

Analyzing the Risk-Return Trade-Off Relationship of Chinese New Energy Firms Using the Capital Asset Pricing Model

Dongqi Lyu*

Financial Technology, Exeter of University, Exeter, The United Kingdom

*Corresponding author: Dongqilyu@gmail.com

Abstract. This study examines the risk-return trade-off for prominent Chinese new energy companies within the context of the country's burgeoning sustainable energy sector. Utilizing the Capital Asset Pricing Model (CAPM), the paper investigates the systematic risk factors impacting the stock returns of BYD, CATL, and Sungrow, which are leaders in the electric vehicles, energy storage, and photovoltaic sectors, respectively. The research highlights the unique beta coefficients indicative of each company's market volatility and explores the implications of these risk profiles for investors and policymakers. While the findings suggest the presence of abnormal returns and provide valuable insights for investment strategies and policy formulation, the paper acknowledges limitations in market-based risk assessment and suggests future research to incorporate a broader range of company-specific factors and comparative analyses. This study contributes significantly to understanding the complexities and dynamics of risk management in China's rapidly advancing new energy market.

Keywords: Chinese New Energy Companies; Capital Asset Pricing Model (CAPM); Systematic Risk Analysis; Sustainable Energy Investment.

1. Introduction

China has the world's largest new energy industry, making its new energy companies key players in the global transition to sustainable energy. The new energy industry plays a crucial role in reducing greenhouse gas emissions and addressing climate change. The Chinese government has demonstrated a strong commitment to expanding new energy production capacity by implementing preferential policies and making significant investments in the industry. For instance, the People's Daily discussed the Chinese government's efforts in recent years to promote the development of China's new energy industry, detailing forthcoming measures to improve product quality, expand use in key areas, and strengthen supporting conditions[1]. Clearly, the Chinese government has recognized the global shift from traditional to renewable energy, and countries and companies that become leaders in the new energy industry will gain significant economic and strategic advantages. China's new energy companies are at the forefront of this transformation. Beyond strategic importance, understanding the risk-reward trade-off faced by these companies can inform predictions of their responses to changes in the economic environment.

In this article, it is reasonable for us to select BYD, CATL, and Sungrow—three new energy companies listed on China's domestic A-shares—as our research subjects. Firstly, these companies span the new energy vehicle sector, the energy battery storage sector, and the photovoltaic power generation and environmental protection sector. By examining these three companies, we can gain a comprehensive understanding of the overall business dynamics of the new energy sector. Secondly, they are all industry leaders within their respective sub-sectors. Studying their transaction data on China's A-shares can also reflect the developmental trends and risks faced by other sub-sectors in the energy sector. Overall, this article will primarily examine the relationship between the market performance of BYD, CATL, and Sungrow's stock returns and the Shenzhen Index based on the CAPM model, and use this analysis to facilitate risk management for investors and to promote better government policy formulation.

2. Literature Review

Nowadays, the shortcomings of traditional energy sources have been exposed. For example, fossil fuels are unsustainable and emit a large number of harmful gases when burned, with carbon dioxide being the primary cause of global warming[2]. New sustainable energy sources have emerged into public awareness. In recent years, the new energy industry has achieved unprecedented development, especially under the guidance of China's policies.

Because of this, studying the risk-return relationship of Chinese new energy companies is of paramount importance. The new energy market plays a key role in mitigating climate change and reducing carbon emissions, in line with the emission reduction and new energy use goals set by the Chinese government. Therefore, a deep understanding of the risk-return relationship of new energy companies is critical to achieving these strategic goals. Furthermore, investors and capital markets need to understand this relationship to make informed investment decisions. Whether you are an individual investor, an institutional investor, or a venture capitalist, understanding the relationship between risk and return is vital for portfolio construction and strategy formulation. Governments and regulatory agencies also need to understand this relationship to formulate relevant policies and regulations that may affect the development of new energy companies, including tax, subsidy, and market access regulations. The new energy industry has immense growth potential in China but is also accompanied by various risks, such as technological, market, and policy risks. Understanding the risk-reward relationship can help ensure sustainable growth in the industry. Additionally, China's new energy companies compete fiercely in the international market, and understanding the risk-return relationship can help them improve their international competitiveness and attract international investors and partners. Finally, as society pays increasing attention to sustainability and environmental protection, the social responsibility of new energy companies has attracted significant attention. A deeper understanding of the risk-return relationship can help these companies better fulfill their social responsibilities and promote sustainable development. Overall, this research is of critical importance to multiple stakeholders.

As highlighted by Curtin et al., carbon-intensive reserves, especially coal, face significant stranding risks; diversification is needed to mitigate these risks. The transition to new energy sources has become a strategic choice for such enterprises[3]. Su et al. evaluated and compared the sustainability of energy sector development in 21 European Union Member States and China from 2005 to 2016, using Multi-Criteria Decision Making Methods to assess progress toward energy efficiency, renewable resource development, decarbonization, and energy security[4]. They highlighted the best-performing countries and provided policy implications based on the observed results.

There is a voluminous body of literature studying the Chinese new energy sector. Firstly, there are studies that focus on the macro level of the new energy industry. Specifically, Shen et al. developed a Chinese investor sentiment index and examined its impact on new energy stock returns and risk behaviors, especially during the COVID-19 pandemic[5]. They found that while investor sentiment affects both new and traditional energy stocks, the influence is more pronounced for new energy, with investors focusing more on risk than returns during the pandemic. Additionally, Lai and Warner analyzed the trends and challenges in the transformation of China's energy sector, particularly focusing on the balance between conventional and renewable energy sources, and the interplay between market forces and state control in managing demand, supply, and environmental impacts[6]. It discusses the strategic, organizational, and policy issues confronting China as it navigates a shift toward cleaner energy amidst rapid urbanization and economic growth.

Secondly, there are studies focusing on more micro aspects of the new energy sector. For instance, Zhang and Xu concluded that management learning channels play a vital role in China's new energy companies, while traditional energy companies have almost no such channels[7]. The increase in stock price information promotes the investment efficiency of new energy companies and helps to improve their financial performance.

Thirdly, there are policy-focused studies. Specifically, Li et al. claimed that the strong influence of China's stock market on the new energy market underscores the need for policy stability during crises to reduce the stock market's overreaction and thereby alleviate the financing difficulties of the new energy industry[8]. Although there are various studies on new energy today, including the impact of investor sentiment and the impact of major events on the industry, there is still a lack of research on the extent of the impact of changes in the Shenzhen market index on the new energy industry. The CAPM model is used to analyze the three leading new energy stocks to obtain the impact coefficient β , quantifying the market's influence on the new energy industry. Such a study plays a guiding role in the adjustment of consumer venture capital and government decision-making. guiding role in the adjustment of consumer venture capital and government decision-making.

3. Empirical analysis

Here, we study the risk-return trade-off of BYD, CATL, and Sungrow. The selection of these stocks for analysis was strategic, representing a cross-section of China's vibrant new energy industry. These entities are distinguished in the electric vehicle production, energy storage innovation, and photovoltaic power generation sectors, respectively, making them ideal subjects for a comprehensive study of the market.

BYD, founded in 1995, is a heavyweight in the electric vehicle market, leading with its range of passenger and commercial vehicles, and is an innovator in battery technology. This company's prowess in electric mobility and energy storage solutions underscores its role in driving the transition to sustainable transportation. CATL, established in 2011, has quickly risen to become a global leader in the production of lithium-ion batteries, which are essential for the new energy economy. Its batteries are pivotal in powering electric vehicles, and its commitment to R&D in energy storage solutions is setting the pace for industry standards. Sungrow, established in 1997, is renowned for its solar energy conversion systems and has played a significant role in shaping the solar industry landscape. With a wide range of products and services in the solar energy sector, Sungrow is instrumental in advancing the adoption of clean energy.

Examining these frontrunners offers invaluable insights into the broader new energy sector's market dynamics and technological trends, providing a rich context for understanding the risk-return trade-offs in this rapidly evolving landscape.

3.1. Data selection and preliminary analysis

We downloaded the stock closing prices for BYD, CATL and Sungrow and the Shenzhen composite index from the WIND database, our data starts from 12th of June 2018 and finishes on 8th of August 2023.

First, we visualize the BYD, CATL and Sungrow's stock prices and Shenzhen composite index, see Figure 1. Figure 1 indicates the series are nonstationary. Therefore, we need to convert them into stationary series, in this case, the continuously compounded rates of return. For individual stock prices/index value, denoted as $\{P_t\}$, the continuously compounded rates of return is generated such as $r_t = \log(P_t) - \log(P_{t-1})$.

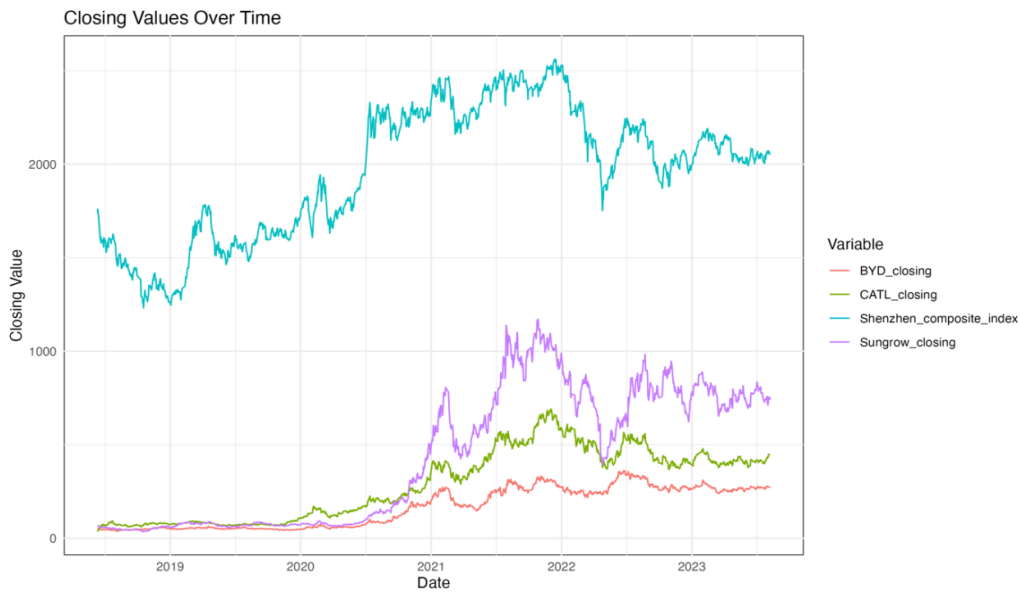


Fig. 1 Closing Stock Prices for BYD, CATL, Sungrow, and the Shenzhen Composite Index (2019-2023)

The rates of return are visualized in Figure 2. Upon inspecting the time series plots of the returns for BYD, CATL, Sungrow, and the Shenzhen Composite Index, it's observable that the returns exhibit characteristics indicative of stationary processes. There is a discernible mean reversion trait, as the fluctuations in returns seem to oscillate around a constant mean value without a long-term trend, suggesting that the values revert to a mean over time.

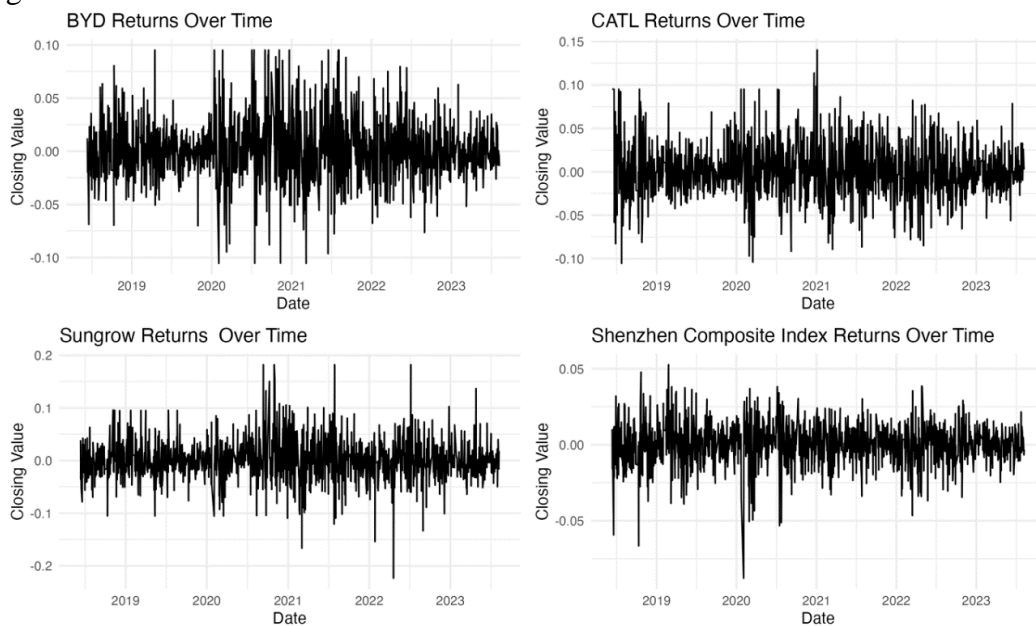


Fig. 2 Continuously compounded rates of return for BYD, CATL Sungrow and Shenzhen Composite Index

However, to ensure the rigor of our analysis, we also inspected the descriptive analysis of these rates of returns, see Table 1. Table 1 presents the descriptive statistics for the continuously compounded rates of return for BYD, CATL, Sungrow, and the Shenzhen Composite Index. The data reveals a pronounced level of kurtosis across all variables, indicating that the return distributions possess heavier tails than a normal distribution, which implies a higher probability of extreme returns. The skewness values for BYD, CATL, and Sungrow are positive, suggesting that the distributions of these returns are right-leaning, with more frequent instances of higher-than-average returns. In contrast, the Shenzhen Composite Index displays a negative skewness, signifying a distribution that

leans towards the left, with a tendency towards lower-than-average returns. The ADF (Augmented Dickey-Fuller) test results are particularly noteworthy, as they are significant at the 1% level for all variables, providing strong evidence of the stationarity of these time series.

Table 1. Descriptive analysis of rates of returns

Variable	Min	Max	Mean	Med	Kurt	Skew	ADF
BYD	-0.1054	0.0954	0.0013	0.0004	4.7411	0.2856	-35.2306***
CATL	-0.1054	0.1406	0.0020	0.0000	4.4346	0.3544	-34.5431***
Sungrow	-0.2231	0.1823	0.0019	0.0003	6.3107	0.1882	-36.0236 ***
Shenzhen_composite_index	-0.0879	0.0528	0.0001	0.0006	5.8677	-0.4985	-34.5336***

Note: Min, Max, Mean, Med, Kurt, Skew, and ADF stand for minimum, maximum, mean, medium, kurtosis, skewness and Augmented Dickey-Fuller test. “***” suggests the ADF tests are statistically significant at 1% significance level.

3.2. CAPM analysis of BYD, CATL and Sungrow

Here we use the capital asset pricing model (CAPM) to investigate the risk-return trade-off for various stocks. The CAPM is a foundational financial theory that seeks to determine the expected return on a stock, given the risk-free rate, the expected market return, and the stock’s systematic risk, measured by the β coefficient. It was introduced by Sharpe and Lintner [9-10].

Specifically, the model takes the following form:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f), \tag{1}$$

where $E(R_i)$ is the expected return on a stock, in our cases, one of BYD, CATL and Sungrow, R_f is the risk-free rate, β_i is the so-called beta coefficient, which measures its volatility relative to the market, $E(R_m)$ is the expected return of the market, thus, $E(R_m) - R_f$ is also known as the risk premium.

The CAPM model does make several assumptions, for instance, it assumes that investors are rational and risk-averse; there are no taxes or transaction. Cost, all investors have access to the same information, and can lend and borrow at the risk-free rates. While these assumptions do not hold in the real world, it is a simplification of the real world which serves as a starting point to conduct risk-return analysis. CAPM remains a key tool in financial management and capital budgeting.

In empirical analysis, we focus on the “excess return” form of the CAPM, specifically,

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_i(r_{m,t} - r_{f,t}) + \epsilon_t \tag{2}$$

Where we imposed a time series structure to the regression, $r_{i,t}$ is the stock’s rates of return at time t , $r_{f,t}$ is the risk free rate at t , α_i is the intercept term, $r_{m,t}$ is the market rates of return (proxied by index returns) at t , and ϵ_t is the error term (assumed to be white noise). In this form, the intercept term α_i , has a clear interpretation. A statistically significant positive α_i indicates that the asset, on average, provides a return above what would be expected based on its beta and the market risk premium. Conversely, a negative α_i suggests the asset underperforms relative to its beta. This form is also more in line with economic intuition, suggesting that investors care about the return of a security relative to a risk-free investment, rather than the absolute return.

Table 2. CAPM regression results

Model	α_i	s.e.(α_i)	t statistics	β_i	s.e.(β_i)	t statistics	R^2	\bar{R}_2
BYD	0.002855	0.0007471	3.8214***	1.2060	0.04709	25.6105***	0.3372	0.3367
CATL	0.003490	0.0008292	4.2089***	1.2044	0.0523	23.0287***	0.2917	0.2912
Sungrow	0.004906	0.0010869	4.5138***	1.3840	0.0685	20.2044***	0.2405	0.2399

Note: s.e. stands for standard errors, and *** indicates statistical significance at 1% level.

From Table 2, it is clear that all β ’s are greater than 1, which indicates that BYD, CATL, and Sungrow are more volatile than the overall market. These relationships are statistically significant, as

if we formulate the t statistics such that $\frac{(\beta_i-1)}{s.e.(\beta_i)}$, the values are 4.3746, 3.9082 and 5.6058, respectively, which are highly statistically significant at 1% significance level.

These findings could be attributed to various factors, including the unpredictable nature of technological advancements and the sensitivity to regulatory changes within the new energy industry. These firms are notably influenced by their heavy investments in R&D, the uncertain outcomes of which contribute to stock volatility. Additionally, new energy companies are considerably impacted by governmental policies and international agreements pertaining to climate change and energy regulations, which introduce further risk and volatility.

Furthermore, all α 's are notably positive and statistically significant, indicating that these companies are not just keeping pace, but indeed outperforming the market. This outperformance may be ascribed to company-specific factors such as cutting-edge technology, strong branding, and successful product lines within the dynamic new energy sector. Such findings underscore the potential for these companies to offer above-market returns, reflecting their unique position to capitalize on the sector's growth and to navigate the associated risks successfully.

4. Conclusion and Discussion

The empirical analysis of the risk-return trade-off among key players in China's new energy industry—BYD, CATL, and Sungrow—utilizing the Capital Asset Pricing Model (CAPM), has yielded significant insights into the financial nuances of this rapidly evolving sector. The research delineates systematic risk levels for each company through their beta coefficients (BYD: $\beta = 1.2060$, CATL: $\beta = 1.2044$, Sungrow: $\beta = 1.3840$), which illuminate the comparative volatility of their stock returns against the market. These findings are invaluable for investors seeking to gauge the inherent risks associated with these innovative firms.

Notably, the positive alpha values for these companies suggest that they have consistently delivered excess returns, outperforming market expectations. This performance could be attributed to their unique competitive advantages, such as pioneering technology, powerful brand presence, and successful product lines in the new energy domain. Moreover, these companies' strategic importance is affirmed by their leading roles in significant sectors: BYD in electric vehicles, CATL in battery technology, and Sungrow in solar energy conversion.

This study extends beyond academic discourse, offering practical guidance for investors in crafting diversified portfolios and for policymakers in developing supportive frameworks for the new energy industry. The evidence of excess returns is particularly compelling in light of China's policy initiatives that have catalyzed the shift from traditional energy consumption to a more sustainable new energy paradigm.

However, the study's scope, centered on market-based risk assessments, presents opportunities for further exploration. Future research incorporating company-specific and policy-related factors could enrich the collective understanding of the multifaceted risk-return landscape, enabling more nuanced decision-making by investors, regulatory authorities, and industry participants.

In sum, this research not only contributes to academic literature but also stands as a strategic tool for stakeholders engaging with China's dynamic new energy sector. As we move toward a greener future, the insights derived from this study will be instrumental in steering investment strategies, shaping policy decisions, and fostering sustainable industry growth.

Reference

- [1] People's Daily. (2023, June 23). Support policies for the high-quality development of the new energy vehicle industry. Retrieved from https://www.gov.cn/zhengce/202306/content_6887954.htm
- [2] Shahzad, U. (2012). The need for renewable energy sources. *Energy*, 2(1), 16-18.
- [3] Curtin, J., McInerney, C., Gallachóir, B. Ó., Hickey, C., Deane, P., & Deeney, P. (2019). Quantifying stranding risk for fossil fuel assets and implications for renewable energy investment: A review of the

- literature. *Renewable & Sustainable Energy Reviews*, 116, 109402. <https://doi.org/10.1016/j.rser.2019.109402>
- [4] Su, W., Zhang, D., Zhang, C., & Streimikiene, D. (2020). Sustainability assessment of energy sector development in China and European Union. *Sustainable Development*, 28(5), 1063-1076.
- Lai, H., & Warner, M. (2015). Transformation of China's energy sector: trends and challenges. *Asia Pacific Business Review*, 21(1), 147-153.
- [5] Shen, Y., Liu, C., Sun, X., & Guo, K. (2023). Investor sentiment and the Chinese new energy stock market: A risk–return perspective. *International Review of Economics & Finance*, 84, 395-408.
- [6] Lai, H., & Warner, M. (2015). Transformation of China's energy sector: trends and challenges. *Asia Pacific Business Review*, 21(1), 147-153.
- [7] Zhang, T., & Xu, Z. (2023). The informational feedback effect of stock prices on corporate investments: A comparison of new energy firms and traditional energy firms in China. *Energy Economics*, 127, 107086. <https://doi.org/10.1016/j.eneco.2023.107086>
- [8] Li, G., et al. (2023). Exploring the interconnectedness of China's new energy and stock markets: A study on volatility spillovers and dynamic correlations. *International Review of Economics & Finance*. <https://doi.org/10.1016/j.iref.2023.10.030>