



Testing Co-Volatility spillovers for natural gas spot, futures and ETF spot using dynamic conditional covariances[☆]



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ARTICLE INFO

Article history:

Available online 6 April 2018

JEL:

C58

D53

G13

G31

O13

Keywords:

Energy

Natural gas

Spot

Futures

ETF

NYMEX

ICE

Optimal hedging strategy

Covolatility spillovers

Diagonal BEKK

ABSTRACT

There is substantial empirical evidence that energy and financial markets are closely connected. As one of the most widely-used energy resources worldwide, natural gas has a large daily trading volume. In order to hedge the risk of natural gas spot markets, a large number of hedging strategies can be used, especially with the rapid development of natural gas derivatives markets. These hedging instruments include natural gas futures and options, as well as Exchange Traded Fund (ETF) prices that are related to natural gas stock prices. The volatility spillover effect is the delayed effect of a returns shock in one physical, biological or financial asset on the subsequent volatility or co-volatility of another physical, biological or financial asset. Investigating volatility spillovers within and across energy and financial markets is a crucial aspect of constructing optimal dynamic hedging strategies. The paper tests and calculates spillover effects among natural gas spot, futures and ETF markets using the multivariate conditional volatility diagonal BEKK model. The data used include natural gas spot and futures returns data from two major international natural gas derivatives markets, namely NYMEX (USA) and ICE (UK), as well as ETF data of natural gas companies from the stock markets in the USA and UK. The data used for the empirical analysis is from 14 May 2007 to 15 April 2016, incorporating 2330 observations. The empirical results show that there are significant spillover effects in natural gas spot, futures and ETF markets for both USA and UK. Such a result suggests that both natural gas futures and ETF products within and beyond the country might be considered when constructing optimal dynamic hedging strategies for natural gas spot prices.

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1. Introduction

Natural gas is a vital component of the world's energy markets, is cleaner than other fossil fuels, and occupies an important position in the energy pantheon. Compared with other fossil fuels, natural gas is cleaner burning, and is an extremely important source of energy for reducing pollution, contributing to health, and

maintaining a clean natural environment. Natural gas releases a lower ratio of carbon emissions than coal and oil in producing heat.

According to the *US Energy Information Administration (EIA)*, Carbon Dioxide Emissions of natural gas is 53.1kg/million Btu,¹ while coal has 95.3 kg/million Btu, gasoline has 71.3 kg/million Btu, and Kerosene has 72.3 kg/million Btu. As carbon dioxide is a well-known greenhouse gas, the use of natural gas will have significant benefits for the environment.

Composed primarily of methane, the main products of the combustion of natural gas are carbon dioxide and water, while coal

[☆] The authors are grateful to two reviewers for very helpful comments and suggestions. For financial support, the first author wishes to thank the Ministry of Science and Technology (MOST), Taiwan, and the second author acknowledges the Australian Research Council and Ministry of Science and Technology (MOST), Taiwan.

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¹ British thermal unit: a Btu is the amount of heat required to raise the temperature of 1 avoirdupois pound of liquid water by 1° Fahrenheit at a constant pressure of 1 atm.

and oil comprise more complex molecules, such as nitrogen and sulfur. When combusted, natural gas releases very small amounts of harmful emissions, including nitrogen oxides (NOx) and sulfur dioxide (SO2), which degrade the environment and have a negative impact on health. The combustion of natural gas releases approximately no ash, substances that do not burn, but enter the atmosphere and contribute to the formation of smog.

Benefits from advances in natural gas exploration technology have led to large production and low prices. The production of natural gas has increased rapidly in the 21st Century, especially in the USA. Such increases in natural gas production have come from shale gas resources, an unconventional gas, which is much more accessible and economical than conventional gas. Shale gas is natural gas trapped within shale formations, and has become an increasingly important source of natural gas. In 2000 shale gas provided only 1% of USA natural gas production, but by 2015 it was approximately 56%, according to data from the US EIA. The world's storage capacity of shale gas is quite large, especially in the USA, Canada, Argentina, Algeria and China. The USA and Canada already have significant shale gas production, while China has ambitious plans to increase shale gas production dramatically.

The prospect of ample natural gas supplies, continuing low prices, and the favorable environmental and economic position of natural gas, have led to expectations of continuing growth in the demand for natural gas, especially in the electricity and industrial sectors. Natural gas is now the third largest usable energy resource in the world, preceded only by oil products and coal. According to the *2015 Key World Energy Statistics*, published by the International Energy Agency (IEA), natural gas provided 21.4% of total energy supply, 21.7% of electricity generation, and 15.1% of total final consumption in the world in 2013.

The natural gas industry is an extremely important segment of the economy, including producers, processing plants, pipeline companies, storage operators, marketers and local distribution companies, with each group having a large number of companies. Natural gas has many applications, primarily in electric power, industry, transportation and residential use, such as house heating and cooking. Electricity generation is the fastest growing use of natural gas. Data from the *2015 Key World Energy Statistics* show that the share of natural gas in electricity generation rose from 12.1% in 1973 to 21.7% in 2013. In the industrial sector, natural gas is a source of heat and power, and an input for producing plastics and chemicals.

In the transportation sector, compressed natural gas is used as transportation fuel, especially in public transit. Residual use is another major consumption of natural gas. Referring to data in 2013 from the *US Department of Energy*, about one-half of US homes used natural gas for heating, and 70% of new homes were built using gas heating systems.

Natural gas is also a critical energy source for energy markets in the future. According to the *US Energy Administration (EIA)*, natural gas will occupy a greater proportion in the USA in both the energy consumption and electricity generation sectors for the next 30 years. The situation of primary energy consumption and electricity generation by fuel in the USA from 1980 to 2040 is shown in Figs. 1 and 2. In 1990, the consumption of natural gas occupied only 23% of total energy consumption in the USA, which had risen to 27% in 2013, and is predicted to rise to 29% in 2040. The proportion of natural gas in electricity generation also increased from 16% in 1990 to 27% in 2013, and is expected to reach 31% in 2040.

Each country has their own strategy for natural gas, with most countries being willing to develop natural gas industries. The US Government believes that natural gas resources are a critical transitional energy during the process of transforming from fossil fuel to clean and renewable energy, and has been willing to provide

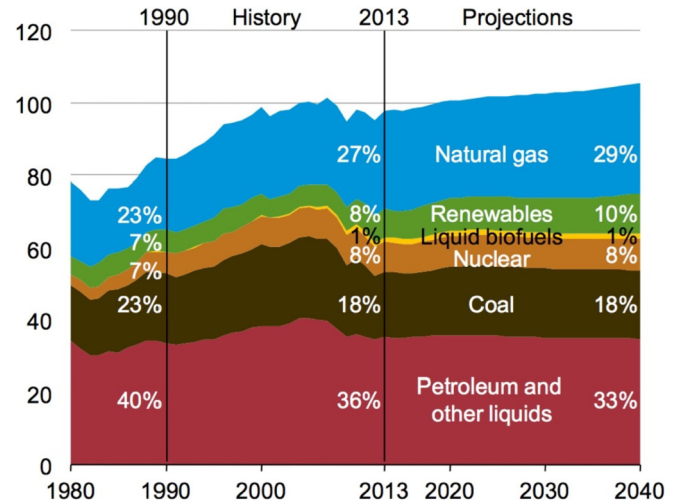


Fig. 1. Primary energy consumption by fuel in the USA.

policy support for natural gas development. The shale gas revolution led by the US Government has made natural gas prices fall rapidly, and has promoted the transformation of coal to gas for electricity generation. The UK Government has also changed their focus from wind and solar energy to natural gas and nuclear energy. Despite their reliance on diesel fuel for several decades, the German Government has begun to promote natural gas as a new type of motor vehicle fuel since the 1990s.

Since the Fukushima nuclear crisis, Japan's consumption of natural gas has risen rapidly, and the Japanese Government has placed great emphasis on natural gas. China has also developed the natural gas industry to reduce carbon emissions. France has been more willing to invest in green and renewable energy, such as wind energy, solar energy, wave energy, and bio-fuel. In general, natural gas will play an important role in the future of energy markets.

Unlike other international commodity markets, natural gas has disparate regional benchmark prices. The Henry Hub price is the major benchmark of natural gas spot prices in USA. In the UK, the National Balancing Point (NBP) gas market is Europe's oldest spot-traded natural gas market, and publishes daily data of natural gas prices. There are other regional benchmark prices, such as the

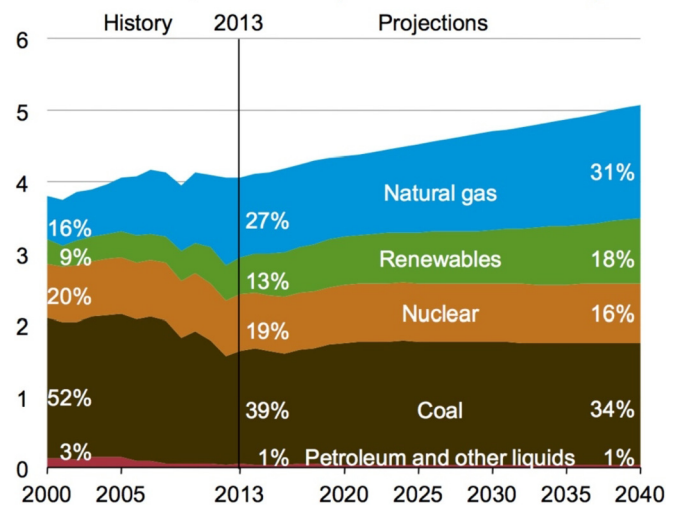


Fig. 2. Electricity generation by fuel in the USA.

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