Implied Cost of Capital: A Forward-Looking Estimate of Equity Risk Premium

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Overview

- **Empirical Asset Pricing:** Factor-Based and Characteristics-Based Risk Premia
- **Option-Implied Equity Risk Premia**
- **Implied Cost of Capital (ICC):** Definition & Estimation
- **Empirical Evidence:** Properties of ICC & Predictability of Equity Returns

Motivation

- Ex-ante expected returns represent forward-looking expectations by investors.
- It is a critical input for investors' asset allocation decisions, corporate capital budgeting, and pricing frameworks.
- Existing empirical methods rely heavily on historical data analysis and statistical modeling.
- **Example:** The historical mean return is frequently used as a proxy for future expected returns.
- **Challenge:** it ignores time variation in risk premia, structural breaks, and non-stationarity in financial markets.

Empirical Asset Pricing Approach: Factor Models

Factor Structure: A firm's expected risk premium (ERP) is modeled as a linear function of

- **Factor Sensitivities** (*factor loadings*, β_i's).
- **Risk Premia** (λ's): Represent the compensation investors require per unit of factor exposure.

The **realized return** of company i is given by:

$$R_{i,t} = \alpha_i + \beta_{i1} F_{1,t} + \beta_{i2} F_{2,t} + \cdots + \beta_{iL} F_{L,t} + e_i. \tag{1}$$

Under equilibrium pricing, the **expected return** is given by:

$$\mathbb{E}[R_{i,t+1}] = \lambda_0 + \beta_{i1}\lambda_1 + \beta_{i2}\lambda_2 + \cdots + \beta_{iL}\lambda_L. \tag{2}$$

Limitations of Factor Models

- Which factors matter?
- Factor loadings and risk premia change over time, but most models assume static relationships.
- Factor-based ERPs perform poorly in both the time-series and cross-section (Lee et al., 2021, Hommel et al., 2023)

Characteristic-based ERPs

Linear combination of firm characteristics, where the weights are derived from the historical cross-sectional relations between realized returns and characteristics (e.g, Lewellen, 2014):

$$E(R_{i,t+1}) = \lambda_{0,t} + \sum_{j=1}^{K} \lambda_{j,t} X_{i,j,t} + \varepsilon_{i,t+1} \tag{3}$$

$$\hat{\lambda}_j = \frac{1}{T} \sum_{t=1}^{T} \lambda_{j,t}$$

- Performs well in the cross-section but exhibits weaknesses in time-series
- Factor instability and lack of time variation
- Ignores market expectations

Equity Premium in Terms of the Volatility Index, SVIX (Martin, 2017)

- The $SVIX^2$ is derived from **index option prices** and serves as a **lower bound** on the equity risk premium.
- The bound is applied to the S&P 500, where R_T represents the gross return on the index.

$$\mathrm{SVIX}^2_{t\to T} = \frac{2}{(T-t)R_{f,t}S_t^2}\left[\int_0^{F_{t,T}} \mathrm{put}_{t,T}(K)\,dK + \int_{F_{t,T}}^{\infty} \mathrm{call}_{t,T}(K)\,dK\right]$$

$$\frac{1}{T-t}\left(\mathbb{E}_t R_T - R_{f,t}\right) \geq R_{f,t}\cdot \mathrm{SVIX}^2_{t\to T}$$

Limitations:

- Option price data is available only from January 1996 onward.
- For estimating **long-term risk premia** (e.g., 3 to 5 years), option markets are illiquid.

Dividend Discount Model

The fundamental value of a firm is given by the **present value of all expected future cash flows**:

$$P_t = \sum_{\tau=1}^{\infty} \frac{\mathbb{E}_t[D_{t+\tau}]}{(1+r)^\tau} \tag{4}$$

Issue: How do we value firms that do not pay dividends?

Solution: Clean Surplus Accounting (Ohlson, 1995): Changes in a firm's book value must be fully explained by reported earnings and dividends:

$$BV_t = BV_{t-1} + E_t - D_t \tag{5}$$

Rearranging, we express dividends as:

$$D_t = E_t - (BV_t - BV_{t-1}) \tag{6}$$

Residual-Income Model

Substitute (6) **into** (4)**:**

$$P_t = \sum_{\tau=1}^{\infty} \frac{E(E_{t+\tau} - dBV_{t+\tau})}{(1+r)^\tau} \tag{7}$$

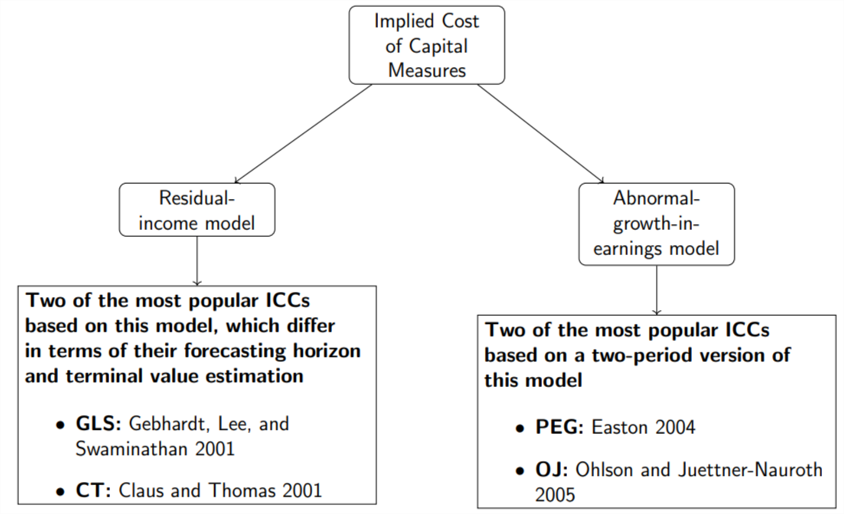
Residual Income:

$$RI_t = EPS_t - r \cdot B_{t-1} \tag{8}$$

Residual Income Valuation Model:

$$P_t = B_t + \sum_{\tau=1}^{\infty} \frac{E_t(ROE_{t+\tau} - r) \cdot B_{t+\tau-1})}{(1+r)^\tau} \tag{9}$$

Implied Cost of Capital



Residual Income Model: GLS (Gebhardt et al., 2001)

Model:

$$P_t = B_t + \frac{E_t[FROE_{t+1} - r_{GLS}]}{(1 + r_{GLS})} B_t + \frac{E_t[FROE_{t+2} - r_{GLS}]}{(1 + r_{GLS})^2} E_t[B_{t+1}] + \sum_{i=3}^{T-1} \frac{E_t[FROE_{t+i} - r_{GLS}]}{(1 + r_{GLS})^i} E_t[B_{t+i-1}] + \frac{E_t[FROE_{t+T} - r_{GLS}]}{r_{GLS}(1 + r_{GLS})^{T-1}} E_t[B_{t+T-1}] \quad (10)$$

Variables:

- B_t: Book value per share at t.
- $FROE_{t+i} = \frac{FEPS_{t+i}}{B_{t+i-1}}$
- $FEPS_{t+i}$: Forecasted EPS (I/B/E/S forecasts).
- After year 3, *FROE* converges linearly to industry median.
- Book value evolution (clean surplus):

$$B_{t+i} = B_{t+i-1} + FEPS_{t+i}(1 - k)$$

- k is the dividend payout ratio.

Residual Income Model: CT (Claus and Thomas, 2001)

Model:

$$P_t = B_t + \sum_{h=1}^{5} \left(\frac{E_t \left[(FROE_{t+h} - r_{CT}) B_{t+h-1} \right]}{(1 + r_{CT})^h} \right) + \frac{E_t \left[(FROE_{t+5} - r_{CT}) B_{t+4} (1 + g) \right]}{(r_{CT} - g)(1 + r_{CT})^5}$$

Variables:

- B_t: Book value per share at t.
- $FROE_{t+i} = \frac{FEPS_{t+i}}{B_{t+i-1}}$
- $FEPS_{t+i}$: Forecasted EPS (I/B/E/S forecasts).
- After year 3, EPS is assumed to grow at a constant long-term growth rate, *ltg*, obtained from I/B/E/S analyst forecast.
- The dividend growth rate in perpetuity, g, equals to the risk-free rate minus 3%.

Abnormal Growth-in-Earnings Model: OJ (Ohlson and Juettner-Nauroth, 2005)

$$r_{OJ} = A + \sqrt{A^2 + \frac{EPS_1}{P_0} * (STG - (\gamma - 1))} \tag{11}$$

where

$$A = \frac{1}{2}\left(\gamma - 1 + \frac{DPS_1}{P_0}\right)$$

and

$$STG = \frac{EPS_2}{EPS_1} - 1$$

- $\gamma - 1$ expected long-run economy growth rate. It is assumed to be equal to $r_f^{10Y} - 3\%$

Abnormal Growth in Earnings Model: PEG (Easton, 2004)

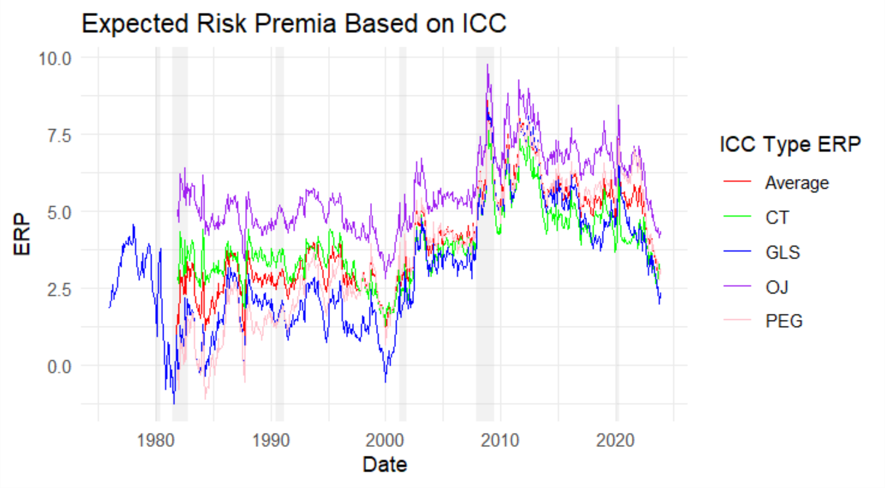
The method is inspired by the price-earnings to growth (PEG) ratio. It is a simplification of (11) that sets $\gamma - 1 = 0$ and ignores dividends, leading to

$$r_{PEG} = \sqrt{\frac{(EPS_{t+2} - EPS_{t+1})}{P_t}}, \tag{12}$$

Data

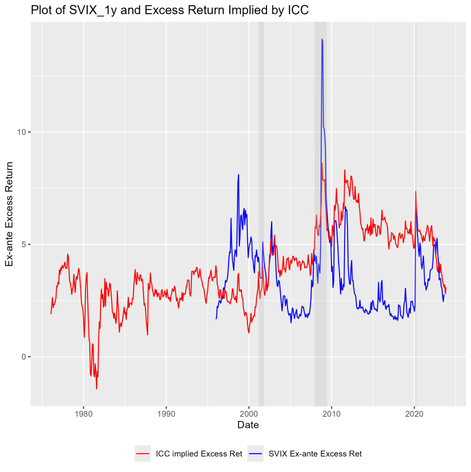
- The dataset consists of monthly data on U.S. common stocks listed on the NYSE, AMEX, and NASDAQ, sourced from CRSP, covering the period from January 1976 to March 2023.
- Annual accounting data is obtained from Compustat.
- Monthly estimates of 1-year and 2-year consensus EPS forecasts, along with long-term growth rate projections, are retrieved from I/B/E/S.
- The **implied risk premium** is computed as the **difference between the ICC and the yield to maturity on the U.S. 10-year government bond**, with bond yield data sourced from FRED.

ICC Based Risk Premia



Comparison between ERP-ICC and SVIX

	ERP (ICC)	ERP (SVIX1Y)	S&P 500
AV	3.90	3.57	8.22
SD	1.69	1.81	15.64



Out-of-Sample (OOS) Predictability: Goyal and Welch (2008)

- **Expanding Window Estimation:** At each time t, estimate the predictive regression using all available historical data up to t:

$$r_{t+1} = \alpha + \beta X_t + \varepsilon_{t+1} \tag{13}$$

where X_t is the predictor variable (e.g., dividend yield, ICC, SVIX).

- Using estimated coefficients $\hat{\alpha}_t$ and $\hat{\beta}_t$, generate a one-step-ahead forecast $\hat{r}_{t+1}$.
- The **OOS** R^2 is calculated as:

$$R^2_{\text{OOS}} = 1 - \frac{\sum(r_{t+1} - \hat{r}_{t+1})^2}{\sum(r_{t+1} - \bar{r})^2} \tag{14}$$

where $\bar{r}$ is the historical mean return.

Out-of-Sample Performance of the ICC-ERP

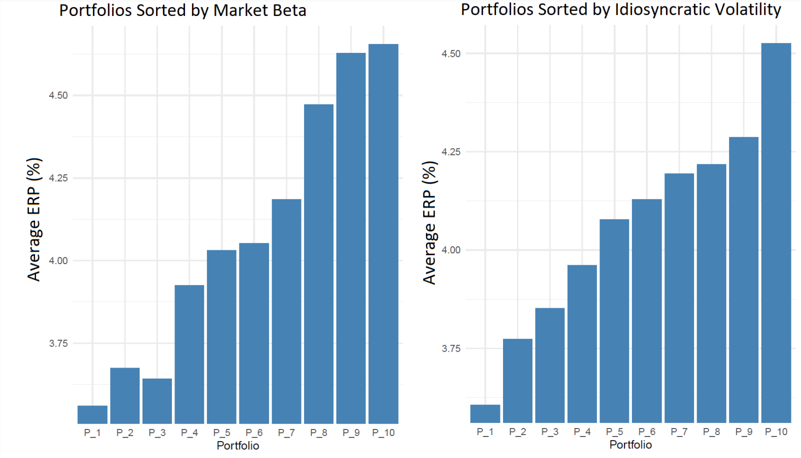
A positive cumulative SSE difference indicates that the predictor provides **better forecasts** than the historical mean.

	R^2 **In-Sample (IS)**	R^2 **Out-of-Sample (OOS)**
Value	7.56	5.44

Average Risk Premia and Stock Characteristics

- To analyze the relationship between ICC-implied risk premia and firm characteristics, stocks are sorted into **decile portfolios** based on key attributes.
- The **average ICC** is computed for each portfolio.
- Stock characteristic data is obtained from Jensen et al., 2023 (via WRDS).
- Characteristics are grouped into **six categories**: Value, Momentum, Intangibles, Investment, Trading Frictions, and Profitability.

Value-Weighted Average Expected Risk Premium Based on ICC



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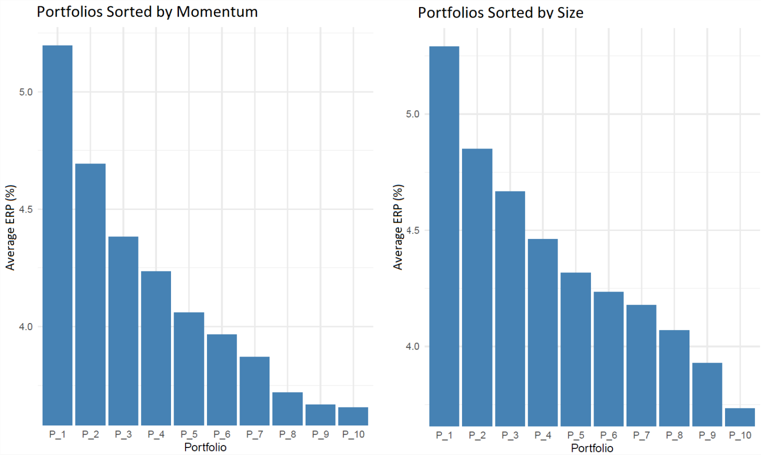

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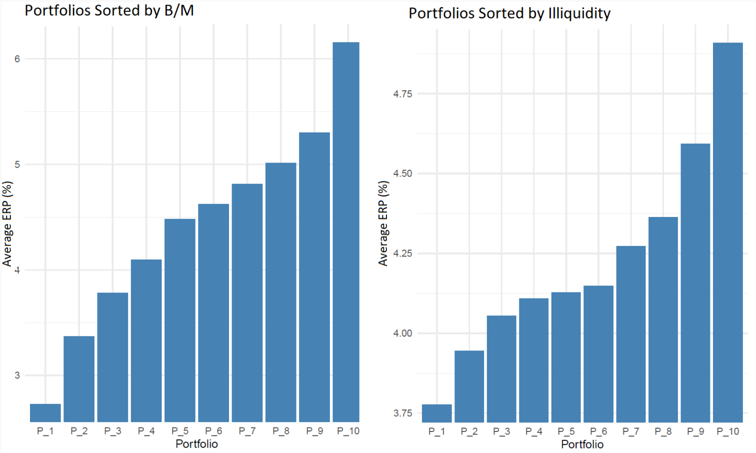

Conclusion

- The **implied cost of capital** is a forward-looking measure of **risk premia** and an alternative to traditional proxies.
- Estimates **ex-ante risk premia** at the **firm level**, which can be aggregated to the **market level**.
- Incorporates **investors' expectations** about future cash flows.
- Unlike factor-based models, characteristic-based approaches, or SVIX, ICC captures **long-term risk premia**.
- Empirical evidence shows ICC is a **robust predictor** of future returns **out-of-sample**.