How efficient are natural gas market in practice?

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The institutional environment of the European natural gas markets have experienced a significant change in the last decade. Trading at the British National Balancing Point (NBP) and the Dutch Title Transfer Facility (TTF) gas hubs has significantly gained traction (Heather and Petrovich, 2017).[2] Concomitantly, the anchored practice of oil indexation in long-term natural gas contracts has progressively gave way to the hub indexation for a better reflection of fundamentals reality. Gas-on-gas competition's share increased from 15% in 2005 to 70% in 2017 (IGU, 2018) and seems to have become the dominant price formation mechanism despite some deep disparities between the European Union countries.[3]

Nevertheless, Europe has not quite created a truly competitive gas market yet that requires non-discriminatory, reliable and timely market information (Garaffa et al., 2019). In the context of scattered reserves and a limited number of suppliers, the question of the quality of competition has not been fully resolved in European gas markets as high arbitrage potential, especially in the short-term, remains unexploited by market participants because of limited access to infrastructure, insufficient reliable and timely information and high transaction costs (Stronzik et al., 2009). Theses questions are in the cross-hair of the European Commission in ensuring sufficient liquidity to reduce price uncertainty and transactions costs associated with natural gas trade and to enhance market integration across the continent.

The question of efficiency of European traded gas hubs is hence questionable. Gas exchanges are prone to substantially help the gas markets to evolve toward maturity with open and transparent markets encouraging trading and competition. With a large number of market participants to maintain a high level of liquidity and allow to adjust portfolio volumes over time, trading gas hubs should constitute an important support for financial risk management of gas portfolios and physical balancing. Closely linked to efficiency, liquidity, defined as the ability to match buyers and sellers at the lowest transaction costs (O'hara, 1995) is the cornerstone of turning information into valid price signals. Price signals in spot and future energy markets condition efficient allocation of resources and are thus of crucial importance. The propensity of spot and future markets to send such price signals is based on the informational efficiency of the market in question with publicly and easily accessible information.

From a theoritical point of view, the causality relationships between futures and spot markets is and has been the subject of lively debate. Theoretical and empirical investigations on the subject did not reach a clear consensus on the causality direction. The theory of storage (Working, 1949) states that spot and futures markets for storable commodities have a long-term relationship through market players that perform intertemporal transactions in order to optimize their portfolio. The model shows that any deviation from the intertemporal equilibrium can lead to arbitrage activities by market players that benefit from substitutability between spot and future markets. Most of the empirical investigations that has addressed the issue of the relationship between spot and futures relied on cointegration techniques based on Johansen (1988) test and vector error correction model (VECM). In commodity markets, Wang and Wu (2013) employed nonlinear

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[2] See also Heather (2016).

[3] These disparities suggest a path of development towards a more established integration of gas markets at the European scale, though growing (Neumann and Cullmann, 2012).

threshold VECM and found that crude oil spot and futures prices are cointegrated only when the price differentials are larger than the threshold value. Stronzik et al. (2009) investigated the application of theory of storage to the European gas market using two indirect tests developed by Fama and French (1988) to study the overall market performance. Most of their findings do not confirm predictions of theory of storage. Indeed, contrary to expectations, they found a positive correlation of inventory level with twelve-month maturity yields, and that natural gas price volatility correlates negatively with both convenience yield approximations. They attribute these results to possible obstacles concerning the appropriate use of storage in European natural gas market: limited access to infrastructure, insufficient information, missing secondary markets for unused capacities, high transaction costs.

An alternative theory that has linked spot and future markets is based on the efficient market hypothesis. The latter is the cornerstone of financial models and is derived from the original work of Cootner (1964) and was formalized by Fama in the 1960s. The theory of efficiency assumes that the price observed in the market instantly reflects all available information. At all time, the price is supposed to be representative of past and future events and the expectations of agents in this market. Implicitly, the information is supposed to be accessible at no cost to a large number of operators that can not on their own exert a significant influence on prices or systematically control the market. It follows threfrom that price changes are only the result of unforeseeable events. This has brought the theory of efficiency closer to the random walk model and the martingale theory (Samuelson, 1965). In this line, Alvarez-Ramirez et al. (2008) analyzed the auto-correlation of crude oil prices between 1987 and 2007 on the basis of the estimation of the Hurst exponent dynamics.

Little attention have been devoted to the question of efficiency on natural gas futures markets and their role in developing hedging strategies. Walls (1995) employed Johansen's cointegration methodology to test the efficiency of the US natural gas futures market with monthly data from June 1990 to January 1994 and found no statistically departures from the unbiasedness hypothesis. (see also Herbert, 1993, 1995). Several studies investigated the issue of efficiency and market integration after the open access reform. De Vany and Walls (1993) tested for cointegrations relationships between price pairs between 20 locations and their results suggested that reforms have led to an increased of spatial integration. Serletis (1997) and King and Cuc (1996) have also analyzed the market integration for the North American market (US and Canada).[4] More recently, Chinn and Coibion (2014) found that futures prices are unbiased predictors of crude oil, gasoline and heating oil prices but not of US natural gas prices. In Europe, the question of natural gas market efficiency have also been investigated by Asche et al. 2000 for France's natural gas market and Asche et al. (2006) that have examined the decoupling of natural gas, oil and electricity prices in UK market.

Even though both theories recognize the existence of a long-term relationship between spot and future prices, only the efficiency assumption suggests a potential sense of causality between the two markets. In this context, the lead-lag relationship and the analysis of information flows between spot and future markets has been studied under the process of price discovery. Garbade and Silver (1983), suggests that futures prices should lead spot prices in an efficient market because futures market are more responsive to new information than spot prices and represent a benchmark in arbitrageurs decision-making (Silvapulle and Moosa, 1999). Other researches support the idea that the spot market provides a potent benchmark underlying any future transaction (Moosa, 1996) or that bidirectional causality between the two markets is more sustainable. In

[4] See also: Mohammadi (2011)

this regard, Bekiros and Diks (2008) investigates the linear and nonlinear causal linkages between daily spot and futures prices of West Texas Intermediate (WTI) crude oil for two periods October 1991-October 1999 and November 1999- October 2007. Their results suggest that neither market leads or lags the other consistently when nonlinear effects are taken into account. Alzahrani et al. (2014) and Polanco-Martínez and Abadie (2016) transformed time series into frequency domain using wavelet method to conduct a linear and nonlinear granger causality analysis to WTI spot and futures prices. Results revealed bi-directional causality between spot and futures prices at different time scales suggesting that spot and futures prices react simultaneously to new information. In natural gas markets, Doane and Spulber (1994) employed Granger causality test to assess US gas market integration Prior to open access, their results have suggested Granger causality between only one of 20 pairs of gas prices from 5 regions. A contrario, open access have lead to instantaneous bi-directional causality .In the same vein, Ghoddusi (2016) examined the integration between different types of physical (upstream/end use) and futures prices of natural gas in the U.S by applying cointegration tests and causality analysis. Based on monthly data from 1990 to 2014, results suggests that futures prices are cointegrated with wellhead, power, industrial, and citygate prices; future prices granger cause all future prices and finally shocks to futures prices have persistent effects on all physical prices.[5] Gebre-Mariam (2011) finds that spot prices in the market hubs exhibit bidirectional or two-way causal relationships, suggesting instantaneous response of price changes across markets. An interesting paper of Rong and Zheng (2008) have sought to investigate how these two approaches managed to capture the true relationship between spot and future prices and how the question of efficiency should be tested. The answer to these questions has led the authors to distinguish the pricing efficiency from the informational efficiency. By pricing efficiency, they mean the no-arbitrage prices depending on whether arbitrage strategies could be utilized and as for informational efficiency, the later is related to the reaction of future prices to new information.If the first one can be tested by investigating the relationship between spot price and future prices, the second should be tested by examining the residuals of future log returns via random walk analysis.

Different areas of improvement emerge from this literature. First, most previous studies have ignored the possibility that direction, extent and strength of Granger causality may vary at different time scales and would consequently result in policy recommendations based on misleading one-shot measures. Secondly, among the studies that have analysed the natural gas industry through the theory of storage, the majority have focused on the North American market (see e.g., Susmel and Thompson (1997); Dincerler et al. (2005) and Serletis and Shahmoradi (2006)). Thirdly, the empirical investigations of price discovery process are also rather thin for European markets and have neglected the nonlinearities governing energy commodities dynamics. More recent empirical studies show the importance of considering non-linearities of price dynamics because of recessions, unforeseen extreme events, transaction costs, market power, geopolitical tensions or asymmetric information or stickiness in prices. Finally, the literature do not provide a clear consensus about the direction of causality: these differences stem from the use of different methodologies and studied periods that need to be fortified.

1. References

Alvarez-Ramirez, J., Alvarez, J., Rodriguez, E., 2008. Short-term predictability of crude oil markets: a detrended fluctuation analysis approach. Energy Economics 30 (5), 2645–2656.

[5]Futures markets are also found to cause fluctuations in spot prices: (Brenner and Kroner (1995).

Alzahrani, M., Masih, M., Al-Titi, O., 2014. Linear and non-linear granger causality between oil spot and futures prices: A wavelet based test. Journal of International Money and Finance 48, 175–201.

Asche, F., Osmundsen, P., Sandsmark, M., 2006. The uk market for natural gas, oil and electricity: are the prices decoupled? The Energy Journal, 27–40.

Bekiros, S. D., Diks, C. G., 2008. The relationship between crude oil spot and futures prices: Cointegration, linear and nonlinear causality. Energy Economics 30 (5), 2673–2685.

Brenner, R. J., Kroner, K. F., 1995. Arbitrage, cointegration, and testing the unbiasedness hypothesis in financial markets. Journal of Financial and Quantitative Analysis 30 (1), 23–42.

Chinn, M. D., Coibion, O., 2014. The predictive content of commodity futures. Journal of Futures Markets 34 (7), 607–636.

Cootner, P. H., 1964. The random character of stock market prices.

De Vany, A., Walls, W. D., 1993. Pipeline access and market integration in the natural gas industry: Evidence from cointegration tests. The Energy Journal, 1–19.

Dincerler, C., Khokher, Z., Simin, T., 2005. An empirical analysis of commodity convenience yields. Unpublished working paper, McKinsey & Co. Inc., University of Western Ontario, Pennsylvania State University.

Doane, M. J., Spulber, D. F., 1994. Open access and the evolution of the us spot market for natural gas. The Journal of Law and Economics 37 (2), 477–517.

Fama, E. F., French, K. R., 1988. Dividend yields and expected stock returns. Journal of financial economics 22 (1), 3–25.

Garaffa, R., Szklo, A., Lucena, A. F., Féres, J. G., 2019. Price adjustments and transaction costs in the european natural gas market. Energy Journal 40 (1).

Garbade, K., Silver, W., 1983. Price movements and price discovery in commodity markets. Review of Economics and Statistics 65 (2), 289–97.

Gebre-Mariam, Y. K., 2011. Testing for unit roots, causality, cointegration, and efficiency: The case of the northwest us natural gas market. Energy 36 (5), 3489–3500.

Ghoddusi, H., 2016. Integration of physical and futures prices in the us natural gas market. Energy Economics 56, 229–238.

Heather, P., 2016. The evolution of european traded gas hubs. Oxford Institute for Energy Studies.

Heather, P., Petrovich, B., 2017. European traded gas hubs: an updated analysis on liquidity, maturity and barriers to market integration. Oxford Institute for Energy Studies.

IGU, 2018. World LNG report-2018.

Johansen, S., 1988. Statistical analysis of cointegration vectors. Journal of economic dynamics and control 12 (2-3), 231–254.

King, M., Cuc, M., 1996. Price convergence in north american natural gas spot markets. The Energy Journal, 17–42.

Mohammadi, H., 2011. Long-run relations and short-run dynamics among coal, natural gas and oil prices. Applied economics 43 (2), 129–137.

Moosa, I., 1996. An econometric model of price determination in the crude oil futures markets. In: Proceedings of the econometric society Australasian meeting. Vol. 3. University of Western Australia Perth, pp. 373–402.

Neumann, A., Cullmann, A., 2012. What's the story with natural gas markets in europe? empirical evidence from spot trade data. In: 2012 9th International Conference on the European Energy Market. IEEE, pp. 1–6.

O'hara, M., 1995. Market microstructure theory. Vol. 108. Blackwell Publishers Cambridge, MA.

Polanco-Martínez, J., Abadie, L., 2016. Analyzing crude oil spot price dynamics versus long term future prices: A wavelet analysis approach. Energies 9 (12), 1089.

Rong, C., Zheng, Z.-l., 2008. Unbiased estimation, price discovery, and market efficiency: futures prices and spot prices. Systems Engineering-Theory & Practice 28 (8), 2–11.

Serletis, A., 1997. Is there an east-west split in north american natural gas markets? The Energy Journal, 47–62.

Serletis, A., Shahmoradi, A., 2006. Measuring and testing natural gas and electricity markets volatility: evidence from alberta's deregulated markets. Studies in Nonlinear Dynamics & Econometrics 10 (3).

Silvapulle, P., Moosa, I. A., 1999. The relationship between spot and futures prices: evidence from the crude oil market. Journal of Futures Markets: Futures, Options, and Other Derivative Products 19 (2), 175–193.

Stronzik, M., Rammerstorfer, M., Neumann, A., 2009. Does the european natural gas market pass the competitive benchmark of the theory of storage? indirect tests for three major trading points. Energy Policy 37 (12), 5432–5439.

Susmel, R., Thompson, A., 1997. Volatility, storage and convenience: Evidence from natural gas markets. The Journal of Futures Markets (1986-1998) 17 (1), 17.

Wang, Y., Wu, C., 2013. Are crude oil spot and futures prices cointegrated? not always! Economic Modelling 33, 641–650.

Working, H., 1949. The theory of price of storage. The American Economic Review, 1254–1262.