Investing in the Batteries and Vehicles of the Future: A View Through the Stock Market

Michael Plante, Ph.D.
Principal Research Economist, Federal Reserve Bank of Dallas, U.S.A.

Full version available at *Federal Reserve Bank of Dallas Working Paper 2314*, March 2024:
https://doi.org/10.24149/wp2314

This study uses high-frequency stock price data to uncover the factors that drive the returns of companies operating in the electric vehicle and battery supply chain. The study's statistical approach separates out the influence of systematic risk factors and factors unique to the supply chain. EV and battery stock returns are found to be exposed to a market and a tech factor. There is also evidence for an EV factor, unrelated to the broader market, that generates common variation among these returns. Lithium companies are found to be exposed to their own unique risk factor.

Introduction

The electric vehicle (EV) and battery supply chain includes a large number of companies that have listed in recent years on a major U.S. stock exchange. This has occurred against a backdrop of dramatic increases in the global demand for EVs, the batteries that power them, and investor interest in the industry.

This study seeks to better understand the behavior of these companies' stock returns, hereafter referred to simply as EV stock returns, and how they relate to the returns of the broader market. I use a statistical approach that can parse out the influence of systematic factors, which affect stock returns more generally speaking, and factors that may be unique to the EV and battery supply chain. This sheds light on the extent to which EV stock returns comove with other stocks and why they comove with each other.

EV stock returns are found to be affected primarily by two systematic risk factors and two factors unique to the industry. The important systematic factors include a market factor, which generates common variation among all stocks, and a factor associated with the returns of tech companies. The ability of these two factors to explain EV stock returns declined in 2023, though, coinciding with a general collapse of clean energy stock prices.

The analysis also uncovers evidence for a factor I dub the "EV" factor. It plays a key role in driving the stock returns of most EV and battery companies but is unrelated to the broader market. There is also evidence of a risk factor specifically associated with the returns of lithium companies (lithium being a key component of the batteries used in EVs).

Relevance

This work contributes to the rapidly growing literature whose goal is to understand the properties and determinants of the returns of clean energy companies. What distinguishes my work from the previous literature is its focus on the EV and battery supply chain, my interest in understanding comovement among these stocks, and the approach I use for measuring systematic risk.

Investors may also find the results of interest, as they shed light on the degree to which the returns of EV and battery companies are correlated with each other and with the broader market. The results also highlight how the returns are exposed to various risk factors, some systematic and some related specifically to the EV and battery supply chain.

Data

The main data used in the study are intradaily stock price data sourced from Polygon.io. Companies are grouped into one of two sets. The first includes companies on the S&P 500 and NASDAQ 100, from which I extract latent factors used as measures of systematic risk. The second set contains companies operating in the EV and battery supply chain.

Using a variety of sources, I identify 78 companies to include in the second set. The list spans the EV and battery supply chain and includes mining companies focused on producing critical minerals, battery companies, EV original equipment manufacturers, and EV charging companies.

One practical issue is the frequency over which to generate returns because market microstructure noise, among other issues, can contaminate high-frequency stock returns. This is of particular concern given the small size and niche lines of business of many of the companies in my study. A 15-minute return window was chosen, based on the results of several statistical tests for the presence of noise introduced in Aït-Sahalia and Xiu (2019). Stocks were removed from the analysis if the tests pointed to significant contamination from noise.

Another practical issue is the number of years to include in the sample. Going back too far in time increases the number of returns but dramatically reduces the number of firms in the analysis. High-frequency data mitigates this problem by increasing the number of observations and allowing relatively short samples. The base results use data for 2022 and 2023. Robustness checks consider other sample periods. For each case, a company is only included if it has a full set of data.

Methodology

As a first step, I use principal components to extract latent factors from the panel of stock returns for companies on the S&P 500 and Nasdaq 100. The approach follows Pelger (2020), which has shown that a small number of latent factors can explain stock returns. A statistical test found in that paper, specifically designed for use with high-frequency data, is applied and shows that the first five principal components are systematic.

Based on their loadings, each of the five factors is shown to have a clear industry interpretation. The first factor loads on all stocks and, hence, resembles a market factor. The second factor, which I refer to as a tech factor, loads positively on tech, communication and consumer discretionary and negatively on defensive sectors, such as utilities and consumer staples. The third and fourth factors are oil and gas factors, while the fifth loads on utilities and real estate.

Each EV stock return is decomposed into a systematic component and an idiosyncratic component using a simple regression model,

$$r_{it} = \alpha_i + \sum_{j=1}^{5} \beta_{ij} f_{jt} + \epsilon_{it}.$$

The systematic component is the part that can be explained by the five systematic factors, while the idiosyncratic component is given the residual. R-squared statistics are used to quantify the ability of each factor to explain the returns.

I also consider a second regression model that includes two additional factors. These are the first and second principal components of the idiosyncratic returns.

Main Results

Figure 1 on the next page shows the explanatory power of the systematic factors for each EV stock. The blue, dark orange, and yellow bars show, respectively, the explanatory power of the market, tech, and the remaining three systematic factors.

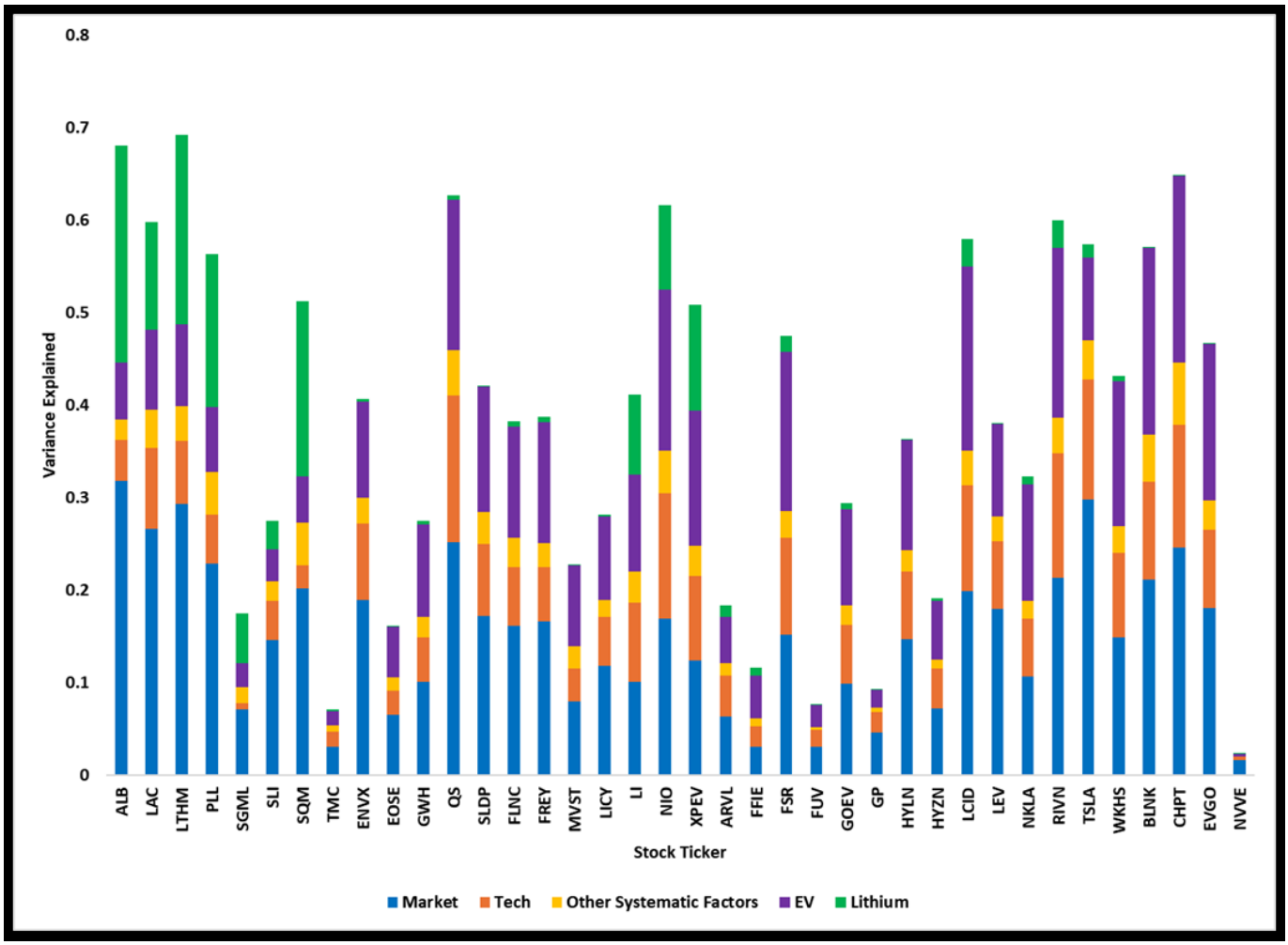
A general pattern that emerges is that both the market factor and the tech factor play an important role in explaining EV stock returns, while the remaining three factors are, more often than not, relatively unimportant. A table in the main paper shows that the explanatory power of the market factor for the typical EV stock, given by the median R-squared across all those firms, is about half that of the typical stock found on the S&P 500 and Nasdaq 100. The explanatory power of the tech factor, on the other hand, is about three times greater for EV stocks.

The tech factor is also found to load on EV stocks in the same direction as it does on tech stocks. As such, it reflects periods where both EV and tech stocks move in the same direction, and opposite to defensive sectors, such as utilities. Previous works, such as Henriques and Sadorsky (2008), have also found a connection between the returns of renewable energy companies and tech companies.

One interesting question is whether EV stock returns comove after controlling for the influence of the systematic factors. To address this question, I apply principal components to the panel of idiosyncratic returns. The first principal component is identified as an "EV" factor, as it loads on all the idiosyncratic returns. The second principal component is found to load heavily on lithium companies, pointing to a risk factor specific to those companies.

The explanatory power of these two factors can be substantial, as seen by the purple and green bars in Figure 1. The R-squared of the EV factor can rival that of the tech factor for many stocks. This points to an important source of common variation in the returns of these companies, one unrelated to the systematic factors. The lithium factor generally has substantial explanatory power for lithium companies, less so for most other companies.

Figure 1
Explanatory Power of Each Factor for Individual Stocks



Note: Mining companies go from ticker ALB to TMC; battery companies from ENVX to LICY; EV companies from LI to WKHS; EV charging companies from BLNK to NVVE. Further details about the companies can be found in the main paper.

Subsample analysis presented in the main paper shows that the explanatory power of the systematic factors declined quite a bit in 2023 for most EV stocks. On the other hand, there continued to be strong, common variation in the returns driven by the EV and lithium factors. That year saw a general reassessment of the viability of many EV and battery companies and a dramatic fall in many of their stock prices. Apparently, this has led to a weakening in the connection between the returns of these companies and the broader market.

Conclusion

Electric vehicles and batteries will be key to a successful energy transition. As demand has grown for both, there has been a proliferation of companies operating in the EV and battery supply chain. In recent years,

many have taken the next step and listed on a major U.S. exchange. My study examines the extent to which the returns of these companies can be explained by risk factors that help stock returns more broadly speaking. It also considers whether there are factors unique to the supply chain. Although these companies are often small and operate in a niche market, they do comove with the stock market more broadly speaking, due to exposure to a market factor and a tech factor. At the same time, they experience important common variation due to several factors specific to their industry.

References

Aït-Sahalia, Y. and D. Xiu, 2019, "A Hausman Test for the Presence of Market Microstructure Noise in High Frequency Data," *Journal of Econometrics*, Vol. 211, No. 1, July, pp. 176-205.

Henriques, I., and P. Sadorsky, 2008, "Oil Prices and the Stock Prices of Alternative Energy Companies," *Energy Economics* Vol. 30, No .3, May, pp. 998-1010.

Pelger, M., 2020, "Understanding Systematic Risk: A High-Frequency Approach," *The Journal of Finance,* Vol. 75, No. 4, August, pp. 2179-2220.

Keywords

Stock returns, principal components, electric vehicles, batteries, high frequency data.

Author Biography

MICHAEL PLANTE, Ph.D.
Principal Research Economist, Federal Reserve Bank of Dallas, U.S.A.

Michael Plante is a Principal Research Economist at the Federal Reserve Bank of Dallas. He received his Ph.D. in Economics from Indiana University in August 2009. His academic research interests include macroeconomics, time series econometrics and energy economics. His research has been published in journals such as the *American Economic Journal: Macroeconomics*, the *Energy Journal*, and the *Review of Economic Dynamics*. Dr. Plante's work at the Dallas Fed also includes analyzing energy markets, with a focus on oil markets, batteries and EVs, and lithium markets.