 (2002), 637-659.

Ferson, W. and C. R. Harvey. "The Risk and Predictability of International Equity Returns." *Review of Financial Studies,* 6 (1993), 527-566.

Frankel, R. and Lee, C. "Accounting Diversity and International Valuation." Cornell University Working paper (1999).

Gebhardt, W.; Lee, C.; and B. Swaminathan. "Toward an Implied Cost of Capital." *Journal of Accounting Research,* 39 (2001), 135-176.

Gode, D. and P. Mohanram. "Inferring the cost of capital using the Ohlson-Juettner Model." *Review of Accounting Studies,* 8 (2003), 399-431.

Goyal, A. and I. Welch. "Predicting the Equity Premium with Dividend Ratios." *Management Science*, 49 (2003), 639-654.

Griffin, J. "Are the Fama and French Factors Global or Country Specific?" *Review of Financial Studies*, 15 (2002), 783-803.

Guay, W.; S. P. Kothari; and S. Shu. "Properties of Implied Cost of Capital Using Analysts' Forecasts." University of Pennsylvania Working Paper (2005).

Hail, L. and C. Leuz. "International Differences in the Cost of Equity Capital: Do Legal Institutions and Securities Regulation Matter?" *Journal of Accounting Research*, 44 (2006), 485-531.

Harvey, C. R. "The World Price of Covariance Risk." *Journal of Finance,* 46 (1991), 111-157.

Heston, S.; K. G. Rouwenhorst; and R. Wessels. "The structure of international stock returns and the integration of capital markets." *Journal of Empirical Finance,* 2, (1995), 173-197.

Hou, K.; G. A. Karolyi; and B. Kho. "What Factors Drive Global Stock Returns?" Ohio State University Working Paper (2006).

Jorion, P. "The Pricing of Exchange Rate Risk in the Stock Market." *Journal of Financial and Quantitative Analysis*, 26, (1991), 363-376.

Jorion, P. and E. Schwartz. "Integration vs. Segmentation in the Canadian Stock Market." *Journal of Finance,* 41 (1986), 603-614.

Karolyi, G. A. and R. Stulz. "Are Financial Assets Priced Locally or Globally?" *In Handbook of the Economics of Finance,* North Holland-Elsevier (2003).

Lakonishok, J.; A. Shleifer; and R. W. Vishny. "Contrarian Investment, Extrapolation, and Risk." *Journal of Finance,* 49 (1994), 1541-1578.

Malkiel, B. and Y. Xu. "Idiosyncratic Risk and Security Returns." Princeton University Working Paper (2002).

Merton, R. "Estimating the Expected Return on the Market: An Exploratory Investigation." *Journal of Financial Economics,* 8 (1980) 323-361.

Modigliani, F. and M. H. Miller. "The Cost of Capital, Corporation Finance and the Theory of Investment." *American Economic Review,* 48 (1958), 261-297.

Nissim, D. and S. H. Penman. “Ratio Analysis and Equity Valuation: From Research to Practice.” *Review of Accounting Studies,* 6 (2001), 109-154.

Ohlson, J. and B. E. Juettner-Nauroth. "Expected EPS and EPS Growth as Determinants of Value." *Review of Accounting Studies,* 10 (2005), 349-365.

Ince, O. and R. Porter. "Individual Equity Return Data From Thomson Datastream: Handle with care!" *Journal of Financial Research,* 20 (2006), 463-479.

Pastor, L., M. Sinha, and B. Swaminathan, “Estimating the intertemporal risk-return tradeoff using the implied cost of capital.” forthcoming, *Journal of Finance* (2007).

Sercu, P. "A Generalization of the International Asset Pricing Model." *Revue de l’Association Francaise de Finance*, 1 (1980), 91-135.

Sharpe, W. F. "New Evidence on the Capital Asset Pricing Model: Discussion." *Journal of Finance*, 33 (1978), 917-920.

Solnik, B. "An Equilibrium Model of the International Capital Market." *Journal of Economic Theory*, 8 (1974), 500-524.

Spiegel, M. and X. Wang. "Cross-sectional Variation in Stock Returns: Liquidity and Idiosyncratic Risk." Yale University Working Paper, 2006.

Stulz, R. "A Model of International Asset Pricing." *Journal of Financial Economics*, 9 (1981), 383-406.

Zhang, X., "Specification tests of asset pricing models in international markets." *Journal of International Money and Finance*, 25 (2006), 275-307

Appendix: Detailed Description of Alternative Implied Costs of Capital

Botosan and Plumlee (2005) provide a description of the assumptions and data requirements among different implied costs of capital methodologies. Our summary is a modified version of their description. Our implementations of the models follow Hail and Leuz (2006).

	CS	Short-horizon	Terminal Value	I/B/E/S Forecasts
r_e	Y	During the explicit forecast period, analysts' forecasts of earnings and book value are assumed to be equal to market expectation. During the explicit forecast period, firm ROE fades linearly to industry ROE, while firms growth rates fade exponentially to long term growth rates.	The explicit forecast horizon we implement is fifteen years. Beyond the forecast horizon, there are two major assumptions underlying our model: (a) growth rate is assumed to revert to long-run GDP growth rate and (b) return on new investment, ROI, is assumed to revert to cost of equity, r_e.	current year, one- and two-year ahead earnings per share. Dividends per share. Book value per share.
r_{OJ}	No	Analysts' forecasts of earnings in years one and two equal the market expectation. Year one earnings and year two abnormal earnings are positive. Abnormal earning is defined as: $r^{-1}\left(FE_2 - rD_1 - (1+r)FE_1\right)$	The explicit forecast horizon is two years. Growth in abnormal earnings occurs at a constant, economy-wide growth rate. Estimated constant rate of growth in abnormal earnings is the same as the market's expectation. Constant rate of growth is below the cost of equity and above zero.	Current year dividends per share. One- and two-year ahead earnings per share.
r_{MPEG}	No	Analysts' forecasts of earnings in years one and two equal the market expectation. Zero dividends in year one. Year one earnings and year two abnormal earnings are positive. Year two abnormal earnings are defined as: $r^{-1}\left(FE_2 - (1+r)FE_1\right)$	The explicit forecast horizon is two years. Beyond the forecast horizon, growth in abnormal earnings are assumed to be zero.	One-year ahead earnings per share. .
r_{CT}	Y	During the explicit forecast period, analysts' forecasts of earnings up to three years ahead are assumed to equal market expectation. Each residual income in the future equals the forecast earnings minus the book value times the implied cost of capital.	The explicit forecast horizon is three years. Beyond the forecast horizon, the nominal residual income is assumed to grow at GDP growth rate.	Current book value per share. One- and two year ahead earnings per share.

CS refers to clean surplus accounting. Y in the CS column means that clean surplus accounting is assumed, while N means that clean surplus accounting is not required.