



Turbulent times: Uncovering the origins of US natural gas price fluctuations since deregulation



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ABSTRACT

In this paper, we investigate supply and demand shocks in the U.S. natural gas market, focusing on how the effects of these shocks have changed over time. Using a sign-identified structural vector autoregression (SVAR) model that allows for both time-varying parameters and stochastic volatility, we find that supply and demand shocks are the main drivers of natural gas price fluctuations during 1993–2015, with speculative activities playing a minor role during a portion of the sample period. We also find that after the recent shale boom, the supply and demand of natural gas in the US have become somewhat more elastic. An examination of several volatile episodes during the sample period suggest that though natural gas price fluctuations are predominately determined by fundamental factors, supply and demand shocks have significantly evolved over time.

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1. Introduction

What is driving the price of natural gas in the United States? As a critical component of the energy industry in the US, the price of natural gas is closely linked to industry output, employment, domestic energy policies, and economic growth. Episodes of prolonged fluctuations in natural gas prices could lead to difficulties in managing production costs and create uncertainties in investments for the industrial sector, hampering economic growth and reducing aggregate employment. Compared however to crude oil and other energy commodities, relatively little is known about the price fluctuations in the US natural gas market and their specific causes.

Such a lack of understanding in these critical issues could have significant consequences in risk management strategies of market participants and domestic economic development policies of regulators. For instance, if the primary source of natural gas price variations comes

from the uncertainties in macroeconomic development, then effort should be focused on diversifying systematic risks and promote economic growth. If instead natural gas prices are mainly supply-driven, then policymakers may wish to focus on improving production infrastructure and expanding pipeline capacities to alleviate production uncertainties and transmission bottlenecks. Alternatively if the speculative demand for natural gas, a common feature of storable commodities, is responsible for the majority of the price variations, then regulations should be established to restrict excessive speculations in the natural gas market so that price mainly reflects the fundamental supply-and-demand relationships.

The purpose of this paper is to evaluate the impacts of supply, demand, and speculation on natural gas prices in the US and investigate how these effects have changed over time. The relevance is highlighted in Fig. 1, which illustrates how prices in the US have experienced significant volatility over the past three decades. For instance, in the aftermath of the supply disruptions caused by hurricanes Katrina and Rita in 2005, natural gas prices hit a record high in both nominal and real terms, followed by a more than 50% drop as weather conditions unexpectedly improved. Then during the financial crisis of 2008, natural gas prices experienced another round of significant shifts, a pattern

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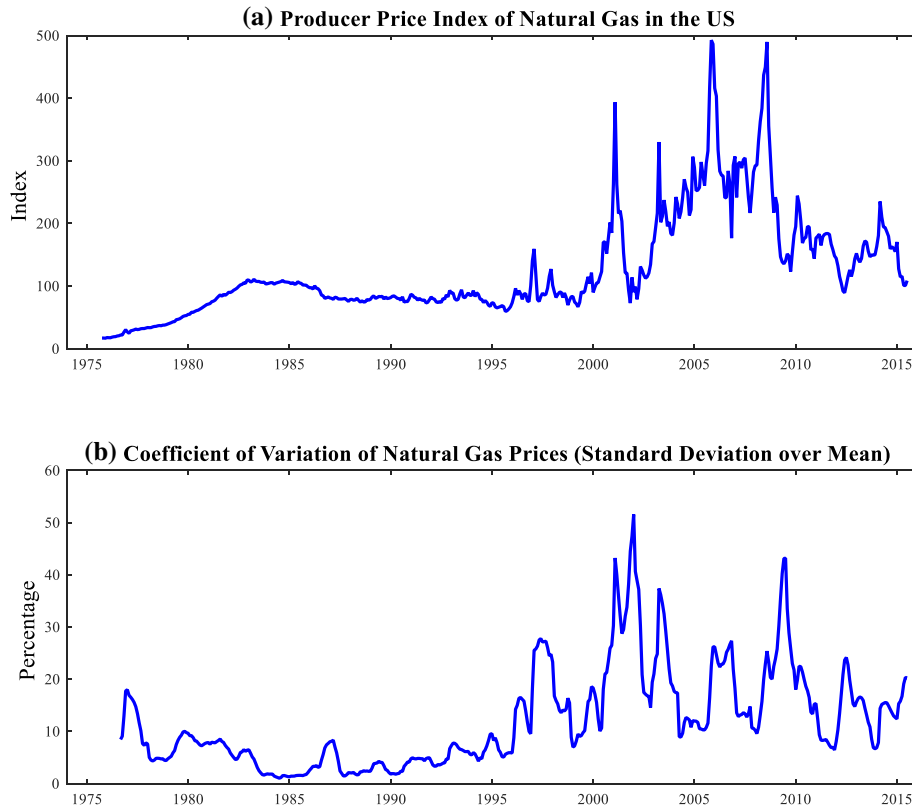


Fig. 1. Natural Gas Producer Price Index in the US and its one-year coefficient of variations (1975–2015).

shared by many other commodities. Most recently, the use of horizontal drilling and hydraulic fracturing techniques has completely revolutionized the market and resulted in abundant natural gas supply in the US. Despite these enormous changes, studies of the driving forces behind natural gas price movements still lag behind those from other energy markets.

Using a sign-identified structural vector autoregression (SVAR) model that allows for both time-varying parameters and stochastic volatility (i.e., the error variance following a random distribution), we estimate the impacts of supply shocks, aggregate demand shocks driven by changes in the US economic activity, and speculation (as measured by precautionary inventory demand shocks in anticipation of future demand-and-supply conditions) on the real price of natural gas in the US.¹ Using quarterly data from 1976 to 2015, we find that the impacts of different structural shocks have evolved considerably since markets were formally deregulated in 1993. We find that natural gas prices in the US are predominately determined by supply and demand shocks, though precautionary inventory demand shocks also have a tangible effect on natural gas price movements. We also find that both the price elasticities of supply and demand have increased in magnitudes in recent years, possibly reflecting the greater flexibility in production and in fuel switching due to technological advances. An examination of several volatile episodes during the sample period suggest that natural gas price fluctuations are driven by different shocks, depending on the underlying market structure.

The remainder of this paper is organized as follows. The next section briefly reviews relevant literature on estimating the supply and demand structure in the natural gas market. Section three describes the

econometric procedure used in this paper, and section four presents the data. Estimation results are reported in section five. In section six, we investigate a few historical episodes and estimate the relative role of supply and demand in these events, and section seven concludes the paper.

2. A brief literature review

Only a handful of studies have attempted to understand the supply-and-demand structure in the US natural gas market, with the majority focusing on the spatial pricing efficiency in regional markets and price relationship with other energy commodities. Previous literatures have found that unlike the prices of oil and coal that are determined globally and by long-term contracts respectively, natural gas prices are determined regionally, reflecting predominantly regional supply-and-demand relationships (e.g. Siliverstovs et al., 2005; Park et al., 2007; Mohammadi, 2011; Renou-Maissant, 2012; Olsen et al., 2015). The pricing relationship between natural gas and crude oil and other energy commodities has as well received much attention from the literature, as for many applications, natural gas and refined petroleum products are close substitutes. Though fuel switching may be limited in the short-run due to technological constraints, researchers overall agree that (1) natural gas and crude oil prices are strongly linked before 2008, and (2) natural gas prices tend to be more influenced by oil prices, rather than the other way around (e.g. Atil et al., 2014; Brigida, 2014; Brown and Yücel, 2008; Hartley and Medlock, 2014; Ji et al., 2014; Ramberg and Parsons, 2012).

A core problem in the natural gas market is understanding how natural gas prices respond to different market shocks and the relative importance of each shock in driving price movements. Recently, Nick and Thoenes (2014) analyze the German natural gas market, and the impact that three significant supply shocks have had on prices using a structural VAR model. They argue that in the short-run temperature, storage, and supply shortfalls play an important role. Woo et al.

¹ Unlike convention SVARs that are identified by Cholesky decompositions, in a sign-identified SVAR the model is identified by imposing signs on the impulse response functions. We further allow the parameters of the model to vary over time, and the variance of the error term to be randomly-distributed (as opposed to being a constant, as is in usual regression models).

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