Evaluating Risk-Return Dynamics in Chinese Energy Companies: An Application of the Capital Asset Pricing Model

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Abstract. This paper examines the risk-return tradeoffs for major Chinese energy companies—China Petroleum & Chemical Corporation (SINOPEC), GD Power Development, and China Yangtze Power Co., Ltd.—using the Capital Asset Pricing Model (CAPM) to analyze daily returns from January 4, 2021, to December 29, 2023. The study evaluates the correlation between the expected rate of return and the market risk, as indicated by the beta coefficients, across these companies. Our findings reveal that these companies also have significant alpha (excess returns), which suggest that distinctive corporate strengths such as technological leadership, efficient cost management, and strategic market positioning contribute significantly to excess returns. These factors are essential for evaluating the overall value and investment potential of these entities. However, the study also identifies limitations due to external macroeconomic influences and discrepancies between estimated and actual beta values, affecting the CAPM's predictive accuracy. Future research is encouraged to integrate macroeconomic factors and dynamic beta estimation to refine risk and return assessments. This study underscores the importance of adapting financial models to accommodate the specific dynamics of rapidly evolving markets like China's energy sector.

Keywords: Capital Asset Pricing Model (CAPM); Risk-Return Analysis; Chinese Energy Companies; Market Risk; Investment Valuation.

1 Introduction

The examination of risk-return tradeoffs for major Chinese energy companies such as China Petroleum & Chemical Corporation (SINOPEC), GD Power Development, and China Yangtze Power Co., Ltd. is paramount given their significant roles in the energy sector, a crucial driver of the country's booming economy.

China's distinctive market conditions, characterized by rapid industrial growth and significant governmental influence, present unique investment landscapes that differ markedly from Western markets.

The energy sector in China, including oil, petrochemicals, and electricity generation, is not only pivotal to domestic economic stability but also to global energy supplies. As these sectors undergo transformation with the integration of renewable energy sources

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and technological advancements, understanding the associated financial risks and returns becomes essential. The application of the Capital Asset Pricing Model (CAPM) to these energy stocks is particularly relevant. CAPM offers a nuanced approach to assess the systematic market risk by isolating the effects of market-wide phenomena from firm-specific events.

Incorporating the CAPM framework allows for a meticulous dissection of the expected returns of these energy stocks in relation to their exposure to market risk, adjusted for the unique dynamics of the Chinese economy. These dynamics include the regulatory environment, state ownership, and the strategic importance of energy security. This analysis is not just pertinent for local investors but also for international stakeholders who are increasingly impacted by China's energy policies and market fluctuations. Through this lens, we seek to provide a thorough understanding of the risk-return profiles of these pivotal Chinese energy companies and offer valuable insights for investment strategies within and beyond China.

2 Literature Review

The Capital Asset Pricing Model (CAPM), as expounded upon by seminal figures such as Sharpe, Lintner, and Mossin, has long stood as a cornerstone in the theoretical framework of financial economics (Sharpe, 1954; Linter, 1965; Mossin, 1966). Each contributor's distinct insights coalesced to form the model's comprehensive understanding of the risk-return paradigm, with Treynor's initial explorations into systematic risk compensation laying the foundational bedrock. Sharpe's groundbreaking work then quantified the concept of beta, a relative measure of systematic risk, thereby providing investors with a tangible gauge for assessing potential returns against inherent market risks[1]. Lintner further refined the model, skillfully incorporating the behavior of asset prices into investment decision processes[2], while Mossin's rigorous mathematical approach solidified the link between risk aversion and asset pricing[3].

China's stock market has been a major interest for research, for instance, Lyu (2024) analyzed the risk-return relationship of leading Chinese new energy companies – BYD, CATL and Sungrow, using the CAPM to assess the systematic risk affecting their stock returns. It highlights each company's unique beta coefficients and discussed the implications for investors and policymakers[4]. Liu et al. (2023) investigated the structure and efficacy of financial sector models within China's unique market environment, looking into 133 reverse-merges. This paper is connected to Liu et al. (2023), since both papers focus on the risk-return trade-off. While CAPM primarily focuses on the market beta to determine the expected returns of securities based on their systematic risk, this paper extends the concept by integrating specific market anomalies and unique characters in Chinese stock market[5]. Urom (2020) presented a dynamic conditional regime-switching GARCH CAPM that incorporates time-varying betas to better estimate the risk and return in energy and financial markets, and compared this model to traditional static CAPM models across 81 markets from 1999 to 2018. Jacobsen and Liu (2008) examined the pricing of securities in China's stock market, using an international capital asset pricing model, It explored how restrictions on foreign and domestic investment impact the price of global, local and currency risks. The paper studied the A shares, accessible for domestic investors, and B shares, available to foreign investors (resembling an emerging market).

The literature review highlights the evolution of the application of CAPM from its theoretical foundations laid by seminal figures such as Sharpe, Linton, and Mossin, to its practical applications in understanding the risk-return dynamics in different market environment. This review encapsulates how CAPM can help in evaluating market-specific risk and informing investment decisions, emphasizing its enduring relevance and adaptability in global finance.

2.1 Data and Method

Here we will study the following three major Chinese energy companies.

(1) China Petroleum & Chemical Corporation (SINOPEC, 600028): As one of the world's largest oil and petrochemical companies, SINOPEC is actively involved in the exploration and production, refining, and marketing of oil and natural gas, as well as chemical products production.

(2) GD Power Development Co., Ltd. (600795): Primarily focused on the generation and distribution of electricity, GD Power operates various power plants across China and is expanding its renewable energy portfolio.

(3) China Yangtze Power Co., Ltd. (600900): Specializing in hydroelectric power, this company, a subsidiary of China Three Gorges Corporation, manages major hydropower stations including the iconic Three Gorges Dam, positioning it as a leader in renewable energy within China.

These companies are significant players in China's energy sector, each representing key segments: oil and petrochemical, electricity generation and distribution, and hydroelectric power, respectively. Analyzing these firms' risk return tradeoff is critical due to their substantial impact on energy production and infrastructure, pivotal role in China's economic growth, and their influence on global energy market.

In this paper, we will utilize the Capital Asset Pricing Model (CAPM). CAPM is a foundational finance theory that delineates the relationship between systematic risk and the expected return on assets, particularly stocks. CAPM is one of the widely used asset pricing models in modern securities theory. This mathematical model can help investors understand the relationship between expected returns and investment risk[6]. It serves as a critical component in the fields of finance and investing, providing a method to estimate an investment's expected return based on its risk, as well as the time value of money. Determine the risk-free rate of return according to the national treasury bonds and deposit interest rate; Using the closing index of the energy market portfolio at different times to determine the yield of the energy market portfolio; The risk coefficient is determined by the ratio of the oblique variance and market variance of the single energy industry enterprise assets to the energy market portfolio, and the expected rate of return is calculated by using the CAPM model[7]. The formula for CAPM is expressed as:

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

where $E(R_i)$ is the expected return on the capital asset, R_f is the risk-free rate of interest (e.g., return on government bonds), β_i measures the sensitivity of the asset's returns to the market, $E(R_m)$ is the expected return of the market, and $E(R_m) - R_f$ is known as the market premium -the excess return expected from the market over the risk-free rate.

In practice, when using CAPM for empirical testing, a regression equation is often utilized to determine the asset's beta and expected return. The regression equation for CAPM is:

$$R_i - R_f = \alpha + \beta_i \times \left(R_m - R_f\right) + \epsilon_i \tag{2}$$

In this regression model, $R_i - R_f$ represents the excess return on the asset over the risk-free rate, α represents the asset's alpha, indicating the abnormal rate of return independent of the market (which, according to CAPM, should be zero), β_i again measures the sensitivity of the asset's returns to the market, $R_m - R_f$ is the excess return of the market over the risk-free rate, and finally, ϵ_i is the error term, representing the residual return not explained by market movements.

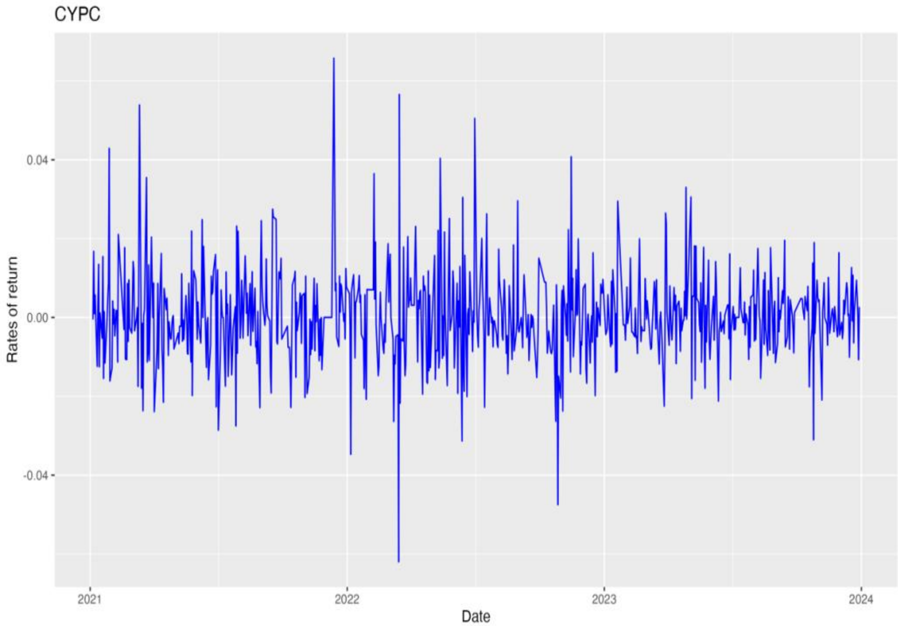
Through this regression, the beta (β_i) of a stock is estimated, which can then be plugged back into the CAPM formula to calculate the expected return. This model posits that the only type of risk that should affect an asset's return is market risk, not firm-specific risk, since the latter can be mitigated through diversification. Thus, CAPM measures the compensation an investor should expect for taking on additional risk beyond that of a risk-free asset.

2.2 Empirical Results

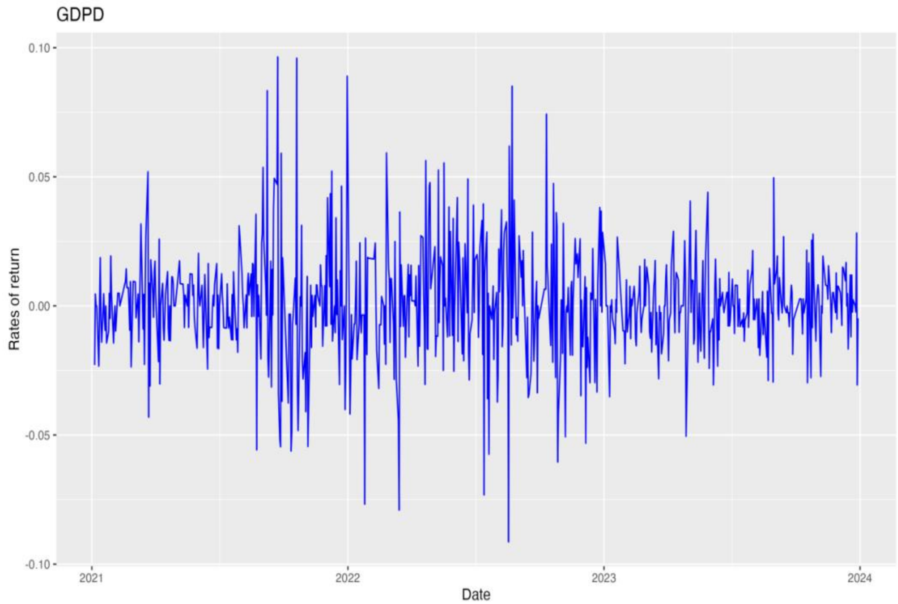
In this empirical analysis, daily closing prices of three major Chinese companies — CYPC, GDPD, and SINOPEC — are examined using data sourced from the Wind database, spanning from January 4, 2021, to December 29, 2023, comprising a total of 750 daily observations.

Clearly, the plots in Figure 1 indicate that logarithmic returns are stationary. A stationary time series is one whose statistical properties such as the mean, variance and autocovariance are constant over time. In these plots, the overall means seem to deviate too much away from zero, because we calculated daily rates of return. Moreover, the plots show fluctuations, but there do not seen to be a systematic change in the amplitude of these fluctuations over time, suggesting the stability of the variance.

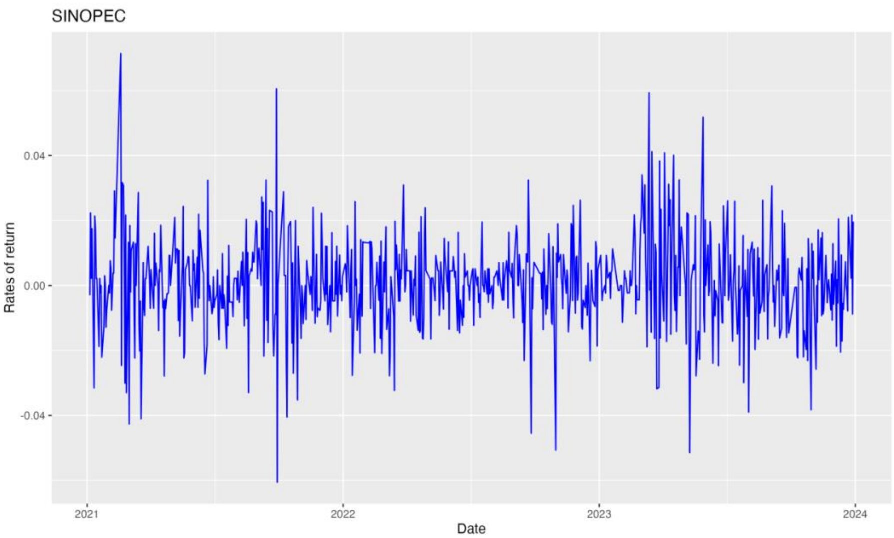
The analysis utilizes the logarithmic returns of the SZSE Component Index. Using logarithmic transformation is preferred in financial data analysis as it better accommodates the asymmetric nature of gains and losses. For example, a 50% loss requires a 100% gain to break even, which directly calculating rates of return can misinterpret. By employing logarithms, the true zero-sum nature of this example is accurately represented.


CYPC
0.04
0.00
-0.04
Rates of return
2021
2022
2023
2024
Date

(a) CYPC


GDPD
0.10
0.05
0.00
-0.05
-0.10
Rates of return
2021
2022
2023
2024
Date

(b) GDPD



(c) SINOPEC

Fig. 1. Logarithmic returns of CNYC, GDPD and SINOPEC.

Statistical tests confirm the stationarity of these return sequences, implying that their statistical properties such as mean, variance, and covariance remain constant over time without any evident trends or seasonal patterns.

The table below summarizes the regression analysis outcomes for CYPC, GDPD, and SINOPEC.

Table 1. Regression Analysis Results: CAPM Estimates for CYPC, GDPD, and SINOPEC.

	Intercept	t-value	F-value	p-value	Multiple R-squared	beta coefficient
CYPC	0.0023119	4.855	65.66	2.196e-15	0.08099	0.3711150
GDPD	0.0044923	5.349	75.47	2.2e-16	0.09198	0.7017141
SINOPEC	0.0040792	7.508	158.2	2.2e-16	0.1751	0.6571872

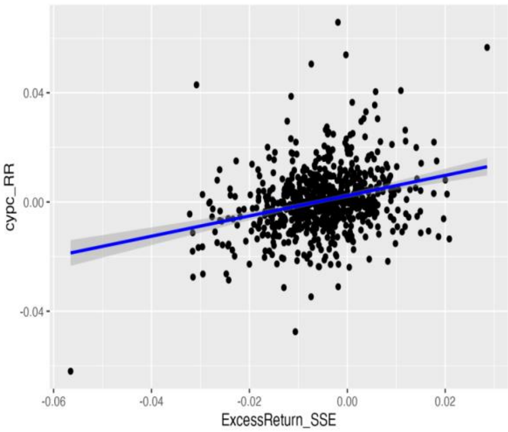
CYPC: The results indicate a statistically significant positive expected return (intercept of 0.0023) even when the market's excess return is zero, suggesting potential firm-specific or other macroeconomic factors influencing returns. The beta of 0.3711 implies that CYPC's returns are less sensitive to market swings. The model explains only about 8.10% of the variance in CYPC's returns, highlighting significant unexplained factors.

GDPD: The intercept value of 0.0045 with a high t-value of 5.349 suggests that GDPD may generate a positive excess return independent of the market. A beta of 0.7017 indicates a stronger correlation with market movements compared to CYPC. The R-squared value of 9.20% still leaves much of the variance unexplained, suggesting external influences or firmspecific attributes affecting the returns.

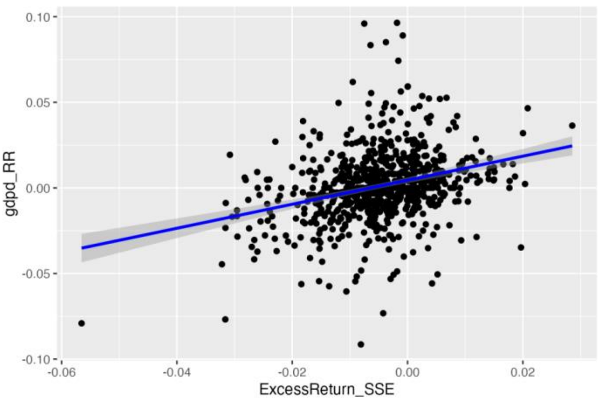
SINOPEC: With an intercept of 0.0041 and a significant F-statistic of 158.2000 , the results support a strong predictive power of the CAPM for SINOPEC. A beta of 0.6572 shows substantial market sensitivity, and the R-squared value of 17.51% is the highest among the three, indicating a better model fit yet still underscoring the presence of other influential factors.

The regression results highlight the CAPM's variable effectiveness across different sectors of the Chinese market. While it provides a framework for assessing risk and return, its application must be nuanced to consider local market dynamics, regulatory impacts, and the global economic environment that uniquely affect each firm. Enhancing the model to integrate these elements could improve its explanatory power and predictive accuracy, offering more robust investment insights. Future research could explore integrating macroeconomic indicators or sector-specific risks to provide a deeper understanding of these influences.

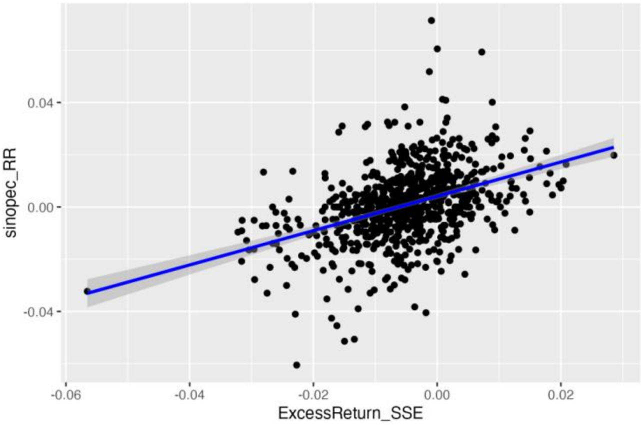
This refined analysis suggests that while the CAPM is a valuable tool in financial modeling, its application in rapidly evolving markets like China requires careful adaptation and consideration of additional variables that influence stock performance.



(a) CYPC



(b) GDPD



(c) SINOPEC

Fig. 2. CAPM relationships for CYPC, GDPD and SINOPEC

Each plot in Figure 2 includes a scatter plot with a linear regression line, depicting the CAPM relationship between two variables, the excess return for the SSE on the x-axis, and the rates of return for CYPC, GDPD and SINOPEC. All the slopes of regression lines are positive, indicating a positive correlation between the market excess return and the returns of these energy stocks, i.e. the excess return of the SSE increases, the rates of returns for CYPC, GDPD and SINOPEC also increase.

The dispersion of the points around the regression lines indicates variability of the relationships, while there are trends indicated by the positive slops, the points are somewhat spread out, suggesting that the relationship has moderate strength and other factors might also influence the rates of the return behind the market excess rates of return. The presence of a few outlier, particularly at the extremes of market excess return, could affect the slope and the intercept of the regression line. Nevertheless, the relationships are statistically significant, as indicated by the results from Table 1.

3 Conclusion

This paper's analysis of daily returns from CYPC, GDPD, and SINOPEC in China, spanning from January 4, 2021, to December 29, 2023, focuses on understanding the relationship between the expected rate of return of an asset and the risk associated (measured by the beta value). The principal findings highlight several critical insights into the dynamics of Chinese energy companies in the stock market.

The paper offers the following key insights. First, in terms of Beta and Market Risk. The data reveals that Chinese energy companies with higher beta values tend to be exposed to greater market risks. This correlation suggests that such companies, being more sensitive to market fluctuations, should theoretically provide higher returns, or alpha, as compensation to their investors. This is consistent with the fundamental premise of the Capital Asset Pricing Model (CAPM), which posits that higher risk should be accompanied by higher potential returns.

Second, in terms of Excess Returns. The analysis also indicates that the expected yield for these companies exceeds the industry average. This suggests that specific corporate attributes, such as advanced technology implementation, effective cost management, and strong market positioning, might contribute to these excess returns. Such findings underscore the importance of corporate governance and strategic advantages in generating shareholder value.

Third, Valuation Implications. Excess returns are crucial for the valuation of companies. In the context of Chinese energy companies, the ability to consistently generate returns above the market average can be seen as a sign of underlying strength and resilience, potentially making these companies attractive investment opportunities. By leveraging the CAPM to estimate expected and excess returns, investors and analysts can make more informed decisions about the long-term profitability and valuation of these companies.

However, this study does have limitation. Specifically, while the findings are enlightening, they are not without limitations. External factors such as macroeconomic conditions, policy changes, and regulatory environments play a significant role in shaping the performance of companies. These elements can obscure or distort the expected relationship between beta and yield, suggesting the need for models that can integrate external variables more effectively.

Additionally, discrepancies between the beta values estimated by the model and actual observed values highlight the potential challenges in using historical data to predict future risks and returns. This discrepancy might stem from the dynamic nature of financial markets or from structural changes within the industry or economy that are not captured by past data.

To address these limitations, future research could focus on the following aspects. First, Developing Enhanced Models through incorporating macroeconomic indicators and policy variables into the CAPM to refine the estimates of risk and return. Second, considering Dynamic Beta Estimation by Exploring methodologies for dynamic beta estimation that can adjust more quickly to market conditions. Third, Sector-Specific Analyses; we could conduct similar studies within different sectors or more granular analyses within the energy sector to compare how different types of energy companies (e.g., renewable vs. non-renewable) respond to market conditions.

By addressing these areas, subsequent studies can enhance our understanding of the financial dynamics of Chinese energy companies, offering deeper insights into the complex interplay between market conditions and corporate performance.

References

1. Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. The journal of finance, 19(3), 425-442.
2. Lintner, J. (1965). Security prices, risk, and maximal gains from diversification. The journal of finance, 20(4), 587-615.

3. Mossin, J. (1966). Equilibrium in a capital asset market. Econometrica: Journal of the econometric society, 768-783.
4. Lyu, D. (2024). Analyzing the Risk-Return Trade-Off Relationship of Chinese New Energy Firms Using the Capital Asset Pricing Model. Highlights in Business, Economics and Management, 30, 429-435.
5. Urom, C., Chevallier, J., & Zhu, B. (2020). A dynamic conditional regime-switching GARCH CAPM for energy and financial markets. Energy Economics, 85, 104577.
6. Latunde, T., Lukman, A., & Dare, D. D. (2020). Analysis of capital asset pricing model on deutsche bank energy commodity.
7. Sun Min. (2022). Research on the calculation of expected return on assets of enterprises in energy industry based on capm model. Coal Economic Research | Coal Econ Research, 42(6), 12-17.