



Co-movements among the stock prices of new energy, high-technology and fossil fuel companies in China



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ABSTRACT

In this paper, a three-variable TVP-SV-VAR model is developed and estimated to investigate the dynamic relationships among the stock prices of new energy, high-technology and fossil fuel companies. The results show that the stock prices of new energy companies correlate more highly with high-technology stock prices than with coal and oil stock prices. We also find empirical evidence of Chinese stock market turbulence in 2015 through our analyses of stochastic volatilities and dynamic correlations. Moreover, the impulse responses of all three of our variables to all three of the shocks have meaningful shapes, indicating that the Chinese government is faced with the double pressure of economic development and environmental protection.

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1. Introduction

Massive consumption of fossil fuel energy has contributed to China's rapid economic growth. As of September 2013, China has supplanted the US as the largest net importer of crude oil and other liquids [1]. However, with the energy shortage and environmental pollution becoming more severe, the Chinese government has managed to develop its economy through sustainable development. Because cutting energy consumption and carbon emissions at the cost of economic growth is not an option, new energy¹ is the

most important alternative in determining whether China can successfully reduce its reliance on fossil fuels and thus cut carbon emissions. According to the National Bureau of Statistics, China's official wind installations in 2015 reached an all-time global record of 32.5 GW, and the 18.3 GW of grid-connected solar installations in 2015 also beat the previous annual world record of 12.9 GW set by China in 2013 [2]. In addition, the further promotion and development of new energy technologies are also critical for dampening the effect of finite fossil fuel resources on the economy [3]. Therefore, questions of interest to policymakers typically involve the relationships among new energy, high-technology and fossil fuel energy. Consistent with this energy policy interest, investors have begun to pay considerable attention to the co-movements among the stock prices of new energy, high-technology and fossil fuel companies. After all, good estimates of correlation and volatility are needed for derivative pricing, portfolio optimization, risk management, and hedging [4].

Although an extensive and high-profile body of literature focuses on the relationship between fossil fuel prices and the returns of new energy companies, there is no consensus among economists

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¹ According to Wikipedia, the term "new energy", which is used in this paper, refers to (1) alternative energy, meaning any energy source other than fuel and (2) renewable energy, meaning energy from resources that are naturally replenished on a human timescale, including sunlight, wind, rain, tides, waves, and geothermal heat. Sadorsky [4] recognized that the terms renewable energy and clean energy tended to be used interchangeably, especially with respect to tracking indices or investment products.

about this relationship. Henriques and Sadorsky [5] found that shocks to oil prices had a very limited effect on clean energy stock prices. In contrast, Mangi and Okimoto [6] revealed that the stock prices of alternative energy companies had been positively and significantly influenced by shocks to oil prices because of a structural change in late 2007. Similar conclusions were drawn by Kumar et al. [7]. The reason they cited for the relationship was that rising oil prices stimulated the substitution of alternative energy sources for conventional energy sources. Bondia et al. [8] showed the existence of a long-run relationship between the stock prices of alternative energy companies and oil prices with two endogenous structural breaks.

Extensive research on the relationship between changes in the price of energy and the pricing of energy stocks has demonstrated that energy price developments are determinants of the pricing of energy corporations' stocks [9–17]. Ewing et al. [18] recognized that new energy and fossil fuel company performance could be effectively measured by capturing movements between stock prices.

Stock price co-movements are an important topic in stock market volatility studies. Sadorsky [4] used multivariate GARCH² and dynamic conditional correlation models to investigate the volatility dynamics of alternative energy stocks and volatility spillover effects among oil prices, technology stocks and clean energy companies. Reboredo [19] demonstrated how fossil fuel prices co-moved with clean energy stock prices by using copula models and explained the implications of these co-movements for the systemic risk of oil prices on renewable energy stock prices by using the CoVaR measure. Wen et al. [20] explored the asymmetric BEKK model to study the volatility spillover effects between the stock prices of new energy and fossil fuel companies in China. Ewing et al. [18] investigated volatility transmission in the oil and natural gas markets by examining the univariate and bivariate time-series properties of oil and natural gas index returns. Phan et al. [21] looked at how differently energy price shocks can affect company returns. Choi and Hammoudeh [22] studied the dynamic volatility behaviour of oil and stock markets in a regime-switching environment.

Many methodologies are frequently employed in exploring the relationship between oil prices and the returns of new energy companies, such as vector autoregressive models [5,7], Markov-switching vector autoregressive models [6], multi-factor asset pricing models [23,24] and multivariate GARCH models [4,20]. This paper complements this line of research using a different model with time-varying coefficients and time-varying stochastic volatilities, called the TVP-SV-VAR model. This model was introduced by Primiceri [25] and used by Gali and Gambetti [26], Benati [27] and Cogley and Sargent [28], although none of these papers applied the model to the equity returns of energy companies.

A recent research trend is to study the dynamic character of the relationship between oil prices and stock markets. Filis et al. [29] and Antonakakis and Filis [30] employed a DCC-GARCH model to examine the dynamic correlation between stock markets and oil prices for oil-exporting and oil-importing countries. The results showed that the correlation changed with the status of the economy, the global business cycle and global turmoil. Broadstock et al. [31] estimated time-varying conditional correlations between oil prices and energy-related stocks in China based on a diagonal BEKK model. The results provided evidence that correlations increased dramatically during the 2008 financial crisis. Choi and Hammoudeh [22] investigated dynamic correlations between strategic commodity prices (oil, copper, gold, silver) and the S&P 500 index. The

findings from the DCC framework showed evidence of increasing correlations between all commodities since 2003 but decreasing correlations with the stock index. Broadstock and Filis [32] used a scalar-BEKK model to examine the time-varying correlations between oil price shocks of different types and stock market returns. The evidence suggested that the stock market response to oil price shocks changed over time, and the US stock market was more responsive than the Chinese stock market to oil price shocks. Managi and Okimoto [6] employed a Markov-switching VAR model to examine the dynamic relationships among oil prices, clean energy stock prices and technology stock prices. The results found a structural break in late 2007 followed by a positive relationship between oil prices and clean energy prices. The time-varying nature of the relationship between oil prices and renewable energy stocks was also evidenced by the time-varying correlation structure suggested by Sadorsky [4].

Recently, some papers have begun to concentrate on the relationship between oil prices and stock market behaviour in China. Cong et al. [33] used a VAR model to study the complexities of the dynamic relationships between oil price shocks and stock prices. The results indicated that oil price shocks did not have a statistically significant impact on the real stock returns of most Chinese stock market indices, except for the manufacturing index and certain oil companies. Broadstock et al. [31] adopted BEKK and CAPM models to investigate the relationship between international oil prices and energy-related stock returns in China. The results illustrated a sharp increase in the conditional correlation after the financial tsunami occurred in 2008 and showed that investors in energy-related stocks were more sensitive to oil shocks. Zhu et al. [34] used a quantile regression methodology to examine the heterogeneous characteristics of dependence between oil price changes and industry stock market returns in China. They found that the structure and degree of dependence varied from industry to industry and that this dependence changed as a result of the onset of structural breaks. Furthermore, positive dependence existed only in bearish markets with low expected returns.

The stock prices of technology companies appear to be highly correlated with those of alternative energy companies and the price of fossil fuel [5–8,23,24]. This correlation suggests that investors might view renewable energy companies as similar to other high-technology companies, which can be explained by the two types of companies competing for the same resources, such as research facilities, prominent engineers and researchers, thermoelectric materials, and integrated circuits.

This paper is related to the study of Wen et al. [20], who used the daily closing prices of China's new energy index and coal and oil index to investigate the relationship between the stock prices of new energy and fossil fuel companies. However, this paper is different from theirs in three respects. First, we focus on the dynamic character of the relationship between the stock prices of new energy and fossil fuel companies based on the TVP-SV-VAR model, whereas Wen et al. [20] studied the asymmetric nature using a BEKK model framework. Second, we introduce a technology variable to investigate the interaction among the stock prices of new energy, fossil fuel and technology companies, whereas Wen et al. [20] examined only the correlation between new energy and fossil fuel companies. Third, we extend the time period considered in Wen et al. [20] by using a dataset up to the end of 2015 that includes observations for the period of the Chinese stock market crash of June 2015 and beyond.

This paper is structured as follows. A data description and stationarity tests are presented in Section 2. Section 3 explains the methodology. The empirical analysis is provided in Section 4. The last section concludes.

² A list of abbreviations is given in the Appendix.

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