Risk of New Energy Investment: A Case Study of BYD

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Abstract. Amid diminishing traditional energy sources and escalating environmental challenges, the new energy sector flourishes, presenting numerous investment avenues. However, increased opportunities are often synonymous with heightened risks, necessitating protective measures for investors through robust risk identification and mitigation. This paper leverages the Capital Asset Pricing Model (CAPM), a revered financial analysis instrument, to study investment risks in the emerging new energy realm, spotlighting China's BYD. Employing a decade's SZSC index data and China's risk-free interest rate, the research evaluates BYD's investment landscape across varying phases, notably during the COVID-19 era, and contrasts it with contemporaries like XPENG, NIO, and others. The findings aim to discern the new energy sector's risk portfolio, culminating in actionable insights for prospective investors.

Keywords: New energy, Investment risk, Capital Asset Pricing Model (CAPM), BYD.

1. Introduction and literature review

New energy, also known as renewable energy, refers to energy sources that are replenishable and have a lower environmental impact compared to traditional fossil fuels. Its significance lies in the following aspects. Firstly, new energy sources, e.g. solar, wind, hydropower, emit few greenhouse gasses and pollutants during power generation, which can reduce air pollution, mitigate climate change, and preserve natural resources. Secondly, new energy helps countries to diversify their energy mix, therefore, enhance energy security. Thirdly, the transition to new energy sources drives technological innovation, which contributes to the overall advancement of the energy sector. Not to mention the positive economic benefit and job creation.

The stock market provides a vital role in providing funding and investment opportunities for companies in the new energy sector. Investors can invest in new energy companies, through means such as direct stock purchases or/and investments funds on the sector. This investment influx can support the development of new energy technologies and projects, leading to a virtuous cycle that enhances the sustainability of the economy. Therefore, in our paper, we focus on the risk-return tradeoff of new sector stocks in China, using the Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965 [1-2]).

Our paper connects to two strands of important literature, new energy studies and CAPM, or more widely, the risk return trade-off literature. There has been voluminous literature on new energy studies, particularly on China. For instance, Ming et al. (2013) [3] provide a comprehensive review of the development of large new energy bases in China, covering hydropower, wind, solar, nuclear; analyze the current construction status, future plans, policy issues, and technological barriers. Ahmed et al. (2016) [4]conduct a comparative review of new energy sectors in China, India and Pakistan (CIP) and explores the potential for energy sharing opportunities among these countries, emphasizing mutual understanding, negotiations, and enhancing trade relations to overcome energy shortage. Chang et al. (2003) [5] review the use of traditional energy in China during the past 30 years and overview China’s new energy development, indicating a promising prospect of the usage of new energy in China. Reboredo and Wen (2015) [6], use a regression model to study the impact of China’s new energy policies on expected changes and volatility in new energy stock prices, discusses the potential influences of policy makers and investors. Wu et al. (2016) [7] deeply investigate the status, constraints, reforms and planning of China’s new energy development, and make recommendations on the transformation of China’s new energy structure. Also, existing literatures has used CAPM to forecast stock index and analyze investment return. For example, Piamsuwannakit, and Sriboonchitta (2015) [8] present a CAPM model with a belief function approach for forecasting the Integrated Oil and Gas Company (CHK) stock and the S&P500 index, and use the model to forecast the return of a particular stock. Sandsmark and Vennemo (2007) [9] use CAPM to analyze the investments in climate change mitigation, and draw out the conclusion that, even though the return is low, the investments in climate change mitigation can be reasonable.

However, investing into new energy sector requires a sustainable amount of capital, and it doesn't come without risk. Existing research has studied the risk of new energy investment. For instance, Sadorsky (2012) [10] modelled the relationship between systematic risk and return for publicly traded new energy companies. Ji et al. (2017) [11] introduce a risk explicit interval two-stage programming (REITSP), providing decision-makers with trade-off information between system cost and risk for optimal long-term electricity system expansion planning. Donovan and Nuñez (2012) [12] use the CAPM framework, and study the investment risk faced by new energy investors in Brazil, China and India, finding that multinational investors face similar risks to investing in emerging markets overall, while domestic investors face country-specific risk. Nadine Gatzert and Thomas Kosub (2016) [13] comprehensively present current risks and risk management solutions of renewable energy projects and identify critical gaps in risk transfer by researching the case of onshore and offshore wind parks, pointing out that policy and regulatory risks appear to represent a major barrier for renewable energy investments. Zeng et al. [14] study the investment efficiency of China's new energy industry and analyze the factors that explain the differences in investment efficiency between different firms and different periods, and point out that new energy investment efficiency of China is low, and it is influenced by both macroeconomic conditions and firm-specific characteristics.

Risk avoidance is paramount for investors, and the study of this crucial topic cannot be undertaken without professional guidance and reference. While existing literature delves into the risks associated with new energy investment, there is often a lack of nuanced analysis and specific recommendations tailored for investors. Addressing this gap, our paper seeks to provide investors in the new energy stock market with in-depth, actionable advice and references. Our objective is to evaluate the investment risks in new energy using the Capital Asset Pricing Model (CAPM), offering robust risk avoidance strategies for these investors.

China stands as a prime example of new energy development. Bolstered by policy support and cutting-edge technology, China is at the forefront of the global new energy race, with the new energy vehicle (NEV) serving as its flagship product. Given this backdrop and considering China's vast stock market landscape, there has been a surge in interest in the new energy sector. Consequently, our paper focuses on China's NEV industry, selecting BYD Company — a pioneer in China's NEV market — as a case study to delve deeper into the investment risks of the new energy stock market.

Several studies have explored China's NEV landscape and the BYD company. Masiero et al. (2016) [15] delineated the factors underpinning the success of China's NEVs, emphasizing the role of government incentives and BYD's strategic maneuvers. Gong H. et al. (2013) [16] offered insights into the future trajectory of new energy in China by assessing the progress of NEV demonstrations and acknowledging the pivotal role of the Chinese government. Ren (2018) [17] unraveled the intricate relationships between various influencing elements and the sustainable growth of NEVs in China. His findings underscored the importance of technological maturity, standardization for NEVs, and R&D investments as the key drivers for the industry's sustainable evolution. Lin, Y. et al. (2018) [18] onducted a thorough case study on BYD to chart a sustainable course for China's NEVs, introducing innovative frameworks like the business model canvas and the triple-layered business model canvas. Lastly, Liu and Meng (2017) [19] dissected the innovation models of leading NEV players, including Tesla, Toyota, and BYD. Their research credited BYD's success to its conducive ecological innovation ecosystem and a savvy market strategy.

2. Model and data

2.1. Model

In this paper, we use the Capital Asset Pricing Model (CAPM), which is a fundamental concept in finance that establishes a linear relationship between the expected return of a security and its risk, measured by the β coefficient. The model takes the following format:

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

Where $E(R_i)$ is the expected return on the investment (stock); R_f is the risk-free rate, which represents the return on an investment that is considered to be risk-free, e.g. a treasury stock, or government bond; β_i is the "beta" of the investment, which measures the sensitivity of the expected excess asset returns on the expected assess market returns; $E(R_m)$ is the expected return on the market, which is typically represented by a board market index, in our case, the Shenzhen composite index.

The CAPM's theoretical underpinning rests on several assumptions, with a pivotal one suggesting that investors maintain a diversified portfolio, thereby nullifying unsystematic risk. Put differently, the model contends that since unsystematic risks can be systematically eliminated via diversification, no premiums are conferred for undertaking such risks. Despite its foundational role, the CAPM isn't without limitations. Its assumptions, which include a tax-free environment, zero transaction costs, universal access to uniform information, consensus on risks and expected returns of all assets, unrestricted lending and borrowing at the risk-free rate, and a market teeming with buyers and sellers ensuring liquidity, can seem overly idealistic.

Nevertheless, despite these simplifying assumptions, CAPM's utility remains profound. Its ability to offer investors an anticipated return derived from a risk-free rate amalgamated with the risk premium corresponding to systemic risk is invaluable. Corporate entities frequently deploy CAPM to discern their cost of capital, and the model has entrenched itself as a pivotal tool in the computation of the weighted average cost of capital (WACC). Moreover, the CAPM serves as an essential instrument for risk security pricing. When an asset appears undervalued or overpriced, CAPM can guide investors towards judicious buying or selling decisions.

2.2. Data

In this article, we analyze the risk-return tradeoff of BYD. BYD was founded in February 1995, and is headquartered in Shenzhen, Guangdong China. Now, the company has more than 220,000 employees, and its business across four major industries including the automobile, rail transit, new energy and electronic. BYD has listed in Hongkong and Shenzhen, and its revenue and market value are above 100 billion yuan. BYD is committed into the promotion of sustainable development by technology. "Technology is king, innovation is the foundation" is the develop concept of BYD. Under its strong innovation and technology, BYD is playing a vital role in its four major fields. In automobile field, BYD has mastered the core technologies of new energy vehicles such as batteries, motors and electronic controls. Plus, in a major shift towards sustainability, BYD announced in 2022 its plan to cease production of combustion engine vehicles, turning its focus exclusively to electric vehicles.

BYD has become a leading enterprise in China's new energy vehicle industry, and its excellent technology and exquisite craftsmanship have become a benchmark for new energy vehicle all around the world. As a leader in the sales of new energy vehicles of China, BYD has become the sales champion of new energy vehicles in China and even the world. For instance, in July 2023, BYD sold about 230 thousand vehicles, occupying 13% of China's new energy vehicle market share. As Figure 1 [1] illustrates the the stock price of BYD has been roughly experiencing an increasing trend since 2021. Whereas, Figure 3 [3] indicates that the SZ composite index has been basically fluctuating in the range of 1500 to 2500. Indicating in Figure 2 [2], the compounded return for BYD stock has fluctuating sharply within the range of -0.1 to 0.1. Figure 4 [4] shows the compounded return of SZC index, which also fluctuated sharply, but within a smaller range around -0.08 to 0.06.

Because of the optimistic development prospects of BYD, it has become many investors' choice in the new energy stock market. BYD's representative status in China's new energy vehicle industry makes it a suitable object for studying the new energy stock market. As a result, this paper chooses BYD as the main research object to learn the risk of new energy investment in China.

Here in this paper, we use the China Government Bond (10-year yield to maturity) as a proxy for the risk-free rate. The reason for choosing the 10-year yield is that shorter-term yields, such as the 1-year yield, are close to zero, making them less suitable as measure for the risk-free rate. It is long enough to be less volatile than short-term yield, but not so long that it's susceptible to extreme long-term uncertainties. We use the return of Shenzhen composite index to proxy the market return of returns, and we use the rates of the return calculated based on the closing price of BYD stock, post adjustment for rights or dividends, as the returns for the asset/stock. Note that the "post-adjustment" happens after dividends or rights issues, such adjustment ensures that historical stock prices reflect current stock structures, allowing for a more accurate comparison over time.

In order to facilitate our understanding, we calculated the descriptive statistics of these variables. They are summarized in the table below.

Table 1. Descriptive statistics for variables

Variables	Mean	Variance	Skewness	Kurtosis	ADF-test
Risk-free rates of return	8.6515e-03	9.19961e-07	4.227234e-01	2.2222e+00 -	5.5606e-01 ***
Rates of return for BYD stock	1.7032e-04	2.4836e-04	-9.1578e-01	7.4426e+00	-1.1694e+01 ***
Rates of return for Shenzhen composite index	8.9415e-04	8.1953e-04	1.7249e-01	5.5815e+00	-1.2199e+01 ***

Note: *, **, and *** stand for statistical significance at 10%, 5% and 1% significance level.

Note that the skewness and kurtosis measure the asymmetry and the "tailedness" of a distribution, whereas the ADF (Augmented Dickey-Fuller test) is a type of unit root tests, its main purpose is to test the null hypothesis of a unit root. From Table 1, we can see that the returns for the BYD stock and Shenzhen composite index have skewness and kurtosis (fat tails). Financial assets in general have leptokurtic behaviors, which mean that extreme price movements (both up and down) happen more frequently than would be expected under a normal distribution. The reason of testing the unit root is because a linear regression assumes a certain set of properties about the data to produce reliable and unbiased estimates, one of the assumptions is that the errors (or residuals) should be stationary, therefore, the dependent and independent variables must also be stationary. Judging from our results, the rates of returns for BYD stock and the Shenzhen composite index are stationary, therefore, they are suitable as input (independent and dependent) variables in a linear regression (CAPM regression). Note that the ADF test for the risk-free rates does not reject, this, however, doesn't indicate nonstationarity, as indicated by the variance of the risk-free rates, which is close to 0, the variable almost is nonstochastic, which renders the unit root test falsely having a non-rejection. In summary, all variables are fine as inputs of a linear regression.

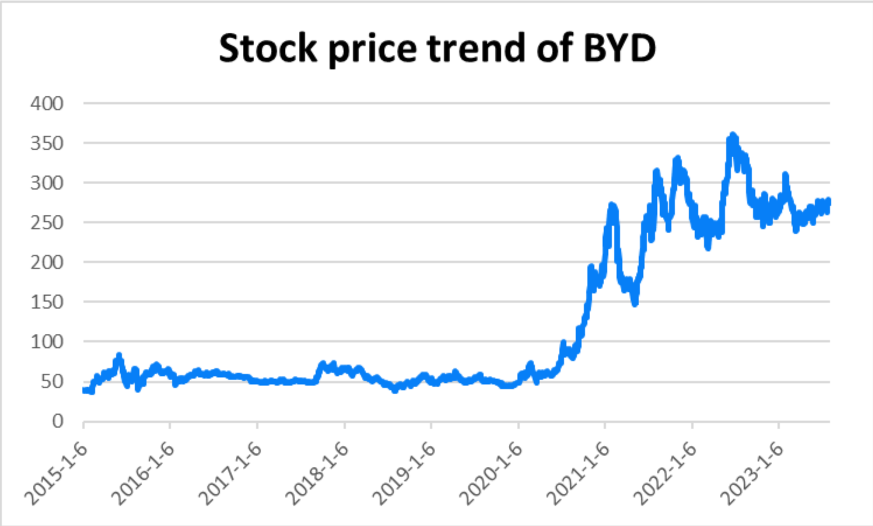

Figure 1. BYD Stock Prices.

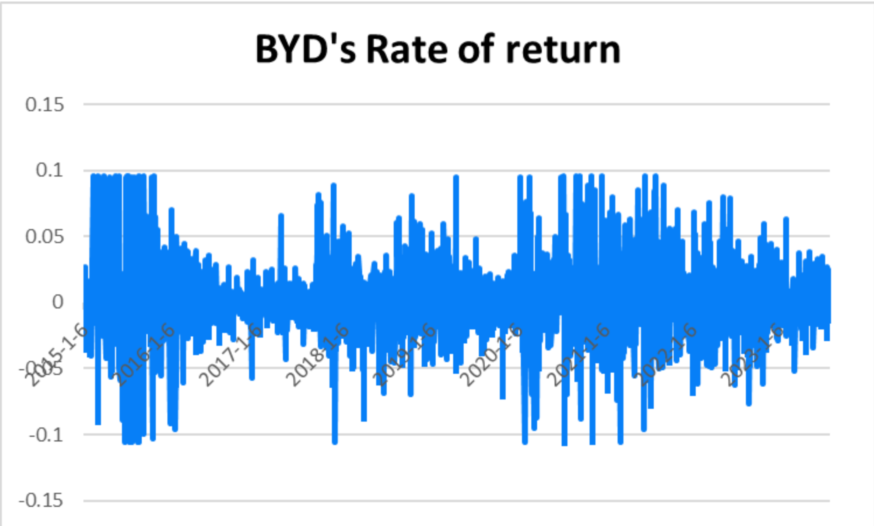

Figure 2. Continuously Compounded Return for BYD Stock.

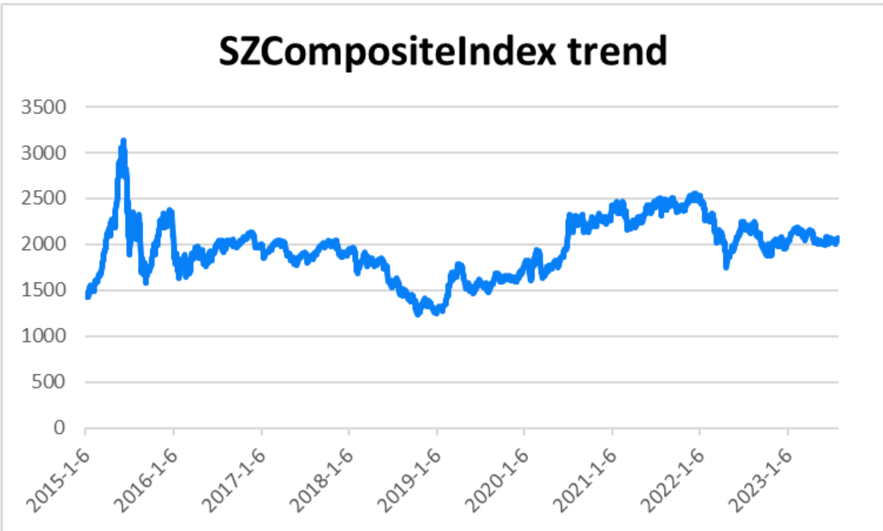

Figure 3. SZ Composite Index.

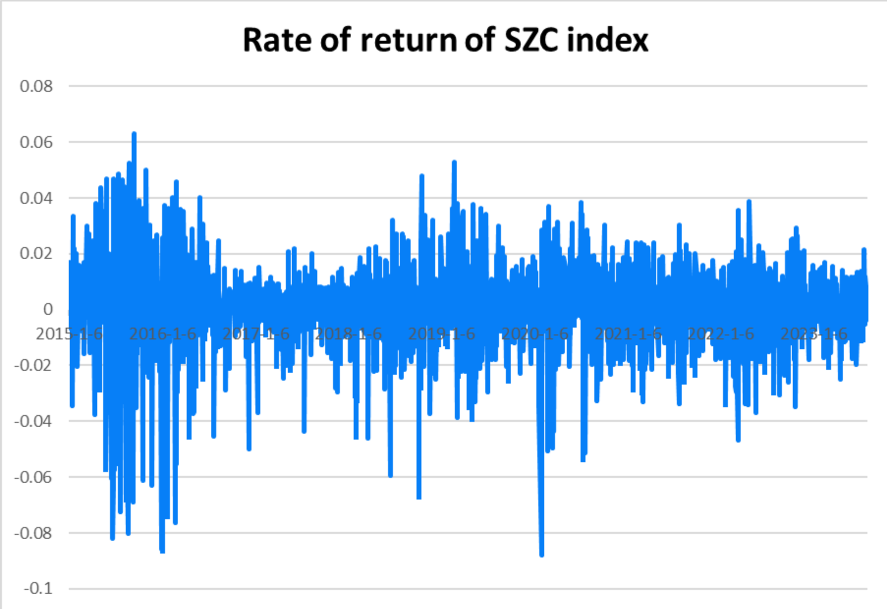

Figure 4. Continuously Compounded Return for SZC Index.

2.3. Regression

Equation (1) is the theoretical equation of the CAPM, where the relationship holds in expectation. To convert equation (1) into a regression equation, we have

$$R_i = R_f + \beta_i(R_m - R_f) + \varepsilon_i, \tag{2}$$

Where R_i is the observed, usually time series, of the stock, which is the rates of return for BYD stock; R_m is the observed market rates of return; and noticeably, ε_i is the error term, representing the factors affecting asset returns that are not captured by the market index.

Equation (2) can be rearranged as follows:

$$R_i - R_f = \beta_i(R_m - R_f) + \varepsilon_i. \tag{3}$$

A clear indication from equation (3) is that if the intercept term for the CAPM is theoretically 0, but in a real-world regression, it might not, which would indicate potential alpha, also known as the abnormal return. Much of the investment exercise revolves around unearthing alpha, which indicates outperformance, in another word, if a stock has a positive alpha, it means it has outperformed its benchmark on a risk-adjusted basis.

Based on the analysis above, the final regression equation is as follows:

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + \varepsilon_i. \tag{4}$$

where α_i represents the abnormal rate of return on BYD stock in excess of what was predicted by the CAPM. It captures the asset-specific returns that aren't explained by market movements, and in our case, measures the outperformance/underperformance of the BYD stock, provided α_i is positive/negative.

2.4. Results

The equation in our research is fitted in a linear model. The charts show the data results of our research, and the significance of them is explained as follow.

2.4.1. Entire interval

(1) Residual analysis

Table 2. Residual data

Min	1Q	Median	3Q	Max
-0.091055	-0.009052	-0.001447	0.007536	0.088553

In our study, the residual value represents the difference between the observed and predicted values, which essentially captures the prediction error. Upon examining the distribution of the residuals over the entire study period, it is observed that the values closely hover around zero. Notably, the median residual value stands at -0.002107. Further, the residual values oscillate within the range of -0.88458 to -0.128654. This close proximity of the residuals to zero underscores the high precision of the predictions made by our model.

(2) Coefficient Estimation

Table 3. Coefficient data

	Estimate	Std. Error	T value	Pr(>|t|)
Intercept	0.0016101	0.0005571	2.89	0.00389 **
Market return	1.1035379	0.0310621	35.53	< 2e-16 ***

The estimated coefficient for the intercept is 0.0016101. In practical terms, when the market return is nullified, the projected stock return is anticipated to be 0.16101%. This intercept is often referred to as the 'alpha' of the stock. It delineates the expected return of the stock in the scenario where market returns are stagnant. An intriguing observation from our study is the consistently positive alpha for BYD throughout the research duration, indicative of its commendable overall performance.

The market return coefficient has been estimated at 1.1035379, representing the stock's beta coefficient. This essentially portrays the relationship between stock and market returns. Given that the estimated beta value surpasses 1, it can be inferred that the stock exhibits volatility slightly surpassing that of the market. Elaborating on this, BYD's market return coefficient of 1.1035379 implies a greater volatility in BYD’s stock price in comparison to the market. Consequently, one might deduce that BYD’s stock carries a risk profile that is elevated relative to the market. The T-test produced values of 2.89 for the intercept and 35.53 for market return, reinforcing the statistical significance of our estimations.

(3) Model Fit and Evaluation

Table 4. Model Fit and Evaluation

Residual standard error	Multiple R-squared	Adjusted R-squared	F-statistic	p-value
0.02274 on 2145 degrees of freedom	0.3704	0.3701	1262 on 1 and 2145 DF	< 2.2e-16

The model's R-squared value stands at 0.3704. This metric suggests that approximately 37.04% of the stock return's variability can be elucidated by the market return. The Adjusted R-squared value, which marginally deviates from the R-squared at 0.3701, indicates the absence of superfluous predictors in our model. Further affirmation of the model's appropriateness is the F-statistic, valued at 1262 on 1 and 2145 degrees of freedom. Given the p-value of less than 2.2e-16, it can be ascertained that the model displays a superior fit to the data relative to a model devoid of predictors.

2.4.2. Pre-, During, and Post-COVID-19 Pandemic

In order to analyze the stock condition of BYD in a comprehensive manner, our research specifically examines BYD’s stock performance across three distinct periods: the pre-pandemic, during-pandemic, and post-pandemic phases. The data results for these periods, along with their respective interpretations, are presented below.

(1) Residual analysis

Table 5. Residual data for the pre-, during and post-COVID-19 pandemic

	Min	1Q	Median	3Q	Max
Pre-pandemic	-0.091055	-0.009052	-0.001447	0.007536	0.088553
During-pandemic	-0.082298	-0.016635	-0.003122	0.012977	0.092443
Post-pandemic	-0.039409	-0.008169	-0.000394	0.007756	0.048439

The residual values for all three periods are proximate to zero. Specifically, the medians for these periods are -0.001447 (pre-pandemic), -0.003122 (during-pandemic), and -0.0003945 (post-pandemic). This consistency in the residuals underscores the accuracy of the predicted values. The residuals can also be seen from Figure 5, where we visualized the data points and fitted CAPM models for pre-,during and post-COVID-19 pandemic periods.

(2) Coefficient Estimation

Table 6. Coefficient estimation for the pre-, during, and post-COVID-19 pandemic

		Estimate	Std. Error	t value	Pr(>|t|)
Pre-pandemic	Intercept	-0.0006212	0.0008223	-0.755	0.45
	Market return	0.9215204	0.0512646	17.976	<2e-16 ***
During-pandemic	Intercept	0.005419	0.001083	5.002	7.07e-07 ***
	Market return	1.429327	0.068462	20.878	<2e-16 ***
Post-pandemic	Intercept	2.379e-05	1.507e-03	0.016	0.987
	Market return	9.990e-01	1.355e-01	7.372	7.69e-12 ***

(3) Pre-pandemic period

The estimated value of stock returns, when the market return is zero, is -0.06212%. This implies that in the absence of market returns, the model anticipates a decrease in stock return by 0.06212%. However, the p-value associated with the intercept is 0.45, surpassing common significance levels. Thus, there's insufficient evidence to assert that the intercept significantly deviates from zero. The market return coefficient, or beta, is 0.9215204. This posits that for every 1% surge in the market return, the stock return is projected to amplify by roughly 0.9215%, suggesting that BYD’s stock is marginally riskier than the market.

(4) During-pandemic period

During this phase, the projected value of stock returns, when the market return is null, is 0.005419%. Hence, in a scenario where the market return is stagnant, the model expects the stock return to elevate by 0.005419%. This figure surpasses the post-pandemic projection. With a p-value of 7.07e-07 for the intercept, there's robust evidence supporting the intercept's significant deviation from zero. The beta coefficient stands at 1.429327, implying that a 1% increment in the market return could lead to an approximate 14.2932% increase in stock return. This period's beta further denotes an elevated risk profile for BYD’s stock compared to the market.

(5) Post-pandemic period

During the post-pandemic period, the estimated value of stock returns, when the market return is zero, stands at 2.379e-05%. Thus, if the market return were to be null, the linear model predicts a slight increase in stock return by 2.379e-05%. Interestingly, the stock return for this phase is considerably higher than that observed during the pandemic. However, with a p-value of 0.987 associated with the intercept, there is no compelling evidence to assert that the intercept significantly deviates from zero.

In this period, the market return coefficient, also referred to as the beta coefficient, is pegged at 9.990e-01. This elevated value suggests that BYD’s stock is substantially riskier compared to the broader market during this phase.

(6) Model Fit and Evaluation

Table 7. Model fit and evaluation for the pre-, during, and post-COVID-19 pandemic

	Residual standard error	Multiple R-squared	Adjusted R-squared	F-statistic	p-value
Pre-pandemic	0.01797 on 751 degrees of freedom	0.3008	0.2999	323.1 on 1 and 751 DF	< 2.2e-16
During-pandemic	0.02594 on 751 degrees of freedom	0.3673	0.3664	435.9 on 1 and 751 DF	< 2.2e-16
Post-pandemic	0.01411 on 165 degrees of freedom	0.2478	0.2432	54.35 on 1 and 165 DF	7.693e-12

(7) Pre-pandemic period

The multiple R-squared value stands at 0.3008, indicating that approximately 30.08% of the variability in stock return is explained by the market return. This serves as a measure of the model's goodness-of-fit. The adjusted R-squared closely mirrors the multiple R-squared, suggesting that the model doesn't include superfluous predictors.

With an F-statistic of 323.1 (for 1 and 751 degrees of freedom) and a p-value less than 2.2e-16, the F-statistic emerges as highly significant. This implies that the model provides a more accurate fit to the data compared to a model devoid of any predictors.

(8) During-pandemic period

The multiple R-squared value is 0.3673, indicating that approximately 36.73% of the variability in stock return can be attributed to the market return. This provides a measure of the model's goodness-of-fit. The adjusted R-squared is nearly the same as the multiple R-squared, implying that the model is devoid of superfluous predictors.

The F-statistic stands at 435.9, based on 1 and 2145 degrees of freedom. With a p-value less than 2.2e-16, the F-statistic is highly significant. This confirms that our model offers a better fit to the data compared to one without predictors.

(9) Post pandemic period

The multiple R-squared value is 0.2478, indicating that approximately 24.78% of the variability in the stock return can be attributed to the market return, serving as a measure of the model's goodness-of-fit. The adjusted R-squared closely aligns with the multiple R-squared, suggesting that the model is free from extraneous predictors.

The F-statistic is 54.35, with 1 and 165 degrees of freedom. Given that the p-value, representing the overall significance level, is above 7.693e-12, the F-statistic is not deemed significant.

The data points and estimated regressions for the entire interval, pre-, during and post-pandemics are visualized as follows.

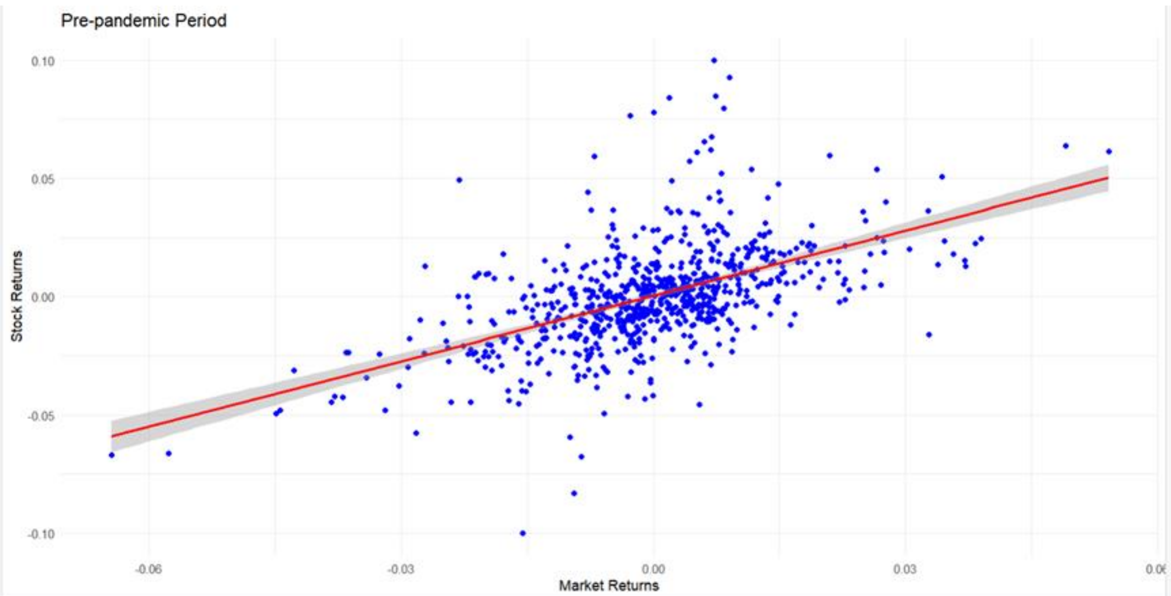

Figure 5. Pre-pandemic

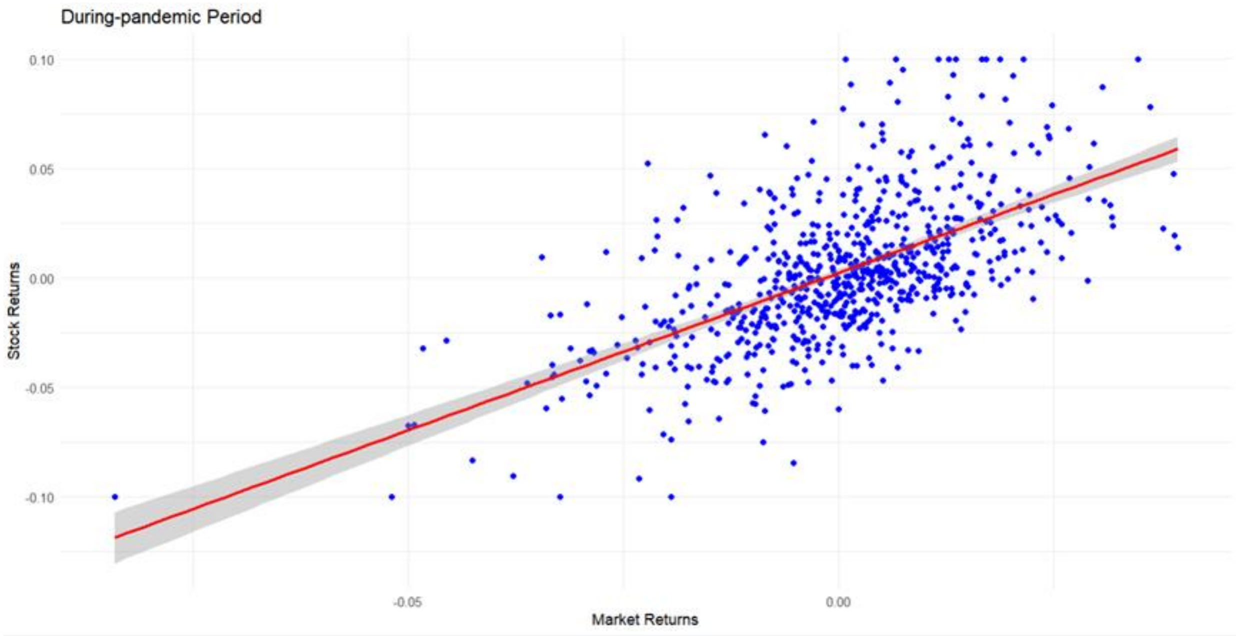

Figure 6. During the pandemic

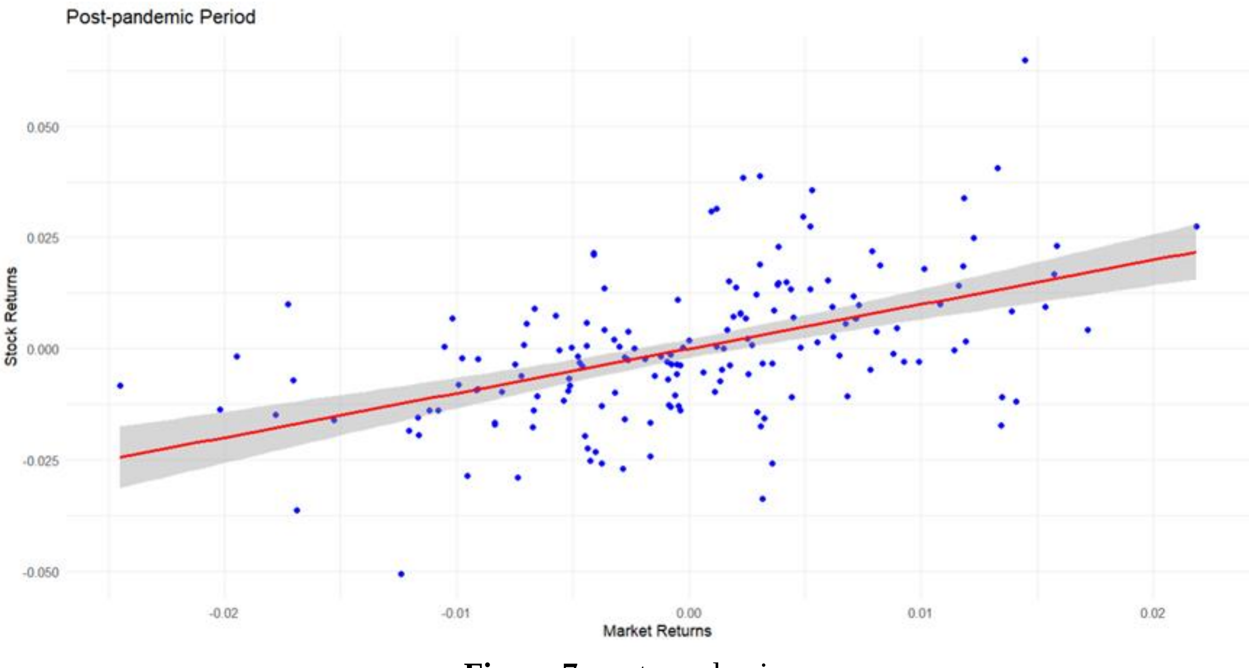

Figure 7. post-pandemic

3. Discussion

The alpha and beta coefficients of BYD's stock across the pre-pandemic, during-pandemic, and post-pandemic periods provide a narrative of sector-specific trends, changing market perceptions, post-pandemic volatility, and subsequent recovery dynamics. China's proactive sector-specific policies set the backdrop for BYD's performance, with the COVID-19 pandemic introducing both challenges and opportunities. As the country battled the immediate effects of the pandemic, it paved the way for a surge in demand for new energy vehicles, influenced by both strategic governmental interventions and a societal shift towards sustainability. Yet, the journey post-pandemic was marked by economic uncertainties, even as China's persistent support for the new energy vehicle sector hinted at a hopeful horizon.

3.1. Sector-specific

From the pre-pandemic period to the post-pandemic period, the alpha coefficient of BYD's stock has shown a consistent increase, highlighting the outperformance of BYD's stock. This positive trajectory in BYD's stock condition is closely tied to the sector-specific trends within the new energy vehicle market in China.

Over the past several years, China has introduced a series of policies to bolster the development of the new energy vehicle industry. In 2016, the Chinese government offered subsidies to consumers, spurring the purchase of new energy vehicles. In 2020, in the aftermath of the pandemic, China chose to extend the subsidy for new energy vehicles and the purchase tax exemption policy, which was set to expire at year's end, for an additional two years. By the close of 2020, the subsidy specifics for new energy vehicles for 2021 were delineated, setting the stage for the continued growth of the sector in the subsequent year.

With the backing of governmental initiatives and policies, China's new energy vehicle industry witnessed significant growth over the past few years, leading to the continuous expansion of the new energy vehicle market. As a direct consequence of this, BYD's stock has experienced commendable performance in recent times.

3.2. Market perception-during pandemic

Concurrent with the outbreak of COVID-19, the new energy industry suffered a setback. As the pandemic's ground zero, China's initial response, coupled with lockdown measures, severely impacted new energy vehicle sales, leading to a sharp decline in the first half of 2020. The unexpected arrival of the virus made consumers more conservative, often hesitating to purchase high-ticket items such as cars.

However, every cloud has a silver lining. The pandemic also paved the way for newfound opportunities for new energy vehicles. As noted by Wen et al. (2021)[20], while COVID-19 suppressed vehicle sales in the short term, it catalyzed the demand for new energy vehicles in the longer run. By the latter half of 2020, as the pandemic was brought under control, the Chinese government rolled out supportive policies for the new energy market, spurring a swift recovery. Buoyed by these strategic policies, sales of new energy vehicles in China surged, setting new records in the second half of 2020. Moreover, the pandemic reshaped public perception: heightened awareness about health led to a collective shift towards healthier and more sustainable lifestyles. As a result, new energy vehicles received a favorable reception, and their sales graph trended upwards. BYD's performance during this period serves as a testament to the pandemic's dual-edged impact. The rising stock prices mirrored the increasing sales of new energy vehicles. Moreover, the positive turn of the alpha coefficient signifies the robustness and resilience of the new energy market during these trying times.

3.3. Increased volatility-post pandemic

In December 2022, China announced that it had gained control over the pandemic, signaling the end of its pandemic phase. However, the cessation of the pandemic does not necessarily equate to an immediate economic rebound. The prolonged health crisis has heightened consumer anxiety and caution in both consumption and investment behaviors. Furthermore, the journey to full economic capacity restoration is ongoing, rendering the post-pandemic economic environment uncertain. Given that the new energy vehicle industry is closely tied to broader economic conditions and heavily depends on government policy support and consumer purchasing power, it has become increasingly vulnerable in the post-pandemic phase. Additionally, BYD's ability to adapt and its resilience both during and after the pandemic could have swayed investor sentiments, subsequently influencing the stock's market sensitivity. The elevated beta coefficient of BYD underscores the state of the new energy vehicle industry during this post-pandemic period.

3.4. Post-pandemic recovery

During the post-pandemic period, the alpha coefficient of BYD's stock surged to notable heights. This elevated return on BYD's stock reflects the company's optimistic outlook, which is inextricably linked to China's effective post-pandemic recovery and adept management of COVID-19.

Following the pandemic's conclusion in 2023, China continued to roll out supportive policies, intensifying their commitment to bolster the new energy vehicle market. The government extended more subsidies not only for those purchasing new energy vehicles but also for their maintenance. They further subsidized the installation of charging stations and ensured the reliable operation of these vehicles. Owing to these measures, the new energy vehicle sector witnessed a swift recovery in the post-pandemic era.

4. Conclusion

The transition from traditional to new energy resources is not merely an environmental imperative but also an evolving economic narrative. As traditional energy dwindles and environmental concerns intensify, the rapid ascent of the new energy domain unfurls a plethora of investment opportunities. Yet, inherent to every burgeoning opportunity is an associated risk, making the discernment and mitigation of these risks paramount. Through the lens of the Capital Asset Pricing Model (CAPM), this research sought to shed light on the investment risks associated with China's new energy vehicle sector, with a focal study on BYD.

Our findings illuminate that the performance and risk assessment of BYD's stock are profoundly influenced by sector-specific developments, market perceptions during the pandemic, post-pandemic volatility, and the recovery mechanics at play. Undergirded by China's unwavering commitment to policy support, the new energy vehicle industry has demonstrated resilience, even amid the turbulence of a global pandemic. This resilience is captured eloquently in the increasing alpha coefficient of BYD's stock from pre-pandemic to post-pandemic periods. Yet, the elevated beta coefficient in the post-pandemic phase speaks to the industry's heightened sensitivity to broader economic dynamics.

As we stand at the cusp of an energy transition, investors, policymakers, and stakeholders must be adept at navigating the multifaceted landscape of new energy investments. Our analysis, underpinned by the robust CAPM methodology, offers a unique perspective into the intricate interplay of risk and opportunity within the new energy vehicle sector. Notably, our insights into BYD's journey—alongside parallels with other industry players like XPENG, NIO, and Li Auto—provide a foundational reference for investors keen on deciphering the new energy investment conundrum.

In conclusion, while the allure of the new energy sector is undeniable, safeguarding investor interests necessitates an astute understanding of the industry's intricacies. Through our comprehensive investigation of BYD using CAPM, we aspire to equip investors with the acumen required to discern opportunity from risk, ensuring both sustainable investments and a sustainable future.

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