Unicorn Illusions: A Novel Approach to Startup Valuation Using ESG

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Abstract: Overvalued startups with unsustainable business models remain a critical issue, driven by market irrationality and overlooked risks. This study introduces an ESG-integrated Discounted Cash Flow (DCF) model to address these valuation inaccuracies. By incorporating Environmental, Social, and Governance (ESG) metrics into the Weighted Average Cost of Capital (WACC), the model effectively accounts for ESG-related risks and opportunities. The analysis reveals that startups with higher ESG ratings experience reduced costs of equity and debt, resulting in a lower WACC and more accurate valuations. This approach highlights the benefits of integrating sustainable practices into business models, promoting long-term stability and investor confidence. A comprehensive review of existing valuation methods identified key gaps, particularly in accounting for qualitative ESG factors. Regression analysis of case studies demonstrated how ESG-adjusted discount rates improve valuation precision without double-counting risks. Findings suggest an inverse relationship between ESG ratings and capital costs, emphasizing the financial advantages of robust ESG frameworks. This research underscores the need for investors and venture capitalists to incorporate ESG considerations systematically, reducing the risk of market bubbles and fostering sustainable business practices. Future studies should explore nonlinear modeling and behavioral finance to further enhance ESG-integrated valuation frameworks.

1 INTRODUCTION

Startups today often face inflated valuations driven by overoptimistic expectations of future profits, neglecting underlying sustainability and ethical risks—a trend reminiscent of the Dot-Com bubble. Traditional valuation methods, such as the Berkus, Scorecard, and Venture Capital approaches, focus mainly on tangible and intangible assets, overlooking long-term sustainability and societal impacts. This oversight not only distorts a startup's true value but also jeopardizes economic fairness and market stability, affecting stakeholders from employees to early investors.

In response, this research proposes an enhanced valuation model that integrates Environmental, Social, and Governance (ESG) factors with critical multiplism. By incorporating multiple perspectives, this approach provides a more nuanced understanding of startup value, promotes transparency, and mitigates risks associated with speculative bubbles. Ultimately, the study advocates for a balanced methodology that aligns financial potential with ethical considerations, paving the way for more sustainable and resilient entrepreneurial growth.

2 PROBLEM

Traditional corporate finance theory values a company based on the present value of expected future cash flows, discounted at a cost of capital reflecting its financing sources. However, a comprehensive startup valuation should also consider factors like business models, market dynamics, and risks. Recently, ESG factors have gained importance in corporate finance, with sustainable investing growing globally. Current valuation models for startups often overlook ESG, failing to capture its impact on long-term value and risk. Key challenges in integrating ESG into startup valuations include adjusting the discount rate or projected cash flows in a DCF model, with issues like double counting and

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difficulty quantifying ESG impacts. This study addresses these challenges by developing an ESG-incorporated DCF model and testing it with a startup already valued without ESG factors. A key challenge for startup investors lies in integrating ESG factors into valuation models, given the limited financial history and uncertain future of early-stage companies. Although CAPM adjustments have been suggested for more mature companies, two primary approaches have emerged to integrate the ESG factors into startup valuation:

1. Adjusting the discount rate in a discounted cash flow (DCF) model: This method posits that startups with poor ESG practices may be perceived as riskier, warranting a higher discount rate and resulting in a lower valuation. However, this approach faces two significant challenges:

1.1 Determining the appropriate adjustment magnitude

1.2 There is a risk of double-counting if the startup ecosystem has already priced in these risks. One of the critical challenges in incorporating ESG factors into startup valuation is avoiding double counting, particularly when adjusting the discount rate. Many traditional risk components, such as company size, market risk, and leverage, already capture certain ESG-related risks indirectly. For instance:

1.2.1 Company Size Premium: The size premium in CAPM accounts for risks associated with smaller firms, such as governance challenges and financial instability. These risks intersect with ESG governance factors, as lower board independence and weaker shareholder rights can amplify governance risks already considered in company-size premiums.

1.2.2 Industry-Specific Risk Premiums: Industries with high regulatory and environmental scrutiny (e.g., energy, manufacturing) already have elevated discount rates due to anticipated compliance costs and policy risks, which could overlap with ESG-related risks.

2. Adjusting projected future cash flows in a DCF model: This approach necessitates estimating the impact of ESG factors on a startup's future revenue, costs, and growth trajectory. While this method encourages investors to consider the tangible effects of ESG issues on the business model, quantifying these impacts remains challenging for early-stage companies.

This study aims to address the challenges posed by the DCF Model discount rate approach (as described in 1.1. and 1.2 above), contributing to the development of more robust and comprehensive startup valuation methodologies that effectively incorporate ESG considerations through the application of critical multiplism. The new ESG-incorporated DCF model will be tested with a startup that has already been valued without an ESG factor to show how the new valuation changes the trajectory.

3 METHODS OF STUDY

This study employs comprehensive literature review as its primary research method to explore the phenomenon of overvalued startups, the traditional and emerging valuation methodologies, and the integration of ESG principles into these frameworks. The literature review involves analyzing a diverse range of sources, including academic reports, company financial reports, industry analyses, and relevant databases such as PitchBook. The following steps outline the research methodology:

1. Literature Review:

1.1 Academic Reports: Peer-reviewed journal articles and books provide a theoretical foundation for understanding traditional and contemporary startup valuation methods. Key sources include seminal works on corporate finance, sustainable investing, and critical multiplism.

1.2 Industry Reports: Reports from industry experts and consultancy firms like Deloitte and CFA Institute offer insights into current practices, trends, and challenges in startup valuation and ESG integration.

1.3 Company Financial Reports: Analysis of financial statements and reports from startups and established companies helps in understanding real-world applications of valuation methodologies and the impact of ESG factors on financial performance.

2. Qualitative Analysis:
The study conducts a qualitative analysis of the gathered literature to identify common themes, gaps, and inconsistencies in the existing valuation methods. Comparative analysis of different valuation models (e.g., Berkus Method, Scorecard Method, Venture Capital Method) highlights their strengths and limitations in incorporating ESG factors.

3. To operationalize ESG adjustments without double counting, our methodology follows a structured process:

3.1 Selection of ESG Factors: ESG factors are screened for their relevance and uniqueness in contributing to the startup's valuation. Only factors with demonstrated financial impact, beyond existing discount rate components, are considered.

3.2 Quantification of ESG Impact: ESG scores from multiple rating agencies are normalized. Regression models are employed to determine the incremental impact of ESG on financial performance.

3.3 Integration into Valuation Model: Discount rate modifications (if necessary) are subject to statistical validation to ensure they capture new information rather than overlapping with existing risk factors.

By implementing these safeguards, our ESG-integrated valuation model ensures a more accurate reflection of startup value while systematically preventing double counting.

4 LITERATURE REVIEW

Business valuation is inherently complex for any company. When it comes to startups with minimal or no revenue, uncertain prospects, and a lack of established financial performance, determining a valuation becomes particularly challenging. For mature, publicly traded companies with consistent revenue and earnings, the valuation process is generally straightforward, typically involving multiples of earnings before interest, taxes, depreciation, and amortization (EBITDA) or other industry-specific ratios such as PEG, P/E, or P/B ratios. However, evaluating a new, privately held venture that might not yet be generating sales is significantly more difficult. The challenge primarily arises from:

1. Absence of Historical Financial Data
2. Uncertain Future Performance
3. Lack of Comparables
4. Dependence on Multiple Funding Rounds
5. Subjectivity and Bias

4.1 Startup Valuation Methods

Valuation methods for startups vary depending on the stage of the startup, ranging from the early pre-revenue phase to later stages with revenue and established operations.

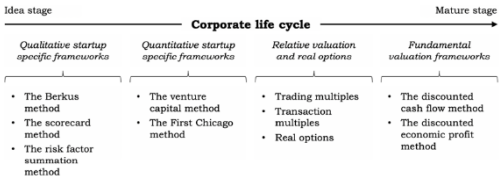

Figure 1: Valuation Framework along Corporate Lifecycle.

The following sections outline several of the most commonly used valuation techniques.

4.1.1 Berkus Method

The Berkus Method, developed in the early 1990s by Dave Berkus, is tailored for pre-revenue startups. It assigns monetary values to key qualitative factors—such as the soundness of the business idea, the strength of the management team, product development, market potential, and strategic relationships—each capped at a predetermined limit. This structured approach helps prevent overly optimistic valuations in the absence of hard financial data. However, its reliance on subjective assessments and fixed value limits may oversimplify the complex risk and opportunity profiles inherent in early-stage ventures.

4.1.2 Risk Factor Summation Model

The Risk Factor Summation Model (RFSM) builds on a baseline valuation by systematically adjusting for various risk factors associated with startups. This model quantifies risks—including management, market competition, technological uncertainty, and regulatory issues—by assigning numerical values to each and then summing these adjustments. While RFSM offers a more comprehensive risk assessment than methods that rely solely on financial metrics, its heavy reliance on subjective scoring and the challenge of accurately weighing different risk factors can result in inconsistent valuations. Ratings for each risk factor can be evaluated as follows.

4.1.3 the Venture Capital Method

The Venture Capital Method takes a forward-looking approach by estimating a startup's current value based on its projected exit value. It involves forecasting future financial performance, applying an appropriate exit multiple derived from comparable market transactions, and discounting the future exit value back to the present using a required rate of return. Although this method is widely used by venture capital investors for its focus on eventual

liquidity and ROI, it is highly dependent on speculative future projections and assumptions about market conditions at the time of exit, introducing significant uncertainty into the valuation.

4.1.4 First Chicago Model

The First Chicago Model addresses the inherent uncertainty of startup performance by employing a scenario-based approach. Developed by Sahlman and Scherlis (1987) and further elaborated by Damodaran (2009), this method constructs multiple financial projections—typically encompassing base, upside, and downside scenarios—and then calculates a probability-weighted valuation. By capturing a broader range of potential outcomes, the First Chicago Model provides a more nuanced view of risk and reward. However, its reliance on accurate probability assignments and multiple assumptions can add complexity and potentially reduce precision. Additionally, the accuracy of the valuation depends heavily on the quality of the assumptions and projections used (Cumming & Johan, 2013).

4.1.5 Discounted Cash Flow Method

The Discounted Cash Flow (DCF) method is a fundamental valuation technique used to estimate the intrinsic value of an investment based on its expected future cash flows. This method is particularly useful for valuing companies, projects, and investments by considering the time value of money and the associated risks. The core principle of DCF is that the value of an asset is equal to the present value of its expected future cash flows.

The DCF valuation process involves several key steps. First, future cash flows are forecasted based on historical performance, industry trends, and management projections. These cash flows typically include revenues, operating expenses, taxes, changes in working capital, and capital expenditures, resulting in the free cash flow (FCF) available to the firm.

Next, an appropriate discount rate is determined. Generally, the Weighted Average Cost of Capital (WACC), which reflects the company's cost of equity and debt, is adjusted for the risk profile of the business.

The future cash flows are then discounted to their present value using the WACC. In addition to the forecast period, a terminal value is calculated to account for the value of the business beyond the forecast horizon. The terminal value can be estimated using the perpetuity growth model or an exit multiple approach.

Advantages of DCF Model:

1 Intrinsic Value: Focuses on a company's fundamentals and cash flow generation.
2 Flexibility: Adapts to different scenarios and assumptions for sensitivity analysis.
3 Comprehensive: Accounts for the time value of money and key value drivers.

Limitations of DCF Model:

1 Assumption Sensitivity: Small changes in inputs (cash flows, discount rates, terminal values) can significantly alter valuations.
2 Complexity: Requires detailed financial projections and deep operational insights.
3 Data Intensive: Reliable data is crucial, making it challenging for early-stage startups with limited financial history.

5 PROPOSED SOLUTION

Traditional corporate finance valuation models, such as the DCF approach, have yet to fully account for the growing influence of ESG factors. The integration of ESG considerations into startup valuation poses unique challenges, particularly in terms of adjusting the discount rate and projecting future cash flows. However, given the increasing importance of sustainable investing and its potential to reshape investment decision-making, it is crucial to develop more robust and inclusive valuation methodologies. To address these challenges, this study proposes a comprehensive solution that incorporates ESG factors into the DCF model, ensuring a more accurate reflection of a startup's long-term value and risk profile. The following methodology outlines a systematic approach consisting of the following steps:

1. Careful selection of ESG Ratings: Obtain ESG ratings from reliable sources such as MSCI or Sustainalytics. These ratings serve as a foundation for quantifying the impact of ESG factors on the valuation process.
2. Quantify ESG Impact: Translate ESG ratings into a numerical score. For instance, MSCI ratings can be converted into a scale from 0 to 100, allowing for easier integration into financial models.
3. Calculate the Base Discount Rate: Begin with a traditional calculation of the discount rate using the Weighted Average Cost of Capital (WACC) or Cost of Equity (CoE). This base rate should reflect traditional risk factors, including market risk, company size, and financial leverage.

4. Adjust for ESG Factors: Use regression analysis to isolate the impact of ESG on the discount rate. This step is crucial to avoid double counting by ensuring that the ESG effect is distinct from other risk factors. Our methodology prioritizes ESG factors that provide additional, independent insights into a startup's risk profile, beyond what is already captured by traditional financial metrics. For instance, social factors such as employee retention rates and customer trust scores are considered alongside governance metrics that directly impact operational risk. ESG factors related to reputational risk are only considered if they significantly impact revenue generation, rather than being assumed to be reflected in the discount rate.
5. Integrate ESG Adjustments: Adjust the base discount rate by applying an ESG premium or discount.

5.1 Comprehensive Approach

5.1.1 Collect ESG Ratings

When collecting ESG ratings, companies typically rely on specialized agencies and platforms that assess and score companies based on their sustainability and governance practices. Here are some key ESG rating agencies and descriptions of how each one rates companies:

1. MSCI ESG Ratings: MSCI evaluates companies on their exposure to ESG risks and their ability to manage them, using data from corporate filings, media, and third-party sources. Ratings range from AAA (leader) to CCC (laggard).
2. Sustainalytics: A subsidiary of Morningstar, Sustainalytics provides ESG Risk Ratings from 0 (negligible risk) to 100+ (severe risk), assessing companies' exposure to and management of ESG risks.
3. FTSE Russell (FTSE4Good Index): FTSE Russell rates companies on ESG practices with a scale from 0 (low) to 5 (high), using over 300 indicators to create indexes like the FTSE4Good.
4. ISS ESG: ISS ESG Ratings focus on corporate and investment practices, ranging from A+ (excellent) to D- (poor).
5. CDP (Carbon Disclosure Project): CDP rates companies on environmental transparency and performance, particularly on climate change and deforestation, with grades from A to D-.
6. S&P Global ESG Scores: S&P Global rates companies' sustainability practices out of 100, with higher scores reflecting better management of ESG risks and opportunities.

5.1.2 Quantify ESG Ratings

Normalizing ESG ratings from different agencies into a consistent number range involves several steps. The first step is selecting a common normalization range, such as a 0-100 scale, where 0 represents the lowest ESG performance and 100 is the highest. Next, it's essential to understand the scoring systems of various agencies, such as MSCI, Sustainalytics, FTSE Russell, ISS ESG, CDP, and S&P Global, by mapping their original scores to the chosen scale. After that, each rating is normalized using a linear transformation formula, which adjusts the original scores to the 0-100 range. The proposed solution to achieve this is as follows:

Step 1: Select a Normalization Range: We propose to normalize all ratings to a 0-100 scale, where 0 represents the lowest ESG performance and 100 the highest.

Step 2: Understand the Scoring Systems: Identify the minimum and maximum values for each rating system. For example:

- MSCI: CCC (lowest) to AAA (highest)
- Sustainalytics: 0 (negligible risk) to 100+ (severe risk) (Note: Lower is better here)
- FTSE Russell: 0 (low) to 5 (high)
- ISS ESG: D- (lowest) to A+ (highest)
- CDP: D- (lowest) to A (highest)
- S&P Global: 0 (lowest) to 100 (highest)

Step 3: Normalize Each Rating: Using a linear transformation formula, we normalize the scores. The formula for normalization to a 0-100 range is:

Normalized Score= Original Sore-Min Original Score Max Original Score -Min Original Score x 100

For example: If a company has a rating of BBB in MSCI ratings, which is between CCC (0) and AAA (6):
Assign numerical values (e.g., CCC=0, B=2, BBB=3, AAA=6)
Applying the formula, the Normalized Score= $(3-0)/(6-0)\times 100=50$
Step 4: Combine the Scores: If you want a single score representing all ratings, you can take the average of the normalized scores:

$$\text{Final ESG Score} = \frac{\sum_{i=1}^{n}(\text{Normalized Score})_i}{n} \quad (1)$$

where n is the total number of agencies.
(or)
Weighted Average: If you want to give more importance to certain rating agencies, assign weights and then calculate a weighted average:

$$\text{Final ESG Score} = \frac{\sum_{i=1}^{n}(\text{Weight}_i \times \text{Normalized Score}_i)}{\sum_{i=1}^{n}\text{Weight}_i} \quad (2)$$

Step 5: Refine and Adjust: The focus is on fine-tuning the normalized ESG ratings to ensure they accurately reflect the company's performance across different dimensions and rating systems.

1. Consider Outliers: If one of the rating systems provides a score that is significantly different from the others, it might indicate a discrepancy in how that particular agency evaluates ESG factors compared to the others. For example, if five rating agencies give a company an average score of 70, but one agency gives a score of 30, this outlier could skew the final combined score. In such cases, you may need to adjust the impact of the outlier, either by down-weighting its influence or by investigating the reason for the discrepancy to determine if it should be treated differently.
2. Check for Consistency: After normalizing the ratings, it's important to review the final scores to ensure they align with the relative importance of ESG factors according to your strategy. This involves verifying that the normalization process has accurately represented the weight and significance of each rating system in relation to the organization's goals. For instance, if environmental factors are more critical to a company's strategy, the final score should reflect this emphasis rather than being overly influenced by ratings that focus on other areas. This consistency check helps to ensure that the normalized ratings provide a meaningful and balanced assessment of the company's ESG performance.

5.1.3 Calculate the Base Discount Rate

For startups, the WACC formula might look like this:

$$\text{WACC} = \text{EV} \times \text{CoE} + \text{DV} \times \text{CoD}\ 1\text{-Tax Rate} \quad (3)$$

Where

E: Market value of equity. The most common way to determine the market value of equity for a startup is through recent investment rounds or through any other models listed in the Literature review section.
D: Market value of debt.
V: Total value of the company (equity + debt).
CoE: Cost of Equity, where beta is used.
CoD: Cost of Debt.
T: Corporate tax rate.
For example, let us assume that

- Market Value of Equity (E): $60 million
- Market Value of Debt (D): $40 million
- Total Value of the Company (V): $100 million (calculated as $60 million + $40 million)
- Cost of Equity (CoE): 9.2% (from the calculation below)
- Cost of Debt (CoD): 5% (before taxes)
- Corporate Tax Rate (T): 30%

WACC=(0.60*9.2%)+(0.40*3.5%)=6.92%

The Weighted Average Cost of Capital (WACC) is 6.92%. This represents the average rate of return that the company needs to generate on its assets to satisfy both equity and debt investors.
The Cost of Equity is the return that equity investors expect for the risk they are taking by investing in the company.

$$\text{Cost of Equity (CoE)} = R_f + \beta \times (R_m - R_f) \quad (4)$$

Where

- R_f: Risk-free rate, usually the return on government bonds.
- R_m: Expected market return.
- R_f - R_m: Market risk premium.
- β: Beta of the startup.

Beta (β) is crucial for evaluating startup risk and return, particularly in calculating the Cost of Equity (CoE) and Weighted Average Cost of Capital (WACC). Since startups rely heavily on equity financing, CoE becomes a key component of WACC. Beta measures a company's volatility relative to the market, and for startups—typically more volatile than established firms—it is often estimated using comparable companies or industry averages with risk adjustments. A higher beta indicates greater risk, requiring investors to demand higher returns, which increases CoE. For instance, while a stable utility company may have a beta near 1, a technology startup may have a beta of 2 or more, reflecting twice the market volatility. As startups face significant market fluctuations, beta serves as a critical tool for assessing their relative risk and investment potential.

For example, let's assume that:

- Risk-Free Rate (R_f)= 2% (e.g., yield on a 10-year government bond)
- Beta (β)= 1.2 (indicating that the stock is 20% more volatile than the market)
- Market Return (R_m)= 8% (expected return of the market)
- Market Risk Premium (R_m - R_f)= 6% (calculated as 8% - 2%)

Then

CoE=2%+1.2*6%=2%+7.2%=9.2%

The Cost of Equity (CoE) is 9.2%.

This means investors expect a 9.2% return on equity to compensate for the risk they are taking.

The Cost of Debt (CoD) represents the effective rate a company pays on its borrowed funds. It's a crucial component of the Weighted Average Cost of Capital (WACC) and reflects the interest expense associated with debt financing. Here's the formula and how it's typically used:

$$CoD=\text{Total Interest Expense} / \text{Total Debt} \quad (5)$$

Where:

- Total Interest Expense: The total amount of interest the company pays on its debt over a specific period.
- Total Debt: The total amount of debt the company has outstanding.

After-Tax Cost of Debt: Since interest expenses on debt are tax-deductible, the after-tax cost of debt is often used in WACC calculations. The formula for the after-tax cost of debt is:

$$CoD\ (\text{after tax})=CoD\times(1-T) \quad (6)$$

where T: The corporate tax rate.

WACC serves as a benchmark for evaluating overall company performance and investment decisions. It represents the minimum average return the company needs to generate across all its investments to satisfy both equity investors and debt holders. It not directly about satisfying the 9.2% expected by equity investors; rather, it's about ensuring the company meets the blended costs of its entire capital structure. Here's a table showing different scenarios for ROI in relation to CoE and WACC with examples:

Table 1: ROI vs. CoE vs. WACC.

Scenario	ROI vs. CoE	ROI vs. WACC	Explanation	Example
Scenario 1: ROI > CoE and ROI > WACC	ROI > CoE	ROI > WACC	The company generates sufficient returns to meet and exceed both the equity and the overall capital cost.	CoE = 9.2%, WACC = 7%, ROI = 10%. This creates value for both equity and debt holders.
Scenario 2: ROI = CoE and ROI > WACC	ROI = CoE	ROI > WACC	The company meets equity investors' expectations and generates enough return for the entire capital structure.	CoE = 9.2%, WACC = 7%, ROI = 9.2%. The company satisfies equity investors and creates value for debt holders.
Scenario 3: ROI > CoE but ROI < WACC	ROI > CoE	ROI < WACC	The company satisfies equity investors but fails to meet the total capital cost, not creating value for debt holders.	CoE = 9.2%, WACC = 10%, ROI = 9.5%. The company satisfies equity investors but doesn't create value for debt holders.
Scenario 4: ROI = CoE and ROI = WACC	ROI = CoE	ROI = WACC	The company exactly meets both equity investors' expectations and the overall capital cost. No value is created, but no value is lost.	CoE = 9.2%, WACC = 9.2%, ROI = 9.2%. The company breaks even; equity and debt holders are satisfied, but no value is added.
Scenario 5: ROI < CoE and ROI < WACC	ROI < CoE	ROI < WACC	The company fails to meet both equity investors' expectations and the total capital cost, creating no value for either.	CoE = 9.2%, WACC = 7%, ROI = 6%. The company fails to meet expectations for both equity and debt holders.
Scenario 6: ROI < CoE but ROI > WACC	ROI < CoE	ROI > WACC	The company fails to meet equity investors' expectations, but still generates enough return to satisfy debt holders.	CoE = 9.2%, WACC = 7%, ROI = 8%. The company satisfies debt holders but not equity investors.

5.1.4 Adjust for ESG Factors

Ensuring ESG adjustments do not overlap with traditional risk components is crucial to maintaining accurate valuations. Double counting can distort a company's risk profile, leading to over- or underestimation.

Additive Adjustment: Applies a fixed ESG premium or discount but lacks precision as it ignores ESG's specific relationship with the discount rate.

Scenario Analysis: Assesses ESG impact under different conditions but is subjective and assumption-driven.

Regression Analysis: A data-driven approach that isolates ESG's effect on the discount rate, minimizing double counting and improving accuracy. Unlike other methods, regression quantifies the unique contribution of ESG while controlling for traditional risk factors—such as market risk, company size, and leverage—that are already embedded in the discount rate. Our approach will utilize Multicollinearity Testing where Variance Inflation Factor (VIF) analysis is used to detect if ESG metrics overlap with traditional risk factors. A low VIF score ensures ESG variables are not duplicating risk already accounted for in the model. The proposed solution will use a Multiple Linear regression model as shown below since there are two or more independent variables.

Step 1: In our proposed solution we will write the Discount Rate (i.e. the Regression Equation) as follows:

$$\text{Discount Rate} = \alpha + b_1\cdot\text{Market Risk} + b_2\cdot\text{Company Size} + b_3\cdot\text{Leverage} + b_4\cdot\text{ESG Score} + \epsilon \quad (7)$$

Where:

- α: Intercept term; the value of discount rate when all other independent factors are zero.
- b: Coefficients for each variable; showing the effect of each independent variable on the discount rate
- Market Risk: Typically represented by beta (β)
- Company Size: Measured by market capitalization
- Leverage: Measured by the debt-to-equity ratio
- ESG Score: The ESG score of the company
- ε: Error term

We will apply a multiple linear regression model using hypothetical data to demonstrate the approach. By refining the discount rate with these additional factors, we aim to offer a more nuanced understanding of how ESG influences risk and return dynamics in startup investments.

Table 2: Data from 10 startup companies.

Discount Rate (%)	Market Risk (%)	Company Size ($M)	Leverage	ESG Factor
8.75	3.45	209.83	0.12	5.97
14.51	1.28	545.66	0.21	4.61
12.32	1.58	130.95	0.43	5.98
10.99	2.31	345.28	0.7	8.9
6.56	1.91	332.9	0.21	9.8
9.12	4.2	250.15	0.35	6.22
11.76	3.1	190.5	0.3	7.15
7.89	2.25	400.75	0.25	6.5
13.45	1.95	320.45	0.4	5.85
12.05	2.75	280.3	0.5	7

Using Microsoft Excel, we obtain the Correlation between the independent variables:

Table 3: Correlation Matrix for the Independent Variables.

Correlatiion Matrix	Market Risk	Company Size	Leverage	ESG Factor
Market Risk	1			
Company Size	-0.46959925	1		
Leverage	-0.07346435	-0.124591348	1	
ESG Factor	0.027413735	-0.119115772	0.318008839	1

Using the Microsoft Excel Regression Analysis feature with the following input,

Y Range: Range for the dependent variable (Discount Rate)

X Range: Select the range for the independent variables (Market Risk, Company Size, Leverage, ESG Score), we obtain the following results:

Table 4: Regression Analysis Output.

SUMMARY OUTPUT				
Regression Statistics				
Multiple R	0.85195078			
R Square	0.725820131			
Adjusted R Square	0.506476237			
Standard Error	1.799489637			
Observations	10			
	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	18.87684755	4.42536876	4.265598773	0.007972159
Market Risk	-0.97901327	0.763470644	-1.28231946	0.255962568
Company Size	-0.00057546	0.005860113	-0.09819948	0.925589098
Leverage	8.105717797	3.791392029	2.137926581	0.085541486
ESG Factor	-0.02283773	0.415133313	-2.95899487	0.031555516

and
Intercept (α): 18.88
Market Risk (β_1): -0.98
Company Size (β_2): -0.0006
Leverage (β_3): 8.11
ESG Score (β_4): -0.023

Step 2: To again confirm there is no multicollinearity, we calculate the variance inflation factor (VIF) for each of the independent variables. For each independent variable X_i in a regression model, VIF is calculated as:

$$\mathrm{VIF}_i = \frac{1}{1 - R_i^2} \tag{8}$$

Where R_i^2 value is obtained from regressing the independent variable X_i against all other independent variables in the model.
Interpreting VIF Values

- VIF = 1: There is no correlation between the independent variable X_i and the other independent variables. There is no multicollinearity.
- 1 < VIF < 5: Moderate correlation exists, but it is usually not problematic. This is often considered an acceptable range.
- VIF > 5: Indicates a high correlation between the independent variable and the other independent variables, suggesting significant multicollinearity.

The VIFs for the above model are calculates as shown below:

Market Risk VIF = 1.332
Company size = 1.332
Leverage =1.147 and
ESG = 1.121

Since all the VIFs are below 5, it indicates that there is no significant multicollinearity among the independent variables. This suggests that the

independent variables are not highly correlated with each other, and we can proceed with the regression analysis without concerns about multicollinearity affecting our results.

Step 3: Next, we will look at the p-values from the regression and its significance. In regression analysis, the p-value is the measure used to determine the statistical significance of the independent variable assuming that the null hypothesis is true.

ESG Factor:

- Null Hypothesis (H_0): The ESG factor has no significant effect on the discount rate.
- Alternative Hypothesis (H_1): The ESG factor has a significant effect on the discount rate.

Company Size ($M):

- Null Hypothesis (H_0): Company size has no significant effect on the discount rate.
- Alternative Hypothesis (H_1): Company size has a significant effect on the discount rate.

Market Risk (%):

- Null Hypothesis (H_0): Market risk has no significant effect on the discount rate.
- Alternative Hypothesis (H_1): Market risk has a significant effect on the discount rate.

Leverage:

- Null Hypothesis (H_0): Leverage has no significant effect on the discount rate.
- Alternative Hypothesis (H_1): Leverage has a significant effect on the discount rate.

A Low p-value (≤ significant level) Indicates strong evidence against the null hypothesis, suggesting that the independent variable is statistically significant in explaining the variability of the dependent variable.
High p-value (> significant level): Indicates weak evidence against the null hypothesis, suggesting that the independent variable may not be a significant predictor of the discount rate. For the above data, with 5% significance level,

1. Market Risk: P-value = 0.256: This is greater than 0.05, suggesting weak evidence against the null hypothesis. The Market Risk is not statistically significant, implying it does not have a strong effect on the discount Rate.
2. Company Size: P-value = 0.926: This is much greater than 0.05, indicating very weak evidence against the null hypothesis. The Company Size is not statistically significant.
3. Leverage: P-value = 0.0855: This is slightly above the 0.05 threshold. It suggests moderate evidence against the null hypothesis, but the Leverage is not statistically significant at the 5% level. However, it might be considered significant at a more lenient level.
4. ESG Factor: P-value = 0.0316: This is less than 0.05, indicating strong evidence against the null hypothesis. The ESG factor is statistically significant and can have a strong effect on the Discount Rate.

5.1.5 Integrate ESG Adjustment

Our regression equation is $= \alpha + b_1 \cdot$Market Risk + $b_2 \cdot$Company Size + $b_3 \cdot$Leverage + $b_4 \cdot$ESG Score + ϵ
In the above regression, we calculated the coefficient of ESG b_4 as -0.023
ESG Adjustment = ESG score * b_4 = 80*(-0.023) = -1.84

We started with 6.92 as the original Discount Rate (from the WACC calculation in 5.1.3)
So, the adjusted Discount Rate with ESG Factor adjustment will be 6.92-1.84 = 5.08

Because the ESG coefficient is negative, there is an inverse relationship between the discount rate and ESG score, which means that companies with higher ESG rating will have a lower discount rate and higher valuation, which reflects the company's commitment to environment, social, and governance responsibilities that mitigate risk and hedge against market disturbances. With the lower discount rate, the DCF analysis will show a higher valuation with an ESG score of 80.

5.1.6 Consideration While Using the Regression Analysis

Multicollinearity: Ensure no high correlation between independent variables to avoid redundancy and inaccurate estimates. For example, including both "total assets" and "total liabilities" might distort estimates if they are highly correlated.

Variable Overlap: Avoid including variables that measure the same concept to prevent double counting.

Correct Model Specification: Include relevant variables and exclude irrelevant ones. For instance, omitting "industry sector" when studying company size's effect on profitability may misattribute sector effects to company size.

Avoid Proxy Variables: Be cautious when using proxy variables, like "employee satisfaction scores" for "organizational culture," as they may overlap with other variables, leading to double counting.

Data Quality: Ensure accurate and consistent data to prevent errors and unintended double counting.

6 FUTURE RESEARCH

1. Nonlinear Models: Investigate polynomial regressions or machine learning techniques to capture complex interactions between ESG factors, market risk, and discount rates.
2. Longitudinal Analysis: Examine how ESG factors influence discount rates over time, contrasting early-stage with mature startups.
3. Policy Impact: Analyze the effects of ESG-related regulations (e.g., carbon taxes, subsidies) on startups' cost of capital for regional and industry-specific insights.
4. Behavioral Finance: Incorporate ESG sentiment indices and investor preferences to better understand market perceptions and valuation dynamics.
5. Sensitivity and Scenario Testing: Perform sensitivity analyses to assess how changes in ESG factors or market conditions affect discount rates and valuations.
6. Case Study: Revalue a startup using an ESG-adjusted DCF model (using data from PitchBook) to compare original and adjusted valuations and illustrate ESG's impact.

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