ESTIMATING PRICE ELASTICITIES OF SUPPLY FOR THE US NATURAL GAS MARKET

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Overview

In order to supply internal energy needs, many countries depend on importing non-renewable energy resources such as petroleum, natural gas, and coal. Due to the high global energy dependency, it is significant to understand how the supply and demand of different fossil fuels respond to changes in price. This response is measured as elasticity and plays an important role not only for modelling supply and demand in a specific market but also in policy evaluation, planning and future trend analysis of the studied sector. The existing empirical literature in elasticities for the energy markets has concentrated mostly on the demand side. Dahl (2007) gathered more than 1.900 studies estimating elasticities of demand. On the supply side, elasticities studies have concentrated mostly on crude oil and its derivatives as well as the coal sector (see Dahl and Duggan, 1998 for a survey of elasticities of supply in the US energy sector). The limited available number of studies and the competitive structure of the North American natural gas market provides ample research potential. The United States is not only the largest consumer of natural gas, but - most relevant for the aim of our analysis - it is currently also the largest producer (BP, 2012).

Some of the previous econometric studies on elasticities of supply derived for the natural gas sector include Erickson and Spann (1971), Dahl (1992) and Krichene (2002). Erikson and Spann estimate elasticities of total discoveries for the US natural gas and oil sector which they compose as the sum of price elasticities of wildcat well drilling, the success ratio and the average discovery size. With the objective to study the response of supply to regulation they estimate the own price elasticity of natural gas discoveries at +0.69.
One of the last studies estimating elasticities of supply in the natural gas sector was conducted by Krichene (2002) with data ranging from 1918 to 1999. Krichene applies a two-stage least square approach (2SLS) and the error correction model (ECM) to estimate the natural gas own price elasticities of supply. When analysing the complete period (1918-1999) using the two-stage least square method he obtains an own price elasticity of -0.14. From this he concludes that the short-run price effect was small implying that supply was determined by production capacity. When analysing the period of 1973-1999 he obtains an elasticity of supply of -0.10 and concludes the market faces the emergence of supplier market power. For the period between 1918 and 1973 he estimates an elasticity of -0.73. Under the application of an ECM the elasticity decreases to -0.59 during 1918-1999 and to -0.56 for the period between 1918 and1973. The results obtained for the period between 1973 and 1999 were not statistically significant. The author explains the relative results arguing that producers could “deliberately restrain output in order to preserve surges in prices”. In conclusion his findings show high inelastic short run elasticities of supply differing in magnitude depending on the period under consideration.

The aim of our analysis is to contribute to the literature by using more recent data (1984 to 2011) to provide an update on elasticities of supply in the US natural gas sector.

Methodology

In order to estimate the proposed elasticities of supply we follow Dahls’ (2002) approach and assume that the quantity of natural gas supplied to the market (S_G), results as a function of own (P_G) and prices for the substitute fuel coal (P_c), operating (OPEX) and capital expenditures (CAPEX) as well as other external factors. These include natural gas flow disruptions (D), drilling activity (DA), governmental policies (G) influencing the natural gas industry or its competitive industries, the size of the pipeline transmission network (T) and national (R_{US}) as well as worldwide reserves of natural gas (R_w).

$$natural\ gas\ supply\ S_G = f(P_G, P_C, OPEX, CAPEX, D, DA, G, T, R_{US}, R_w)$$

At the time of writing the econometric model to be estimated applying the ordinary least square method is defined as follows:

$$ln\, S_G = \beta_0 + \beta_1\, ln\, P_G + \beta_2\, ln\, P_C + \beta_3\, \mathrm{OPEX} + \beta_4\, \mathrm{CAPEX} + \beta_5\, R_{US} + \beta_6\, R_w + \beta_7\, DA + \beta_8\, T + \varepsilon$$

where P_G is the US wellhead natural gas price and P_C the average US coal price as reported by the EIA; OPEX and CAPEX are measured in million 2009 US dollars, and taken from a financial report published by EIA. Data on natural gas reserves in the US and the world are published by BP. Drilling activity is approximated by the rig count as provided by Baker Hughes Inc. and T is the aggregated length of the transmission pipeline network (in miles) published by the US PHMSA. The left hand side variable S_G is supply of natural gas in the US calculated as production plus imports less exports as reported by EIA.

(Preliminary) Results

Based on economic theory we expect supply to be relatively price inelastic in the short term. Suppliers are expected to react to price increases producing more natural gas, assuming that the producers have some spare capacities. Nevertheless, the natural gas industry is mainly due to its capital intensity considered to be non-labor intensive. Therefore the quantity supplied will adjust slowly to the increase in price in the long term. This means that supply will be more elastic in the longer run by i.e. increasing the drilling activity and therefore increasing the quantity supplied.

Our preliminary results (Table 1) show an estimated natural gas short-run elasticity of supply of -0.14. Hence, a one percent increase in price would result in a 14% decrease in the quantity of natural gas supplied. This result could indicate that suppliers have small spare capacities and cannot increase significantly their production in the short run. Surprisingly, the estimated coefficient on the number of rigs is not significant. The estimated cross-price elasticity between coal and natural gas is -0.47 indicating that a 1 percent increase in the price for a coal decreases supply of natural gas by 47%. In this simplistic approach we find no evidence of operating and capital expenditures for development and extraction on the actual supply of natural gas. Also, the size of the transmission network does not seem to have an effect on suppliers.

Table 1: Preliminary Estimation Results (OLS)

	Estimated coefficient	Standard Error	t statistic
Constant	4.434***	0.430	0.000
P_G	**-0.137*** **	0.032	0.001
P_C	**-0.471*** **	0.083	0.000
OPEX	0.004	0.002	0.158
CAPEX	0.0003	0.0004	0.500
Rigs	0.00002	0.00003	0.405
US reserves	**0.035** **	0.16	0.041
World reserves	0.0007	0.0006	0.248
Transmission network	-0.0004	0.0009	0.654
N	26		
R^2	0.96		

***, ** indicates significance at 1% and 5% level

Conclusions

Our preliminary results indicate high inelastic supply of natural gas in the US. However, limitations to our work are obvious. Future work must include dummy variables for flow interruptions, governmental policies and interaction terms. Also storage capacities and/or levels need to be considered given their strategic role in supplying natural gas. Additionally, the results need to be compared to the existing literature taking into account different estimation techniques (ECM).

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