THE U.S. SHALE GAS REVOLUTION AND ITS EFFECT ON INTERNATIONAL GAS MARKETS

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Overview

The development in new technology for shale gas drilling increased shale gas production in the U.S. from 1% to 20% between 2000 and 2010. It is believed that this shale gas revolution has caused a downward pressure on gas prices worldwide (Stevens, 2012). This dramatic movement in the U.S. gas market, which is said to began in late 2005, is now known as the 'shale gas revolution'(McGregor, 2012). As the amount of extracable natural gas is increasing in the U.S., the U.S. will likely start to expand fracking to export shale gas to other countries. However, infrastructure such as the new liquefaction facilities and other technologies to liquefy natural gas is currently almost non-existent, and it may take several years before the U.S. is able to export this gas to other countries. Thus, although the shale gas revolution has dropped the price of natural gas in the U.S. market, we believe that the effect of the U.S. gas market on the international gas market is still limited at this stage. If this hypothesis is correct, it might be that the impact of the U.S. shale gas revolution is still a domestic phenomenon.

The objectives of this paper are to elucidate this issue and to determine whether the effect of the shale gas revolution on the U.S. gas market is still a domestic phenomenon or whether this revolution is influencing the global natural gas market. Accordingly, we will test how the relationships among the U.S., European, and Japanese natural gas markets have changed before and after the shale gas revolution took place around the mid-2000s.

The paper consists of two parts. In the first part, we statistically identify the break date using the U.S. natural gas marketed production time series data. Although it is claimed that the shale gas revolution occurred the in the mid-2000s, no agreement exists in the U.S. regarding when exactly it happened. Hence, we assume that the statistically identified break point around the mid-2000s in the U.S. marketed production time series is the point at which the revolution began. In the second part of the paper, we split the U.S., European, and Japanese natural gas price series using the break point discovered in the first part and test how the price relationships among these three natural gas markets change.

We expect that the price relationships among the three countries will not change if the U.S. gas market continues to move together with the international market even after the shale gas market caused a dramatic change in the U.S. domestic market. However, if the price linkage between the U.S. and the international gas market changes after the break point we would guess that the shale gas revolution brought the U.S. market to move differently from the international market.

We believe that the results of our study will help elucidate how the newly discovered unconventional gas resources will influence the domestic market of the country where such new production becomes possible and how such production will affect the international gas market.

Methods

As we think that the effect of the U.S. shale gas revolution would be most apparent in the natural gas withdrawal data we use the U.S. natural gas marketed production (million cubic feet) data for identifying the break point. This data is obtained from the U.S. Energy Information Administration (EIA) and the length of the series we used is the 1992:1-2012:10 period. We use the Bai-Perron (BP) method (Bai-Perron, 1998) to statistically determine the break points in the production data. It is known that this method is useful when the break point is unknown and the time series data contains more than one break point (Aruga and Managi, 2011). We expect that the the BP test will identify other break points than the one found around mid-2000s. We create exogenous dummy variables for these break points, if any, to incorporate the effects of these breaks when testing for the cointegration relationships.

After the break point relavant to the shale gas revolution is identified, which we expect to find around the mid-2000s, we separate the U.S., European, and Japanese natural gas price series into periods before and after this break point. All the price series are obtained from the International Monetary Fund (IMF) and the U.S. price represents the spot price at the Henry Hub terminal in Louisiana. The European price is the Russian border price in Germany, and the Japanese price is the imported Indonesian liquefied natural gas price.

For testing the international price linkages, we apply the Johansen cointegration method (Johansen and Juselius, 1990). We conduct the stationarity tests on all prices series before performing the cointegration test. We use the augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests for this purpose. These unit root and cointegration tests are performed among the U.S., European, and Japanese prices series for the period before and after the break point around the mid-2000s.

Results

The results of the BP test indicated that there are two breaks in the U.S. natural gas marketed production series. One in 2006:8 and the other in 2009:9. As it is believed that the shale gas revolution took place in the U.S. around the mid-2000s (McGregor, 2012) we assumed that the break point relevant to the revolution is the break found in 2006:8. We believe that the break identified in 2009:9 is related to the world financial crisis and this was used to create an exogenous dummy variable to be included in the cointegration model. As 2009:9 is after 2006:8 this dummy variable was included when testing the cointegration relationships for period after 2006:8.

The stationarity tests peformed on the U.S., European, and Japanese price series for the period before and after 2006:8 all indicated that they are integrated of order one, which means that they are stationary for their first differenced series. Thus we performed the cointegration tests for period before and after 2006:8 among the pairs of natural gas prices for the three countries.

Cointegration test

Before the shale gas revolution (1992:1-2006:7)

Variables	H_0: rank=r	Trace test	Max test
US vs Japan	r=0	15.672**	15.265**
	r<=1	0.407	0.407
US vs Europe	r=0	16.290**	14.265*
	r<=1	2.430	3.841
Europe vs Japan	r=0	24.347**	23.665**
	r<=1	0.682	0.682

After the shale gas revolution (2006:8-2012:10)

Variables	H_0: rank=r	Trace test	Max test
US vs Japan	r=0	9.868	8.592
	r<=1	1.276	1.276
US vs Europe	r=0	25.491**	17.680**
	r<=1	7.811**	7.811**
Europe vs Japan	r=0	11.806	11.455
	r<=1	0.351	0.351

** and * denotes significance at 5% and 10%

As shown in the table, the cointegration test on period before 2006:8 suggested that all the pairs of the three countries have cointegration relationships. On the other hand, the test conducted for period after 2006:8 indicated that none of the pairs of the three countries have cointegration relationships. These results imply that the market linkage among the U.S. and the international gas market has weakened after the break in 2006:8. It is probable that this weakening of the price linkage happened because the drop in gas price occurred only in the U.S. and prices of the European and Japanese markets did not fall accordingly after the shale gas revolution.

Conclusions

Because the world still lacks the technology and infrastructure for gas export, we anticipated that the significant drop in the natural gas market related to the shale gas revolution in the U.S. is currently only a domestic phenomenon. We tried to show this phenomenon by testing whether the market linkage between the U.S. and international gas markets changed after the period when the shale gas revolution is said to have occurred. As we expected, our results indicated that the U.S. gas market had a price linkage with the international market for the period before the revolution affected the U.S. gas production, but this price linkage disappeared for the period after the revolution.

Our results indicated that the U.S. gas market became more independent from the international gas market after the shale gas revolution occurred, but this revolution has not yet increased the amount of U.S. gas export and does not currently influence the international gas market. Hence, it can be concluded that, currently, the effect of the U.S. shale gas revolution is a domestic phenomenon However, the results of this study will likely change when the facilities and technologies for exporting gas become available and when the production of shale gas or other unconventional gas begins to increase dramatically in other parts of the world. We believe that our study will become a useful comparison when such changes occur in the future.

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