What Drives Natural Gas Prices? – A Structural VAR Approach

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TWO PAGES MAXIMUM

(1) Overview

In this study, we develop a structural vector autoregressive model (VAR) for the German natural gas market. Our setup allows us to analyze the determinants of the natural gas price in a comprehensive framework. We illustrate the usefulness of our approach by disentangling the effects of different fundamental influences on gas prices during three recent supply interruptions: the Russian-Ukrainian gas dispute of 2009, the Libyan civil war in 2011 and the withheld Russian exports in 2012. Our results show that the natural gas price is affected by temperature, storage and supply shortfalls in the short term, whereas the long-term development is closely tied to both crude oil and coal prices. Moreover, the historical supply shortfalls investigated had only limited impact on gas prices and hence fail to explain the price movements during these periods. This finding suggests that market power of Russian gas exporters has been historically overestimated.

(2) Methods

Our data set comprises weekly data within the period from January 2008 to June 2012. It consists of German natural gas wholesale prices, the Brent oil price, the North-Western-European coal price, heating degree related data, gas storage data, shortfalls of gas supplies to the European market and European LNG import data. We refers to the last two variables on a European rather than on a German level, since the major European gas markets are highly interdependent, as shown by Robinson (2007) and Growitsch (2012).

Structural VAR models have been applied in particular for the modeling of crude oil markets (e.g., Kilian and Murphy (2010)). With regard to the market for natural gas, this empirical setup allows us to capture the endogenous interaction among gas prices and storage flows as well as cross commodities effects. This clearly represents an enrichment of empirical research on gas markets, as previous approaches, for example Brown and Yücel (2008), Mu (2007) or Ramberg and Parsons (2012) treat gas inventories and alternative commodity prices as exogenous with respect to gas prices. However, we nevertheless account for the exogenous character of some gas price determinants (e.g., weather conditions) by introducing instantaneous and lagged restrictions in the VAR framework. Impulse response analysis and forecast error variance decomposition are applied to investigate the magnitude and the time horizon of different drivers of gas prices.

Moreover, we follow the approach of Baumeister and Kilian (2012) as we draw upon the structural innovations generated by our model to disentangle the contribution of various gas price determinants during periods of supply shortfalls. For this purpose, we extract the actual sequence of the relevant structural shocks and simulate their impact on gas prices in the subsequent periods.

(3) Results

The impulse responses of the natural gas price as well as its forecast error variance decomposition are consistent with economic reasoning: Extraordinary cold weather results in an immediate and strong increase in the natural gas price. The structural response functions also provide evidence of significant interdependencies among energy commodities, since the price of gas responds positively to shocks of both oil and coal prices.

In the short run, supply disruptions and unexpected temperature deviations are of major importance for the natural gas price. However, the impact of these shocks has only transitory character. For longer horizons, the forecast errors of gas prices can be explained more precisely by developments related to the coal and oil markets. Interestingly, coal prices exhibit at least equal explanatory power for gas price variations than the oil price does. This finding questions the strong focus on oil market variables as determinants of gas prices in previous gas market research. We attribute the strong interdependency of coal and gas markets to the physical substitution potential within the power sector.

The historical disentangling of contributions to gas price variation reveal that supply shortfalls clearly fail to explain all gas price variation during periods of supply interruptions, as some of the discussed shortfalls occurred simultaneously with extraordinary demand conditions. These conditions comprise both extremely low temperatures and precautionary demand resulting from the anticipation of further supply interruptions. Consequently, attributing the price movements of these periods exclusively to supply-side effects clearly overestimates the impact of supply shortfalls on gas prices.

(4) Conclusions

The empirical results emphasize the importance of both supply- and demand-side gas price determinants. Consequently, attempts to improve the security of German gas supplies should not only focus on supply-sided measures, but could also address flexibility options on the demand side of the market. A further extension of temperature-indexed interruptible contracts for industrial customers could be a conceivable measure to target demand flexibility. Alternatively, modifications in the current market design for gas storages could keep these facilities available despite narrowing seasonal price spreads. With regard to future econometric modeling of gas markets, our structural VAR approach emphasizes that accounting for the endogenous interaction of gas market fundamentals within a multivariate framework provides deeper insights in gas price determinants than previous research based on alternative econometric models. Thus, future investigation of gas price drivers and of the interaction of gas market variables should take place within a structural VAR framework.

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