Volatility Contagion and Market Integration across major Coal Markets: A Diagonal BEKK GARCH approach

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Abstract

The present study attempts to meaningfully add to the existing strand of literature on coal market predictability by examining the level of market integration across three major coal export markets. Using a tri-variate diagonal BEKK GARCH framework, the study investigates the own-volatility persistence and cross-volatility contagion effects among European, Australian, and South African coal markets. The results validate the presence of strong volatility contagion among the three markets, indicating a high level of market integration. The contagion effect is observed to be heterogeneous across market pairs. Further, while the study finds convincing evidence for volatility clustering, the EGARCH results fail to affirm the presence of leverage effect among the returns series. In short, the study unveiled complex dynamics in the coal markets' price generation mechanism that necessitates active portfolio management. As such, besides having significant policy implications, the study's findings would be of pertinent interest to financial practitioners and investors who seek to diversify their portfolio through investments in global commodity markets.

Keywords: Coal Market; Volatility Contagion; Diagonal BEKK GARCH; Leverage Effect

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Extended Abstract[1]

1. Introduction

Volatility is a concept that is of great interest to economists for the very reason that it is a measure of uncertainty. Over the last few decades, there has been an increasing number of studies that look into the transmission of volatility and its contagion effects, most of which pertain to international stock markets, global crude oil markets and foreign exchange markets. This growth in literature was primarily due to scholarly efforts aimed at understanding the integration of global capital markets in the light of liberalization of capital accounts, across the globe. Such liberalization offered a gateway for international investors towards portfolio diversification across currencies, commodities and national stock markets.

However, similar studies in the area of global coal markets have not received due attention despite coal being one of the most vital and influential commodities traded globally. Coal is an important source of power generation, and more than 35% of the power generated globally is dependent on this fuel. Countries like South Africa, Poland, China, and Australia have been relying on coal for about 70% of their power generation. Additionally, countries like Japan, India, South Korea, Germany, UK, and Russia heavily depend on coal imports to meet a significant percentage of their total power generation. Moreover, with economies world over becoming more and more energy-hungry, the dependence on coal reserves has been constantly increasing as is the case with other energy generating sources.

Thus the exceptional fluxes and volatilities in the international coal prices send across a huge impact across the globe which manifests itself in the form of unstable energy prices. Understanding the nature and characteristics of global coal prices and analyzing the magnitude and direction of volatility transmissions across global coal prices, particularly in the case of major coal exporters would be of paramount importance. The present study is a step in this direction.

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[1] Please contact the authors for a full version of the paper

2. Literature Review

The emergence and evolution of coal trade have been discussed by Rudianto et al. (2006) and Rudianto Ekawan, (2006) but no econometric evidence was provided to support the same. Zaklan et al. (2012) empirically analyzed the globalization of steam coal markets using comprehensive multivariate cointegration analysis in the three parts of steam coal value chain - namely transport, export and import prices. Warell, (2005) also suggests that there has been the partial integration of coal markets to some extent until the early 1990s between Europe and Japan.

To understand the volatility in coal, electricity and CO2 markets in Germany, GARCH, GJR-GARCH and exponentially weighted moving average methods had been used by (Kiesel & Metka, 2013) and found evidence for high price volatility and suggested the need to set up risk management by power utilities. An extensive study was done by Papiez & Śmiech, (2013) to understand the integration of steam coal markets using ARMA GARCH and ARMA EGARCH methods. The results showed that the coal prices tend to exhibit a significant reaction to impulses if they had come from the same regions over and above, had the impulses been from coal prices of different regions. However, some papers [(Li et al. 2010), (Smiech et al. 2016) and (Papiez & Śmiech, 2015)] show mixed results in regard to the degree of integration among the various coal markets. Studies that explore the volatility spillover among the major coal indexes of coal API2, API 4 and API 6 are further limited (Papiez & Śmiech, 2013).

3. Data and Methodology

Understanding from (Papiez & Śmiech, 2013) on API 2 CIF ARA (Amsterdam Rotterdam and Antwerp) European prices, API 4 FOB Richards Bay terminal South African prices and API 6 CIF Newcastle Australian prices were taken into consideration to study the volatility contagion effects in the coal market price indices. Weekly data from 3rd September 2010 till 23rd September 2016 were considered for the study.

At the outset, the ARCH test is conducted to check for volatility clustering. An EGARCH model is then used to validate the presence/absence of leverage effect. The E-GARCH model is used in

our study for its two innovative properties. Firstly, it ensures a non-negative conditional variance without having to impose complicated restrictions on parameters. Secondly, in the return generating process, the model allows for an asymmetrical response of conditional variance in assets to positive as well as negative shocks.

Finally, we deploy a Trivariate Diagonal BEKK GARCH Model to estimate the time-varying conditional variance and to examine the own volatility persistence as well as the cross volatility contagion effects among the three underlying variables. The Diagonal BEKK GARCH model is employed in order to assess the volatility contagion effects between the three major coal markets. Diagonal BEKK is a multivariate GARCH model that allows for the explicit and dynamic parameterization of conditional covariances (Engle and Kroner, 1995). By restricting the parameter matrices to be diagonal, the model significantly reduces the number of parameters estimated and by ensuring that the conditional covariance matrix is always positive definite, it also effectively overcomes the difficulty with the alternative VECH model.

4. Key Results/ Findings

Using a weekly time series data over a period of six years, (September 2010 through September 2016), the study found all three coal indices to move in tandem. A general downward trend was observed until mid-2015, after which the prices started to pick up. The study employed a parsimonious ARCH (1) model to test for volatility clustering and found evidence for volatility clustering at 5% level of significance for all three markets. Appropriate EGARCH models were used to test for the presence of a negative correlation between the past return and the future volatility of returns (leverage effect). Surprisingly, the study failed to find any convincing evidence for the same.

A Diagonal BEKK GARCH model was then employed in order to assess the integration of global coal markets by way of volatility transmissions and contagion effects among the three underlying coal markets. The study showed that there exists a higher level of market integration among the three coal markets while the volatility contagion is observed to be heterogeneous across the pairs. A strong GARCH effect was observed while the ARCH effect was found to be relatively weak. It can thus be deduced that there exists a statistically significant co-variation in shocks that are

dependent more on its lags rather than on past errors. The study observed all the three coal export prices (ARA, NewCastle, and RB1) to be interdependent evidencing a high level of market integration in the coal export sector.

5. Implications

An important implication of this study for financiers, multinationals, and international investors is that investing in two or more global coal indices will not diversify and reduce the portfolio risk. They should thus diversify their portfolio across commodities. Further, correlations and volatility contagion across all these markets should be closely observed before making policy decisions or portfolio creation, as markets turn out to be more integrated as markets become agitated/ volatile. This would also mean that a high level of financial integration weakens the portfolio against external shocks. Understanding the level of integration among the global coal markets will also help in decision making for both policymakers (understanding of fuel supply for power generating plants) and investors alike.

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