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Title: International Natural Gas Market Integration

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Overview

We explore the relations among the North American, European and Asian natural gas markets for evidence of convergence and integration for the January 1997 through May 2011 period. Monthly natural gas prices in Japan, South Korea, Taiwan, the UK, and the US are analyzed employing convergence and recursive cointegration tests. The analyses are conducted under a multivariate framework, so the dynamics among the prices can be captured without the necessity of identifying an anchor price series.

Methods

In order to examine the existence of integration among gas prices we use two techniques. We first employ a regression based convergence test introduced by Phillips and Sul (2007), and we complement the convergence tests with recursive cointegration analyses of the gas prices. Phillips and Sul's (2007) formulation is useful in measuring transition towards a long-run growth path or individual transitions over time relative to some common trend or some representative variable. An advantage of the test is that it does not rely on any assumptions of trend stationarity or stochastic non-stationarity in the data. Moreover, the test allows for transitional divergence (i.e. the series can temporarily diverge from the general convergence path).

The gas price of country i in time period t , P_{it} , can be decomposed as:

$$P_{it} = g_{it} + a_{it}, \quad (1)$$

where g_{it} is the systematic component, including permanent common components, and a_{it} represents transitory components. Phillips and Sul (2007) transform (1) to separate common and idiosyncratic components. Specifically,

$$P_{it} = \left(\frac{g_{it} + a_{it}}{\mu_t} \right) \mu_t = \delta_{it} \mu_t, \text{ for all } i \text{ and } t \quad (2)$$

where μ_t is a common component and δ_{it} is a time-varying cross-section specific component. Following Phillips and Sul (2007) we define convergence (or long-run equilibrium) between the price series as:

$$\lim_{s \rightarrow \infty} \frac{P_{it+s}}{P_{jt+s}} = 1, \text{ for all } i \text{ and } j, \quad (3)$$

or equivalently:

$$\lim_{s \rightarrow \infty} \delta_{it+s} = \delta, \text{ for all } i. \quad (4)$$

This allows for the test of convergence for a full panel of price series representing the markets/regions of interest. In case the null of convergence is rejected for the full panel, Phillips and Sul (2007) suggest an algorithm based on repeated regressions tests for the identification of convergence subgroups in the full panel. According to Phillips and Sul (2007), when there are convergence subgroups in the panel, the evidence is usually most apparent in the final time-series observations. So the first step of the algorithm involves the ordering of individuals in the panel

according to the last observation or some time-series average of the last fraction of the sample when there is substantial time-series volatility.

We also employ the cointegration techniques often used in testing for market integration. Long-run common stochastic trends in the prices are taken as evidence of market integration. If one fails to detect cointegration, it is concluded that the markets are not integrated. Such an approach, however, might not be informative if markets are converging toward integration during the in-sample period. The reason would be that convergence is too slow to be reached before the end of the sample period. It is also possible that integration is reached but the integrated period is too short to permit detection of cointegration.

The price series employed in our analyses are sourced from the FACTS Global Energy database. The series are delivered LNG prices for Japan, South Korea, and Taiwan, and pipeline prices for National Balancing Point (NBP) and Henry Hub (HH), in the UK and the US, respectively. Raw prices are US\$ per million Btu (MMBtu). The monthly prices from January 1997 to May 2011 are averages of daily prices for each location, modeled as the logs of prices.

Over the period, the Asian prices tend to move together over the full period while the UK and US prices do not follow the Asia pattern or each other. The NBP price appears to begin to follow the pattern of movement shown by the Asian prices by late 2007 or early 2008, but the large drop in late 2008, relative to the Asian prices, may reveal the more significant impact of the Global Financial Crisis felt in Europe compared to Asia. The large drop in the HH price in late 2008 also suggests the GFC impacted the US more strongly than Asia. We also observe a further divergence in the HH price from the NBP and Asian prices in the later period, which likely reflects the significant impact that the shale gas developments in the US have had on its prices.

Results

The combined results of our convergence and cointegration analyses suggest that the three Asian natural gas markets are integrated and they have been joined by the UK. Long-run relations are also found among these prices in the cointegration analyses, however these are not stable and evolve over the study period. On the other hand, the US, represented by the Henry Hub price, represents a separate and distinct market. This aspect of the US market is best explained by the gas-on-gas nature of the competitive market in North America, and this distinction has been amplified recently by the developments in shale gas which give it an even more distinct character from the rest of the world.

The Asian integration seems to have an interesting aspect to it. While Japan is the original player in the region, integration within the region does not appear to have held until South Korea and Taiwan became significant in the region; prior to their entry Japan was the only player in the region, and therefore it constituted the sole market. Following the entry of South Korea and Taiwan, Japan then seems to have adjusted from a dominant and separate market to one integrated with the other two. Given the long-term contractual nature of the trade in the region, we interpret this to be Japan's pricing structure evolving as contracts expired and were renewed to match those of the two newer players in the region. All three base their contracts primarily on crude oil basket prices, but it would have taken time for the Japanese contracts to shift to recognize the changed competition for natural gas trade in the region.

Conclusions

Our empirical results lead us to conclude that there is not yet an integrated international market for natural gas. There appears to be a clear divide between the North American market and the rest of the world, with the European and Asian markets converged and integrated. However, this latter convergence and integration appears to be based more on contractual links to oil than inter-regional arbitrage. The North American segmentation appears to be due to a combination of a history of gas-on-gas pricing and the more recent shale gas developments, which have not yet influenced the natural gas dynamics of the rest of the world. As both of these influences eventually reach the rest of the world, there is potential for an integrated international market for natural gas to emerge driven by market forces and arbitrage. Moreover, the convergence tests impart useful information beyond that resulting from cointegration alone.

References mentioned in this abstract

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