Systemic Risk in the Global Energy Sector: Structure, Determinants and Portfolio Management Implications

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The energy sector is one of the most crucial sectors of any economy as it involves the energy resources necessary for the advancement of modern society and its distress damages almost all economic sectors through their heavy dependence on energy. Energy companies are a key player in meeting global energy demand and ensuring the stability and efficient functioning of the economy. Understanding the interdependence and mechanisms of transmission of information and risk across energy companies and, hence, the level of systemic risk in the global energy sector is a matter of undeniable relevance as it can greatly influence not only the performance of the overall stock market, but also the world supply of energy and, hence, the real economy and the socio-economic development of many countries. The main aim of this paper is to provide a comprehensive overview of the structure of dependence in the global energy sector during tranquil and extreme bearish and bullish market conditions. In particular, we analyse mean and lower and upper tail dependence among stock returns of 105 large energy companies from 26 developed and developing countries spanning three geographical regions, namely America, Asia Pacific, and Europe, in both static and dynamic settings. A partial correlation-based dependence measure is used to quantify the underlying relationships between energy firms under diverse market states, controlling for common market factors. Then, a dependence network based on the Triangulated Maximally Filtered Graph (TMFG) technique is constructed to assess the level of systemic risk in the energy sector. Special attention is also paid to the analysis of the stability of the dependence structure in the energy sector over time under different market circumstances. Lastly, a simple portfolio trading strategy based on the ranking of dependence of energy firms is formulated and evaluated.

The empirical results show a high interdependence in the worldwide energy sector regardless of market conditions and geographical proximity seems to play a major role in this dependence network. The strongest dependence between energy stock returns is observed under extremely bearish market conditions, in line with the commonly held idea that the co-movement of stocks intensifies in times of very adverse market states. Overall, American and European energy firms are more interconnected and contribute more to systemic risk in the energy sector than Asian-Pacific companies, suggesting that the size and maturity of the stock markets have a significant effect on the pattern of dependence in the energy sector. Moreover, the level of dependence in the energy sector varies considerably over time, reaching its greatest heights as a result of the outbreak of the COVID-19 pandemic, particularly during extreme bearish states. Likewise, the highest instability in the dependence structure between energy companies is found during extremely bearish market conditions. Lastly, a portfolio trading strategy based on the dependence ranking of energy companies on the energy sector clearly outperforms a naïve equally weighted buy-and-hold portfolio strategy. Gaining a greater insight into the propagation of risk within the energy sector can help supervisory authorities identify early warning signals of heightened systemic risk and implement the regulatory and policy measures necessary to improve the stability and resilience of the energy system to sys-

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temic shocks and to maintain economic development. This knowledge can enable investors and portfolio managers to develop more refined portfolio allocation decisions and risk management strategies. Finally, this information can also help energy firm managers find out the level of vulnerability of their companies to systemic events and make more suitable operational and buyout strategies.