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Further evidence on the debate of oil-gas price decoupling: A long memory approach

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ABSTRACT

The long-run oil–gas price relationship has been challenged more often in recent years, as these two prices have shown evidence of decoupling from each other. This paper proposes the use of a long-memory approach and a rolling-windows method to model the time-varying oil–gas price relationship in three markets, namely, the United States, Europe and Japan. The results extend existing research conclusions on the oil–gas price relationship and answer the question of whether it is a temporary phenomenon or a permanent market change. Our findings indicate that the US oil–gas relationship remains nonstationary at almost all windows and illustrate strong evidence of decoupling. Conversely, the European and Asian oil–gas prices exhibit temporary decoupling over time, although the overall relationship still favours the oil-indexation hypothesis. The US experience suggests that oil and gas do not share the same fundamentals and a pricing hub can better reflect the true value of natural gas. Policy makers in Europe and Asia should reinforce their efforts towards a market based pricing mechanism for gas.

1. Introduction

Since the North American shale gas revolution, the role of natural gas has become more important in the global economy, with ever-increasing impacts on international energy markets. Major consumers of natural gas have increased their demand for natural gas, for example, Japan after the Fukushima accident, and China with the burgeoning pressure of polluted air. Russia, one of the major suppliers of natural gas to Europe, has brought uncertainties to the European market due to its recent conflict with Ukraine. Moreover, a major change in the US' role in the international energy market has caused recent turmoil in international oil markets. These new developments have increased research interest in the relationship between natural gas price and oil price.

For many years, natural gas prices have generally been indexed to crude oil prices, often referred to oil indexation. Even today, most natural gas trades in Europe and the Asia-Pacific region are priced through oil indexation (Ji et al., 2014; Asche et al., 2017). According to the International Gas Union (International Gas Union (IGU), 2016), 83.7% of Asia's total natural gas imports in 2015 were oil indexed. However, oil indexation has started to lose its foundation in the face of dramatic changes in the global energy market (Stern, 2014; Shi and Variam, 2016). Shi and Variam (2017) investigate the influence of oil indexation on economic behaviour in the East Asian gas sector and they suggest that the transition of pricing mechanisms from oil indexation to hub pricing should be advanced and claim that "the market failures due to exogenously pricing demonstrates the need for hub pricing". In recent years, there have been extensive investigations into whether these two prices are decoupled (e.g. Hartley et al., 2008; Erdős, 2012). There is also a heated debate in the literature on whether oil indexation is the best solution for the natural gas market (Komlev, 2016) or whether to establish pricing hubs to better reflect the fundamentals in natural gas itself (Stern, 2014).

In order to contribute to the debate and provide evidence of the oil–gas price link, it is important to further investigate the dynamic relationship between oil and natural gas prices. This paper adopts a long-memory approach, which extends existing empirical strategies by introducing a more flexible technique to model the time-series behaviour of oil and natural gas prices. A rolling-windows method is also used to enable us to show the time-varying possibility of the oil–gas relationship. Another major contribution of this paper is the use of a cross-market comparison to acknowledge the fundamental differences between natural gas markets around the world.

Unlike crude oil, which has a global market, natural gas markets are

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geographically segmented into three distinct regional markets: North America, Europe and Asia (Geng et al., 2014, 2016a). Pricing mechanisms differ significantly across these three markets and they all face substantially different demand side factors. The North American market has switched over to gas-to-gas competition pricing for a long time. The European market has been in the process of shifting to market-based pricing, while the Asian market is mostly priced according to oil indexation.

In addition, energy mix in these three regions has distinctive differentiation (BP, 2017). In 2016, the share of oil and gas in the total primary energy in the North America is 37.5% and 31.8%, respectively. Gas production in the US has increased quickly since 2008 due to the shale gas revolution and caused a downward pressure on gas prices. However, decreased gas prices has raised its comparative advantage over oil in the US and also eliminated the need of import gas, which further changed the relationship between oil and gas (Geng et al., 2016a; Caporin and Fontini, 2017). In the Europe & Eurasia region, gas has become the largest energy source with a 32.3% share, whereas the share of oil is only 30.9%. In the Asia Pacific region, coal and oil still dominate the energy mix with market share of 49.4% and 27.9%, respectively. The share of gas is much lower than the other two markets with a merely 11.7%. These characteristics have led to a series of studies investigating whether there is a separation between oil and gas prices across regions (Erdős, 2012; Geng et al., 2016b; Oglend et al., 2015).

Technically, oil indexation can be interpreted as a long-term equilibrium relationship. In other words, oil and natural gas prices should be cointegrated or should follow an error-correction model. Either price can move away from the equilibrium (if it exists) due to external shocks, but the deviation should not persist. In other words, an error-correction mechanism will retain the equilibrium in the long run. Some earlier studies, such as those of Asche et al. (2006) and Brown and Yücel (2008), have found supporting evidence of the long-term relationship; however, more recent research has concluded that the cointegration relationship is weak and has even disappeared (Ramberg and Parsons, 2012; Batten et al., 2017).

The inconclusiveness of existing studies is not overly surprising since markets have become more complicated in the twenty-first century. The 2008 global financial crisis brought significant changes in international energy markets. Moreover, financial markets have been shown to be more influential in energy prices, and the energy market has become more financialised (Creti and Nguyen, 2015; Zhang, 2017). Oil and gas prices have been found to include more information from financial markets than from their own fundamentals. This means that supply and demand fundamentals can no longer fully explain the market price volatilities and that there are more new driving factors affecting market trading behaviour (Ji and Guo, 2015).

Another explanation for the inconsistent findings regarding the oil–gas relationship revolves around methodological issues. The majority of existing empirical studies have established an error-correction model, either with a constant cointegrating relationship (e.g. Panagiotidis and Rutledge, 2007) or allowing multiple regimes (Brigida, 2014) in the relationship. One of the common features of these models is their assumption of either confirming or refuting the long-term relationship. Zhang et al. (2015) criticise such models as being overly restrictive, suggesting that a more flexible model is needed to gain a better understanding of the underlying mechanism behind the data. A fractional integrated approach should be used to capture the possible long-range dependence. One more methodological issue is that the relationship may be time varying. It would be interesting to know whether a particular pattern of the oil–gas relationship is only a temporary phenomenon or has permanent effects. This imposes a major concern for the major gas importers of the European and Asia Pacific regions and especially relevant to the existing debates on oil-indexation versus hub pricing mechanism. Therefore, it is necessary to allow the underlying relationship to change over time.

To address the aforementioned methodological issues and complement the findings of existing studies, this paper makes at least two major contributions. First, it uses a long-memory approach (technically equivalent to the fractional integrated model) and a rolling-windows estimation method. The first approach allows flexibility, whereas the second makes it possible to show the time-varying relationship between oil and gas prices. Noteworthy, the dynamics between oil and gas prices are modelled to provide further evidence of the issue of whether the oil–gas relationship is temporary or permanent. Second, a cross-market comparison is undertaken to address the regional characteristics of the natural gas market. The data from the three main gas markets are used to cover a market with pure hub pricing system (the US), a mixture of hub pricing and oil indexation (Europe) and also a major oil indexation regime (Japan). The empirical results provide further insights to the understanding of a dynamic relationship between oil and natural gas and have important implications for policymakers in natural gas-importing countries as well as for the portfolio strategies of market investors.

The remainder of this paper is organised as follows: Section 2 summarises the previous literature on the topic. Section 3 briefly describes the long-memory model and the estimation techniques used in the paper. Section 4 discusses the price data. Section 5 reports and explains the empirical results. Finally, Section 6 concludes and discusses with policy implications.

2. Literature review

Earlier studies have supported the long-term cointegration relationship between oil and gas prices. For example, Villar and Joutz (2006) study the relationship between the Henry Hub natural gas prices and the WTI crude oil prices. Their empirical results support the long-term equilibrium between these two prices. Brown and Yücel (2008) also find a stable and long-term oil–gas price relationship in the US, especially when market fundamentals are included. Hartley et al. (2008) also confirm the long-term relationship between oil and gas prices in the US and find that the short-term disequilibrium are mainly influenced by weather, inventories and other seasonal factors.

Compared to the highly regulated European continental energy market, the UK natural gas market has been liberalised, with the National Balancing Point natural gas-trading hub being founded in 1994. Asche et al. (2006) use a vector error-correction model to the UK data and support a single energy market in the UK and they find that the Brent crude oil price is exogenous and represents the leading price. Panagiotidis and Rutledge (2007) confirm a similar cointegration relationship. Asche et al. (2017) find that the UK natural gas prices and the Brent prices are cointegrated for the majority of the sample from 1997 to 2014 with a regime switching framework. Gas prices tend to decouple during the fall and early winter when gas-specific pricing becomes dominant due to the increased demand for heating.

Several studies have investigated the impact of the shale gas revolution on the oil–gas relationship (Wakamatsu and Aruga, 2013; Caporin and Fontini, 2017; Geng et al., 2016a). Atil et al. (2014) show that oil prices lead natural gas prices using a nonlinear autoregressive distributed lags model. Ji et al. (2014) find that the global economic condition is the primary contributing factor to natural gas prices in North America, while the prices in Asia and Europe are still driven mainly by oil prices.

The equilibrium relationship between oil and gas prices has recently been challenged. Erdős (2012) finds that both the UK and the US had a long-term oil–gas price equilibrium before 2009 but that the relationship broke in the US around January 2009. Erdős (2012) also raises the question of whether this decoupling from oil indexation is permanent. Ramberg and Parsons (2012) confirm that the cointegration relationship between oil and gas prices is not constant and can shift dramatically over time. Brigida (2014) explicitly models the possible time-varying cointegration between natural gas and oil prices via a regime-