

Measuring Industry Mispricing: An Empirical Analysis of CAPM Alphas For U.S. Industry Portfolios

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Abstract

This study examines industry-level valuation through the framework of the Capital Asset Pricing Model (CAPM) using monthly data for 49 U.S. industry portfolios from January 2000 to November 2025. First, a graphical analysis of total risk and return provides preliminary evidence of a positive risk–return relationship across industries. To isolate systematic risk, CAPM regressions are estimated to obtain industry betas and Jensen’s alphas. The Security Market Line (SML) is then used to assess whether industry returns are consistent with market risk exposure. The results indicate that while beta explains a substantial portion of return variation, several industries exhibit statistically meaningful positive or negative alphas, suggesting deviations from CAPM predictions. These findings highlight cross-industry differences in risk-adjusted performance and provide insights into industry valuation and the limitations of the single-factor model.

Keywords: CAPM, Jensen’s alpha, Industry portfolios, Systematic risk, Asset pricing

1. Introduction

Understanding the relationship between risk and expected return remains a central objective in financial economics. The theoretical foundations of modern asset pricing can be traced back to Markowitz (1952), whose mean-variance portfolio theory demonstrated how rational, risk-averse investors optimally diversify to maximise expected return for a given level of risk. Building directly on this framework, the Capital Asset Pricing Model (CAPM), independently developed by Sharpe (1964), Lintner (1965), and Mossin (1966), provides an equilibrium extension that links individual asset returns to their contribution to overall market risk. By relating expected returns solely to exposure to systematic market risk, the CAPM offers a parsimonious and intuitively appealing benchmark for evaluating portfolio performance, estimating the cost of capital, and guiding investment decisions. Despite its subsequent development of multi-factor asset-pricing models (e.g., Fama-French three factor model, Fama and French, 1992), the CAPM continues to play a prominent role in both academic research and practical analysis due to its simplicity, interpretability, and widespread institutional use.

A key empirical implication of the CAPM is that, in equilibrium, all correctly priced assets should lie on the Security Market Line (SML), implying that abnormal risk-adjusted returns should not systematically persist. Deviations from this prediction are commonly measured using Jensen’s (1968) alpha, which captures the portion of the realised returns not explained by exposure to market risk. Positive alphas indicate performance exceeding CAPM expectations, whereas negative alphas signal underperformance.

Consequently, testing whether alphas differ significantly from zero provides a direct assessment of the model's empirical validity and of potential mispricing across assets or portfolios.

While early empirical studies often focused on individual securities, subsequent research has increasingly relied on portfolio-level analysis. Among the most influential datasets in empirical asset pricing are the Fama-French industry portfolios, which group firms into economically meaningful sections and provide long, consistent return histories. The 49 industry portfolios offer particularly rich cross-sectional variation in risk exposures, making them well suited for evaluating the CAPM performance across different segments of the real economy. Analysing Jensen's alphas within this framework allows for a systematic investigation of whether certain industries exhibit persistent over- or under-performance relative to the single-factor benchmark.

This study employs the CAPM to estimate Jensen's alphas for the 49 Fama-French industry portfolios, with the objective of assessing the extent to which realised industry returns conform to the model's predictions. By examining the sign, magnitude, and statistical significance of the estimated alphas, the paper evaluates whether deviations from the SML are widespread or concentrated within particular sectors. Such evidence contributes to the broader debate on the empirical adequacy of the CAPM and the necessity of multifactor extensions, including the Fama-French three-factor and subsequent models, which were partly motivated by systematic anomalies unexplained by market beta alone (Fama and French, 2004).

Beyond its theoretical implications, this analysis also carries practical relevance for portfolio management and performance evaluation. Persistent positive or negative alphas at the industry level provide information that portfolio managers can incorporate into sector allocation decisions and active management strategies. Industries that consistently generate positive alphas may indicate potential mispricing, structural advantages, or risk factors not captured by the CAPM, thereby offering opportunities for excess risk-adjusted returns. Conversely, industries exhibiting negative alphas may signal systemic underperformance or potential overvaluation and may therefore be allocated lower weights or avoided altogether to mitigate downside risk. Evaluating the CAPM at the industry level further allows for a more granular assessment of whether specific sectors systematically outperform or underperform relative to their exposure to market risk. Such evidence contributes to understanding whether deviations from the SML are concentrated in particular economic sectors or reflect broader model limitations.

The remainder of this paper is organised as follows. Section 2 outlines the theoretical foundations of the CAPM and discusses the interpretation of the SML and Jensen's alphas. Section 3 presents the data and methodology employed to estimate excess returns and regression parameters for the 49 industry portfolios. It then reports and discusses the empirical results, structured into two subsections: the first examining the relationship between risk and expected return, and the second analysing the position of portfolios relative to the SML to identify over- and under-performance. Finally, Section 4 concludes with the main findings and their implications for asset-pricing theory and future research.

2. Capital Asset Pricing Model

The CAPM is one of the most influential and widely applied models in financial economics for explaining the relationship between risk and expected return. It builds on the mean-variance framework developed by Markowitz (1952) and was independently formalized by Sharpe (1964), Lintner (1965), and Mossin (1966) as an equilibrium model of asset pricing. Developed within the framework of modern portfolio theory, the model rests on several key assumptions, including that investors are rational, risk-averse and

seek to maximise the expected utility of wealth. Because of this behaviour, investors optimally hold diversified portfolios, implying that only risk that cannot be eliminated through diversification should command a risk premium. In equilibrium, prices adjust such that expected returns compensate investors solely for bearing systematic risk. In this setting, unsystematic risk (risk that is specific to an individual firm or asset) can be largely removed by holding a sufficiently diversified portfolio. Competitive markets therefore do not reward investors for bearing this type of risk. Instead, expected returns are determined solely by systematic risk, which reflects exposure to broad market movements driven by macroeconomic conditions such as economic growth, recessions, inflation, and financial crises. Investors require higher expected returns as compensation for bearing greater systematic uncertainty when allocating their capital. CAPM further assumes the existence of a risk-free asset, such as short-term government Treasury securities, that provides a certain return. All investors combine the risk-free asset with a common market portfolio containing all risky assets, differing only in the proportion allocated to each according to their individual risk tolerance. More risk-averse investors allocate a larger share of wealth to the risk-free asset, whereas more risk-tolerant investors hold a greater proportion of the market portfolio. Consequently, the expected return of any individual asset is determined by how strongly its returns co-move with the market portfolio, making the market portfolio the central benchmark for measuring risk. Under the CAPM assumptions, the market portfolio lies on the efficient frontier and represents the tangency portfolio in equilibrium.

Formally, the theoretical CAPM expresses the expected return of an asset as:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) \quad (1)$$

where $E(R_i)$ is the expected return on asset or portfolio i , R_f is the risk-free rate, $E(R_m)$ is the expected return on the market portfolio, and β_i measures the asset's or portfolio's sensitivity to systematic market risk. This linear relationship implies that assets with higher market exposure must offer proportionally higher expected returns, forming the basis for the SML, a central prediction of CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966, Fama and French, 2004).

The SML provides a graphical representation of the CAPM and depicts the theoretical relationship between an asset's or portfolio's expected return and its level of systematic risk, as measured by beta. On the x-axis, beta captures the sensitivity of an asset's or portfolio's return to movements in the overall market portfolio. A beta of 1 indicates that the asset's or portfolio's return moves proportionally with the market, a beta greater than 1 implies greater systematic risk and higher responsiveness to market fluctuations, and a beta less than 1 indicates lower systematic risk and comparatively smaller reactions to market movements. On the y-axis, the asset's or portfolio's expected return is plotted. The SML therefore appears as a straight line that intersects the y-axis at the risk-free rate, corresponding to the expected return of an asset or portfolio with zero systematic risk. The slope of the line equals the market risk premium, which represents the additional return investors require for bearing one extra unit of systematic risk. Consequently, the SML summarises the central CAPM prediction that expected returns increase linearly with beta, and assets or portfolios positioned above or below the line may be interpreted as underpriced or overpriced relative to the model's equilibrium.

In theory, the CAPM predicts that all correctly priced assets or portfolios should lie on the SML, as their expected returns are fully explained by exposure to systematic market risk. When observed returns deviate from this prediction, the difference represents the abnormal performance relative to the model. This

deviation is captured by Jensen's alpha (Jensen, 1968), a measure that quantifies the gap between an asset's or portfolio's realised return and the return implied by the CAPM. Jensen's alpha is therefore commonly used as a performance metric to evaluate whether active management generates returns beyond passive market exposure. It reflects the component of returns that cannot be explained by market movements alone and indicates whether an asset or portfolio persistently outperforms or underperforms the CAPM benchmark.

To estimate Jensen's alpha empirically, the theoretical CAPM relationship is reformulated into a regression specification that allows abnormal performance to be measured directly:

$$R_{it} - R_{ft} = \alpha_i + \beta_{im}(R_{mt} - R_{ft}) + \varepsilon_{it} \quad (2)$$

In this regression specification, $R_{it} - R_{ft}$ denotes the excess return on asset or portfolio i at time t , representing the return earned above the risk-free rate and thus the additional compensation for bearing risk. Similarly, $R_{mt} - R_{ft}$ is the market excess return, capturing the extent to which the overall market outperforms a risk-free investment over the same period. The coefficient β_{im} measures the asset's or portfolio's exposure to systematic market risk, consistent with the theoretical CAPM prediction. The intercept term, α_i , represents Jensen's alpha, quantifying the deviation from the SML and indicating abnormal risk-adjusted performance. A positive Jensen's alpha suggests undervaluation relative to CAPM expectations, whereas a negative Jensen's alpha indicates overvaluation.

3. Data, Methodology and Empirical Results

The data used in this study consists of monthly return data for the 49 industry portfolios obtained from Kenneth R. French's Data Library, which is a widely used and academically recognised source for asset-pricing research. The sample period covers January 2000 to November 2025, providing a long time series that allows for robust estimation of systematic risk exposures and Jensen's alphas over different market conditions.

The 49 industry portfolios are constructed by classifying firms listed on the US stock exchanges (NYSE, AMEX, and NASDAQ) into 49 distinct sectors based on the four-digit SIC (Standard Industrial Classification) codes. This industry classification enables the analysis to capture economically meaningful groupings of firms that reduces the influence of idiosyncratic firm-level noise. As a result, the portfolios are sufficiently diversified and better suited for testing asset-pricing models at the industry level rather than relying on individual stock returns.

The portfolios are value-weighted, meaning that larger firms within each industry exert a greater influence on portfolio returns. This weighting scheme reflects market capitalisation and aligns the portfolios more closely with investable market exposures. Using value-weighted portfolios ensures that the results are not disproportionately driven by small firms and provides a more realistic assessment of industry-level performance relative to systematic market risk.

3.1 Risk-return relationship across industry portfolios

Using R programming, a scatter plot was constructed to examine the relationship between risk and expected return across the 49 industry portfolios. The x-axis represents risk, measured by the standard deviation of monthly returns, which captures the return volatility over the sample period. The y-axis represents expected return, measured as the average monthly return of each industry portfolio over the

sample period. This graphical approach provides a preliminary assessment of whether a positive risk-return trade-off exists at the industry level, consistent with the predictions of asset pricing theory.

Figure 1: Risk-return diagram of industry portfolios



Figure 1 indicates a positive correlation between risk and expected return. Industries with higher return volatility tend to be located in the upper-right region of the graph, while lower-volatility industries are concentrated in the lower-left region. This pattern suggests partial support for the theoretical prediction that higher systematic risk is associated with higher expected returns. However, the relationship does not appear perfectly linear, and substantial dispersion exists among industries with comparable risk levels. Despite the general upward trend, several industries deviate from the expected risk-return relationship. Certain sectors exhibit similar levels of volatility but substantially different average returns, indicating heterogeneity in performance that cannot be explained by simple volatility measures alone. These deviations suggest that factors beyond total risk, such as industry-specific characteristics, exposure to macroeconomic shocks, structural differences, or omitted risk factors, may influence expected returns. Industries such as Food Products (Food), Consumer Goods (Hshld), Utilities (Util), Medical equipment (MedEq) and Pharmaceutical Products (Drugs) are clustered in the low-risk, low-return region of the graph. These sectors primarily produce essential goods and services with relatively inelastic demand. Because consumption of these products remains relatively stable across economic conditions, firms operating in these industries experience more predictable cash flows and lower return volatility. Consequently, lower risk is associated with lower expected returns, consistent with equilibrium pricing theory.

In contrast, industries such as Automobiles (Autos), Construction (Cnstr), Entertainment (Fun) and Real Estate (RIEst) are positioned in the high-risk, high-return region of the scatter plot. The performance of

these sectors is strongly linked to macroeconomic conditions and business cycle fluctuations. During economic expansions, rising income levels, favourable credit conditions, and increased investment activity drive demand for durable goods and capital-intensive projects, generating high profitability. Conversely, these industries experience significant contractions during economic downturns. The higher volatility associated with their sensitivity to macroeconomic cycles is accompanied by higher average returns, consistent with compensation for bearing greater systematic risk.

Specifically, for the automobile industry, technological innovation and product development, particularly in areas such as electric vehicles, autonomous driving technologies, and improvements in fuel efficiency, require substantial investment in research and development. These investments create significant uncertainty, as there is no guarantee that new technologies will achieve commercial success or widespread consumer adoption. As a result, firms in this industry are exposed to higher operational and financial risk, which contributes to greater return volatility. At the same time, successful innovation can generate competitive advantages, increase market share, and enhance profitability. This upside potential may contribute to higher average returns as compensation for bearing greater uncertainty.

There are also a few industries that deviate from the general risk-return pattern. For example, Textiles (Txlts) and Computers (Hardw) exhibit relatively high return volatility but do not generate proportionally high average returns. One possible explanation is the intense global competition and rapid technological change characterising these industries. Frequent shifts in consumer preferences, short product life cycles, and continuous innovation create substantial uncertainty and firm-level risk. However, competitive pressures may compress profit margins, limiting the ability of firms to translate elevated risk into persistently higher returns. As a result, these industries display high volatility without commensurate compensation. Similarly, the Communication industry (Telcm) appears among the lowest-return sectors despite exhibiting moderate volatility. Telecommunications is highly capital intensive, requiring continuous investment in infrastructure, spectrum acquisition, and technological upgrades. At the same time, strong competitive forces and regulatory constraints often lead to price competition and declining margins (Schwarz, 2025). Consequently, while investment requirements and technological uncertainty contribute to return variability, competitive dynamics may suppress profitability, resulting in relatively low average returns. Printing and Publishing (Books) also exhibits comparatively high volatility. This may reflect long-term structural changes driven by digitalisation and shifting consumer preferences away from traditional print media toward digital platforms and online entertainment. Increased substitution possibilities reduce pricing power and compress margins, contributing to weaker performance. Structural decline rather than cyclical risk may therefore explain the combination of elevated volatility and subdued returns.

In contrast, industries such as Defense (Guns) and Tobacco Products (Smoke) appear to achieve relatively high average returns despite only low to moderate volatility. Tobacco demand is often characterised as relatively inelastic, partly due to the addictive nature of the product. This allows firms to maintain pricing power and sustain profit margins even during economic downturns, resulting in stable cash flows. Investors may therefore receive comparatively high returns without correspondingly high observed volatility. Defense equipment exhibits a similar pattern, though for different reasons. Revenues in this sector are largely driven by government expenditure rather than household income, reducing sensitivity to the business cycle. Long-term procurement contracts and stable defence budgets can dampen return volatility. At the same time, barriers to entry and specialised technological capabilities may allow firms to

The estimated betas and corresponding expected monthly returns for each industry were plotted against the SML, with beta on the x-axis and expected return on the y-axis. The SML, derived from the CAPM, represents the theoretical linear relationship between systematic risk and expected return. It therefore provides a benchmark of assessing whether an industry portfolio's return is consistent with the exposure to market risk. Industries positioned above the SML exhibit a positive alpha, indicating realised returns higher than those predicted by the CAPM, whereas industries below the SML display a negative alpha, suggesting returns lower than those predicted by the CAPM.

In figure 2, industries such as Tobacco Products (Smoke) and Defense (Guns) lie above the SML, indicating positive alpha. This suggests that their average returns exceed what would be expected based solely on their market beta. One possible explanation relates to industry-specific characteristics that are not fully captured by the CAPM. Tobacco firms, for example, are often classified as "sin stocks" and may be avoided by certain investors due to ethical considerations, litigation risk, and regulatory pressures. Reduced investor demand may lead to lower valuations and consequently higher expected returns for investors willing to hold such assets. Furthermore, demand for tobacco products is relatively inelastic, allowing firms to maintain pricing power and generate stable cash flows even during economic downturns. Similarly, the defense industry is largely driven by government expenditure rather than consumer income, which may dampen sensitivity to business-cycle fluctuations. Long-term contracts and barriers to entry can contribute to stable profitability. The combination of these characteristics may result in higher observed returns relative to market risk exposure (Blitz, 2017).

Conversely, several industries with moderate to high beta values appear below the SML, indicating negative alpha. Industries such as Textiles (Txlts), Computers (Hardw), and Telecommunications (Telcm) exhibit substantial exposure to market risk but do not generate returns commensurate with their systematic risk levels. One potential explanation is that these industries may be subject to intense competitive pressures and rapid technological change, which compress profit margins and increase uncertainty. Additionally, periods of heightened investor optimism or speculative interest may lead to elevated valuations. If growth expectations subsequently fail to materialise, realised returns may fall short of CAPM predictions, resulting in negative alphas. These findings suggest that factors beyond market beta, including structural industry characteristics or omitted risk factors, may play an important role in explaining cross-industry return variation.

4. Conclusion

This paper examined industry-level valuation through the CAPM by estimating Jensen's alphas for 49 U.S. industry portfolios over the period January 2020 to November 2025. The empirical results provide evidence on the extent to which industry returns are explained by exposure to systematic market risk and whether persistent deviations from the SML exist. The findings indicate that certain industries exhibit significant positive or negative alphas, suggesting the presence of systematic over- or under-performance relative to CAPM predictions. Overall, the market risk explains a substantial proportion of return variation, deviations from the model remain observable across selected sectors.

The main contribution of this study lies in its industry-level assessment of valuation using risk-adjusted performance measures. By focusing on diversified industry portfolios rather than individual stocks, the analysis reduces idiosyncratic noise and provides a clearer view of structural deviations from CAPM equilibrium. The results contribute to the ongoing debate regarding the empirical validity of the CAPM and its usefulness as a benchmark of performance evaluation. From a practical perspective, the findings

are relevant for portfolio allocation, sector rotation strategies, and benchmarking performance against passive market exposure. Persistent positive or negative alphas at the industry level may signal mispricing, structural risk factors not captured by the CAPM, or economic characteristics specific to certain sectors. Therefore, the analysis provides useful insights for investors and portfolio managers who rely on risk-based valuation frameworks.

Despite its insights, this study is subject to several limitations. Most importantly, the analysis is solely based on the CAPM, which is a single-factor model, and may not capture the cross-sectional variation in returns. Multi-factor models such as the Fama and French (1992) three-factor model may explain additional return variation that appears as abnormal performance under the CAPM specification. Future research could extend the analysis by incorporating multi-factor models to determine whether industry-level alphas persist after controlling for size, value, or other factors. Additionally, alternative time horizons, different geographic markets, or subperiod analyses could further enhance the robustness of the findings.

5. References

1. Blitz, D. (2017) Research reveals why sin stocks outperform: <https://www.robeco.com/en-me/insights/2017/09/research-reveals-why-sin-stocks-outperform>
2. Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *The Journal of Finance*, 47(2), 427–465.
3. Fama, E. F., & French, K. R. (2004). The capital asset pricing model: Theory and evidence. *Journal of Economic Perspectives*, 18(3), 25–46.
4. Jensen, M. C. (1968). The performance of mutual funds in the period 1945-1964. *The Journal of Finance*, 23(2), 389–416.
5. Kenneth R. French's Data Library: https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
6. Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economic and Statistics*, 47(1), 13–37.
7. Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91.
8. Mossin, J. (1966) Equilibrium in a capital asset market. *Econometrica*, 34(4), 768–783.
9. Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The Journal of Finance*, 19(3), 425–442
10. Schwarz, L. (2025). Top 27 Challenges Facing the Telecom Industry for 2025 and Beyond: <https://www.netsuite.com/portal/resource/articles/erp/telecom-industry-challenges.shtml>