論 文 概 評

論文の内容の要旨

The dissertation tests the effectiveness of the time-series method with time-varying parameters for the fossil fuel market. It explores the time-varying issues related to the fossil fuel market to understand fossil fuel price instability. Sudden shocks such as the 2008 financial crisis and the COVID-19 pandemic have devastating impacts on energy prices, and decarbonization influences energy policies. As it is becoming increasingly important to incorporate the effects of external factors in time-series analyses and to understand how fossil fuel markets are susceptible to time-varying factors, this dissertation investigates how the fossil fuel markets are affected by external shocks by applying time-varying components in the time series analyses. For this purpose, the dissertation conducted time series analyses on fossil fuel data from the following four aspects.

In the first part of this dissertation, it employed the time-varying parameter vector autoregressive (TVP-VAR) model to examine the pass-through rate of the Chinese Yuan (CNY) and Japanese Yen (JPY) on the Chinese LNG import price. Given the Chinese exchange rate reform of 2005 and the Chinese new energy policy of 2013 to switch from coal to imported natural gas, it examined whether exchange rate fluctuations impact the price stability of imported LNG. The sample period was from August 2005 to September 2018. The TVP-VAR model was adopted to verify the pass-through rate of the exchange rates on the LNG import price using the Markov chain Monte Carlo (MCMC) method. The result indicated that the pass-through rate of JPY on the Chinese LNG import price was decreasing, while that of the CNY was increasing since September 2005. Notably, after 2008, the pass-through rate of CNY on Chinese LNG import

prices began to exceed that of JPY. Moreover, the lag effect of the CNY on the Chinese LNG import price has increased compared to that of JPY since 2005. If any new currency reform of the CNY is implemented in the future, then the impact of JPY on the Chinese LNG import price could be reduced, and the lag effect of the CNY on the Chinese LNG import price could become longer. Therefore, fluctuations in CNY are becoming an important factor in understanding the movements of Chinese LNG import prices. This implies the significance of considering the effect of the exchange rate on the energy market when the market is influenced by a monetary reform of the importing country.

In the second part of the dissertation, it applied the recursive cointegration test to identify the dynamic relationship between the Chinese domestic coal and international fossil fuel markets from 2000 to 2020. The Chinese coal market accounts for 70% of China's energy consumption, but besides its domestic supply, China depends on its coal in the international market. Hence, it examined how the Chinese domestic coal market is related to international fossil fuel markets to provide useful information for conducting policies to stabilize coal prices. It found that the relationship between Chinese coal prices and international coal, natural gas, and crude oil prices have different trends before and after 2008. It also revealed that the Chinese domestic coal price was only cointegrated with the prices of international natural gas prices after 2018. These results indicate that the dynamic relationships between the Chinese domestic coal and international fossil fuel markets changed within the investigated period. Natural gas is one of the major energy sources following the 13th Five-Year Plan of China. The stakeholders and policymakers of the Chinese coal market need to consider the impact of international natural gas prices in identifying Chinese coal price movements to generate more accurate expectations.

In the third part of the dissertation, it used the recursive cointegration test to examine whether the dynamic relationship between the Chinese and international fossil markets changed during the 2008 financial crisis and how it changed during the COVID-19 pandemic. The impact of the crises is analyzed by including the periods affected by the crises as dummy variables in the VAR and VECM models. Monthly data for the 2000:1 – 2020:12 period was used. The results suggest that the effects of COVID-19 on the linkages between the Chinese and international fossil fuel markets are not as evident as in the 2008 financial crisis. The study identifies that the effects of the 2008 financial crisis and the COVID-19 pandemic on the linkages are mostly driven by the impacts of these crises on Chinese fossil fuel markets. This indicates the importance of controlling the risk involved in the Chinese fossil fuel market when events such as the 2008 financial crisis and the COVID-19 pandemic are changing the linkages between the Chinese and international fossil fuel markets.

Finally, in the fourth part of the dissertation, it employed the Bayesian DCC-MGARCH models to analyze how the relationship between the fossil fuel and clean energy stock, gold, and bitcoin market is changing until the COVID-19 pandemic took place. The study used the US daily

data from January 2, 2019, to February 26, 2021, which was divided into pre-during (before 2020) and post-pandemic crisis periods (after 2020). The study identifies that the Bayesian DCC-MGARCH model with the skew multivariate generalized error distribution is credible for fossil fuels, clean energy stocks, gold, bitcoin market to estimate the time-varying conditional correlations between them. The results suggest that the fossil fuel relationships to clean energy stock, gold, and bitcoin markets are changing, and they have almost become positively correlated since the pandemic occurred. Hedging between fossil fuels and other assets is also important to assure capital for purchasing fossil fuels, which will help stabilize the energy supply. However, events such as the pandemic could make it difficult for the suppliers of energy to hedge the risk of changes in the fossil fuel price by combining their portfolios with financial assets, such as gold and Bitcoin. It is important to foster energy and financial market stability and choose optimal hedging strategies that minimize the diversification of risk during the pandemic.

Based on the above four parts, the novelty of this dissertation is that it applied three time-series models to explore the time-varying issues from four perspectives. The dissertation concludes that the three time-series models such as the Bayesian and recursive cointegration models are proven to be suitable for the analysis of the fossil fuel market related to time-varying issues. The dissertation also suggests that the linkages among the energy markets are more likely to be affected when energy and monetary policies change and exogeneous shocks like the financial and COVID-19 crises occur. The results of this dissertation provide an important reference for investors and policymakers related to energy markets and deliver helpful information for those seeking to supply energy sustainably.

論文審査の結果の要旨

本研究では、主にTVP-VAR、Recursive 共和分、Bayesian DCC-MGARCH という比較的新しい時系列データ分析の手法を用いて、2005 年の為替改革、2008 年の金融ショック、2013 年のエネルギー政策の変換、2019 年以降のコロナショックといった外生的ショックが近年の化石燃料市場に及ぼす影響を分析した。こういった分析手法をエネルギー市場へ適用した研究はまだ数が少なく、エネルギー市場の分析にこのような手法が活用できることを確認した点は評価できる。また、外生的ショックが化石燃料市場価格へ及ぼす影響は大きく、化石燃料市場の動きを理解する上で、こういった外生的要因を考慮することの重要性を明らかにした点も評価できる。

第一に、TVP-VAR モデルの通常の自己回帰（VAR）モデルとの違いについての質問が出た。従来の VAR と異なり、誤差項に時間変動の影響を分析する手法であるという回答があった。TVP-VAR モデルでマルコフ過程がどう使われるのかということに関する質問も出たが、この部分に関しては、十分回答できていない部分もあった。

次に、伝統的な推計パラメータを固定と仮定するモデルではなく、パラメータを時変

と仮定する手法を使う必然性はあるのかという質問が出た。これに対し、唐氏は、過去の先行研究の結果からパラメータを固定と仮定した場合は、分析結果にバイアスが発生することが知られており、時変とする分析の方がバイアスを少なくでき、より多くの情報を把握することが可能であることが知られているという回答があった。さらにここでの討議において、研究では、実際に固定パラメータモデルと時変パラメータモデルの比較をしているわけではないため、論文では時変パラメータモデルの優位性を強調する必要はないのではないかという点も指摘された。

続いて、金融ショックやコロナショックがどのような理由から中国の化石燃料市場に影響を及ぼすと考えられるのかという質問があった。これに対し、唐氏は、国内政策の変換や海外市場のショックが影響しており、投資家もショックに応じて行動を変更した可能性があるという回答があった。ただし、こういったショックが長期的に続く理由を経済学的な観点からどう説明できるのかという点についての回答は不十分な部分も見られた。本研究では、価格情報の中に需要や供給サイドの動きが反映されているという仮定のもとで分析が行われているため、今後はこういった需要や供給に関する変数も含めた分析、外生的ショックが実際の投資家の行動にもたらした影響、ショックがエネルギー市場に影響をもたらした原因についてもより深く探る必要があるという指摘があった。

最後に、財政・金融政策の拡大による流動姓の高まりや、不動産市場におけるバブル崩壊後の金融市場の変化がエネルギー市場に与えた影響についても、今後の研究で議論していくと良いという指摘があった。

以上より、いくつかの課題は指摘されたものの、本論文では時系列データの分析手法に関しては最新のものが使われており、SSCI を含む 4 本の論文が本論文をベースに出版されている点は評価できることから、審査委員会は、本学位論文が博士の学位要件を十分満たしていると全会一致で判定した。