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Dynamic Integration in the Regional U.S. Natural Gas Markets

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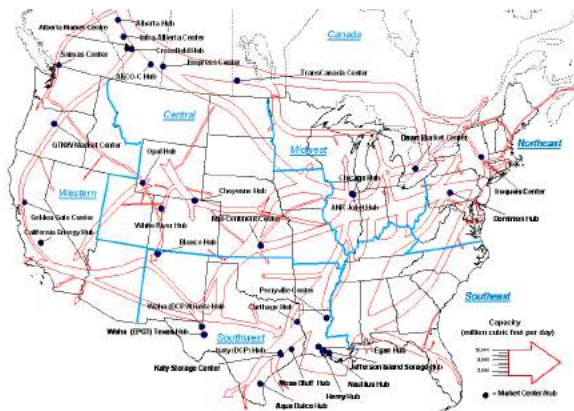
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Introduction:

- After 1980s, under the the Natural Gas Policy Act of 1978 (NGPA), the natural gas market started the deregulation process.
- One of the main goals is to promote a national efficient natural market through competition.
- If the deregulation is achieving its intended goal:
 - Natural gas regional spot markets should be highly integrated;
 - The law of one price should hold - difference in prices re transportation costs, efficient allocation of resources;
 - Price in one market should react to shocks originated from another market.

Natural Gas Market Centers and Hubs in Relation to Major Natural Gas Transportation Corridors, 2009.



Objectives:

In this study, we investigate the degree to which the law of one price holds (integration) and determine each individual market's role in the price discovery process:

1. Understand the time-varying market integration in the U.S. regional natural gas markets;
2. Quantify the magnitude of information spillover between regional markets;
3. Identify information transmitter and information receiver in the U.S. regional natural gas markets.

Method:

Calculating the Generalized Forecast Error Variance Decomposition (GFEVD) from a VECM model:

- Assess the fraction of the H step-ahead error variance in forecasting x_i that is due to shocks to $x_j, \forall j$.

Connectedness measures by Diebold and Yilmaz (2012)

$$\theta_{ij}^g(n) = \frac{\sigma_{ii}^{-1} \sum_{l=0}^{n-1} (e_i' A_l \sum_{j=1}^n e_j)}{\sum_{l=0}^{n-1} e_i' A_l \sum_{j=1}^n A_l e_j}$$

- Σ is the variance matrix for the error vector ε ;
- σ_{ii} is the standard deviation of the error term for the i th equation;
- e_i is a selection vector, with one as the i th element and zero otherwise;

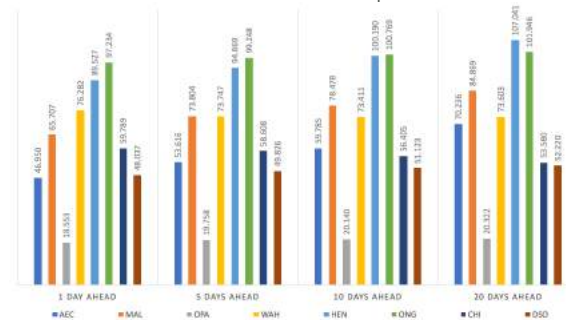
Results & Discussion:

Results of lags, cointegration and total connectedness

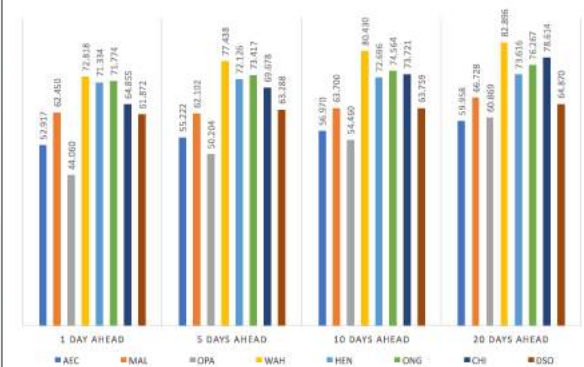
Sample	Start Date	End Date	Obs	Lags	Cointegrations
Whole sample	05/02/94	10/31/16	5870	3	7***
1st sub-period	05/02/94	04/30/99	1304	3	5***
2nd sub-period	05/03/99	04/30/04	1305	3	6**
3rd sub-period	05/03/04	05/01/09	1305	3	6***
4th sub-period	05/04/09	05/02/14	1305	3	7**
5th sub-period	05/05/14	10/31/16	651	3	7***

Sample/Horizon	1 day	5 days	10 days	20 days
05/02/1994 – 10/31/2016	62.760	65.434	67.538	70.477
05/02/1994 – 04/30/1999	60.505	64.111	66.703	69.703
05/03/1999 – 04/30/2004	72.346	74.214	75.910	77.925
05/03/2004 – 05/01/2009	72.092	73.672	75.065	77.121
05/04/2009 – 05/02/2014	74.404	76.765	78.736	81.111
05/05/2014 – 10/31/2016	44.341	54.845	61.404	67.469

Directional price spillover transmitted by market i to all other j markets - Whole Sample



Directional price spillover received by market i from all other j markets - Whole Sample



Net directional price spillover for each market - Whole Sample



Conclusions

- U.S. regional natural gas markets overall well-integrated: a large number of long-run relationships exist between spot markets.
- With the exception of the most recent sub-period, markets become more connected - total price spillover index increased over the years.
- Consistent with Serletis (1997), Park et. al (2008) and Olsen (2015): no east - west split.

Acknowledgments

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