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Natural gas vs. oil in U.S. transportation: Will prices confer an advantage to natural gas?☆

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ABSTRACT

The U.S. Energy Information Administration (EIA) projects that U.S. natural gas prices will provide a substantial cost advantage over petroleum products as a transportation fuel during the next 30+ years. Although U.S. natural gas prices closely tracked those of world oil prices from the mid-1990s to early 2009, U.S. natural gas prices have been much lower relative to those for oil since early 2009. The break owes to technological change that substantially increased the supply of U.S. shale gas resources.

Although recent weakness in world oil prices has restored at least some temporary comparability between U.S. natural gas prices and those for petroleum products, EIA projects U.S. natural gas prices will rise more slowly as world oil prices recover. Relatively weaker gains in U.S. natural gas prices would support the substitution of natural gas for other fuels—such as petroleum products in transportation—whether such substitution is driven by business or policy decisions. Will U.S. natural gas prices be sustainably lower relative to those for petroleum products so as to support the increased use of natural gas in the transportation sector? An interpretative review of current market developments and recent research finds the answer is yes.

1. Introduction

As shown in Fig. 1, U.S. natural gas prices closely tracked world oil prices from the mid-1990s to early 2009. Because crude oil has relatively low transportation costs, crude oil prices are set on an international market with shipments of crude oil arbitraging prices between different parts of the world. Because natural gas has relatively high transportation costs between continents, its prices have been mostly set in continental markets, often in competition with petroleum products. Nonetheless, shipments of liquefied natural gas (LNG) are increasingly playing a role in arbitraging natural gas prices across continents.

Examining data from this period of time, Villar and Joutz (2006), Brown and Yücel (2008) and Hartley et al. (2008) find that U.S. natural gas prices and world oil prices move together over the long run and that movements in crude oil prices lead those of U.S. natural gas prices. According to Brown and Yücel (2008) and Hartley et al. (2008) interfuel substitution between refined petroleum products and natural gas accounts in U.S. markets for the co-movement between international crude oil prices and U.S. natural gas prices.

Hartley et al. examine interfuel substitution in the electric power sector. Huntington (2007) shows how interfuel substitution works for the industrial sector including in the planning process. Brown and Yücel (2008) consider the substitution processes more broadly—including fuel switching within a given facility, the choice of which facilities to use, the effects on different sectors of the economy, and the effects of international competition between petrochemicals produced from natural gas in the United States and petrochemicals produced from petroleum derivatives in other parts of the world. They also consider how price differentials affect the choice between drilling for oil or natural gas.

After early 2009, however, U.S. natural gas prices declined sharply and disconnected from world oil prices (Asche et al., 2012; Erdős, 2012; Øglend et al., 2015). The shale gas revolution made natural gas much more abundant in the United States (Brown et al., 2010a; Asche et al., 2012; Erdős, 2012; Brown, 2014) and swamped the substitution processes that once linked U.S. natural gas prices to those for oil. Reports by Navigant Consulting (2008), the Potential Gas Committee (2009) and Kuuskraa (2009) underscore how substantially the availability of U.S. natural gas resources was changed by the shale gas revolution.

Although depressed world oil prices have restored at least a temporary comparability between petroleum products and natural gas, the U.S. Energy Information Administration (EIA) projects that U.S. natural gas prices will remain relatively lower as world oil prices recover (EIA 2017). These projected prices will provide a substantial cost advantage

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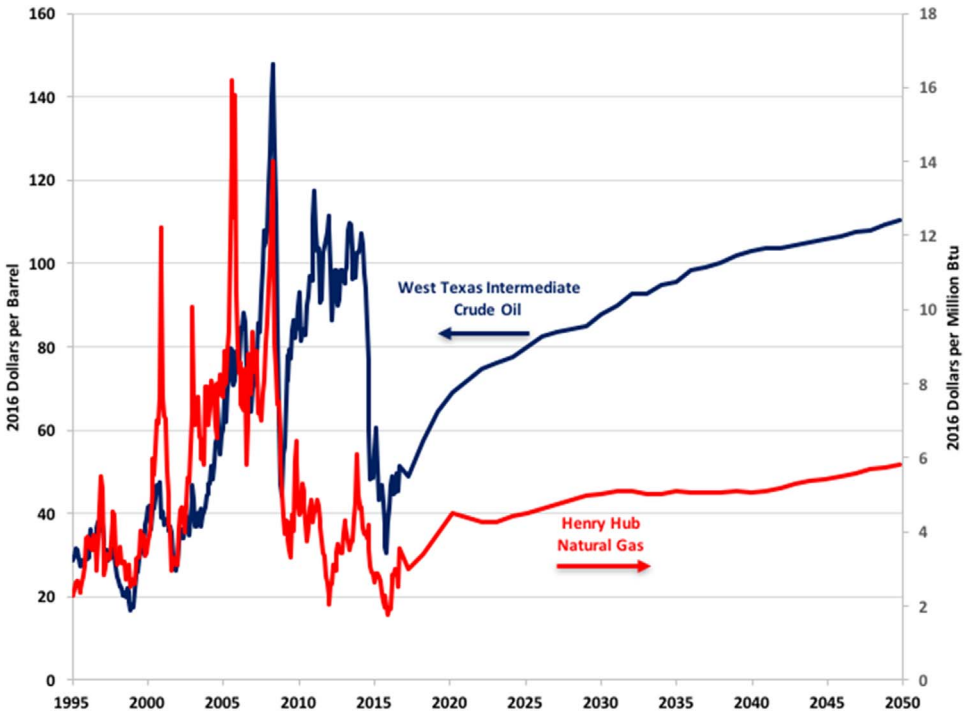

Fig. 1. Crude oil and natural gas prices. Sources: U.S. Energy Information Administration; US. Bureau of Labor Statistics; Author's Calculations

to natural gas as a transportation fuel over petroleum products during the next 30+ years. They also may foster increasing use of natural gas in the U.S. electric power and industrial sectors. Relatively inexpensive natural gas supports the substitution of natural gas for other fuels—such as coal in the electric power sector and petroleum products in the industrial and transportation sectors.

Although U.S. natural gas prices have not tracked those of crude oil since early 2009, substitution processes, the potential U.S. exports of natural gas and the effect of relatively weak prices for natural gas on natural gas production raise concerns about whether the break in the relationship will be sustained. Energy users and policymakers have a considerable interest in knowing whether the break in the relationship is permanent. Knowledge that the break is permanent would support business planning and the development of policies that would allow the United States to rely more heavily on natural gas because the fuel would remain relatively inexpensive, particularly as crude oil prices rise.

Accordingly, the present exercise examines current market developments, recent research about the economic forces shaping U.S. natural gas prices and the U.S. Energy Information Administration's *2017 Annual Energy Outlook* (EIA 2017) to assess the outlook for natural gas prices. In doing so, it considers how the relative prices of natural gas and petroleum products will affect the use of natural gas as a transportation fuel. It also examines to what extent interfuel substitution and price incentives for U.S. natural gas production might bring natural gas prices back in line with those for crude oil. It also examines the possibility that the United States will export substantial quantities of LNG, which could link U.S. natural gas prices to world crude oil prices through arbitrage in the global natural gas market.

The remainder of this article is organized as follows: Section 2 examines the relationship between U.S. natural gas prices and world oil prices in more detail. Section 3 examines the likely interfuel substitution across major sectors of the U.S. economy—the electric power, industrial, commercial, residential and transportation sectors—with an eye toward determining whether U.S. natural gas prices are likely to remain low relative to petroleum product prices. Section 4 considers the possibility of arbitrage of U.S. natural gas prices with those in the rest of the world through LNG exports. Section 5 concludes by assessing the overall likelihood that U.S. natural gas prices will remain well below their previous historical relationship with world crude oil prices and examines the implications of lower natural gas prices for policies to promote its use in transportation.

2. World oil prices and U.S. natural gas prices

An evaluation of U.S. natural gas pricing through several different means shows a substantial change in the relationship between U.S. natural gas and international crude oil prices in early 2009. Rules of thumb once used by the oil and gas industry no longer well explain the relationship between crude oil and U.S. natural gas prices. Econometric testing of price data after February 2009 no longer finds that U.S. natural gas prices move with world crude oil prices. Perhaps reflecting the end of the historical relationship, EIA's *2017 Annual Energy Outlook* does not project U.S. natural gas prices moving with world crude oil prices.

2.1. Rules of thumb

Brown and Yücel (2008) examine two rules of thumb used by the U.S. oil and gas industry to describe the relationship between oil and natural gas prices. The newer six-to-one rule indicates a price of natural gas at 1/6th the price of crude oil. It approximates the fact that a barrel of West Texas Intermediate crude oil (WTI) has 5.8 million Btu and natural gas is priced per million Btu at Henry Hub, while allowing for the higher transportation costs of natural gas. The older ten-to-one rule indicates a lower price of natural gas at 1/10th the price of crude oil and was commonly observed in the 1990s. The older relationship may be the result of both the inefficiency in old peaking generators using natural gas and the higher transportation costs of natural gas.[2] As

[2] Burner-tip parity rules, explained by Barron and Brown (1986) and updated by Brown and Yücel (2008), explicitly account for both the prices of competing fuels at the burner-tip and the differential in transportation costs between petroleum products and natural gas. Although burner-tip rules better describe the relationship from the mid-1990s to early 2009 than either the ten-to-one and six-to-one rules of thumb, regression models developed by Villar and Joutz (2006), Brown and Yücel (2008) and Hartley et al. (2008) are superior to both in explaining the relationship between natural gas and crude oil prices.

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