Energy Economics 33 (2011) 44–55

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Evaluating the economic cost of natural gas strategic storage restrictions

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ARTICLE INFO

Article history:
Received 29 December 2009
Received in revised form 12 April 2010
Accepted 15 April 2010
Available online 21 April 2010

JEL classification:
D92
E32
Q48

Keywords:
Natural gas
Seasonal arbitrage
Strategic storage policy

ABSTRACT

The European Commission wants to implement a single market for gas. One of the components of this market is a regulated provision for "security of supply" which consists of rules for the implementation and use of a given reserve stock of gas. We investigate the impact of this policy on the profitability of a storage operator, using data from Denmark and Italy. Keeping storage capacity constant, the costs of the strategic stock are around 20% of the value of the storage market for Denmark, and 16% for Italy. This cost is due to the inability to extract arbitrage profits from the captive stock. Furthermore, the strategic storage restriction induces behavior that would virtually never be replicated by a private storage operator in an unconstrained market, in particular in the first 6 months of the year when unconstrained firms empty their reservoirs much faster, suggesting the strategic restriction is unnecessarily distorting the market.

1. Introduction

The European Commission wants to implement a single market for gas. One of the components of this market is a regulated provision for "security of supply" which consists of rules for the implementation and use of a given "strategic" reserve stock of gas. Given the forecasted dependence of Europe on imported gas, this policy deserves serious consideration. This paper investigates the impact of this policy on the profitability of a storage operator, and therefore indirectly on the incentive to invest in storage. The cost component we focus on — the loss due to the inability to use the captive stock for arbitrage gains — is largely absent from any academic or policy literature on gas storage, but, as this paper shows, it is far from negligible.

In order to implement the creation of strategic storage the policy maker regulates the use of the existing stocks owned and managed by commercial operators. This regulation takes the form of a penalty on the "improper" use of the last *x*% of total capacity in any storage facility — the strategic part of the stock. Proper uses are determined by the regulator. The policy analysis here is the comparison of optimal behavior and profits of a storage operator with and without the penalties.

Regulatory intervention is justified in the presence of externalities. Just like the European Commission, this paper assumes that market failures and externalities exist in connection with the market for natural gas, such that it is important for the policy maker to complement the commercial supply of stored gas with an extra stock to be released in case of emergency. Such positive externalities are likely to be dispersed throughout the economy, while the costs of regulation are potentially borne directly by storage operators.[2] It is therefore useful to quantify the impact of regulation on the behavior and profitability of storage operators. In this way, the regulator will be able to design the appropriate compensation package for the social service provided by strategic storage.

Another assumption used in this paper is that the storage component of the market for natural gas can be unbundled from production and distribution activities and function in a competitive environment. Although storage facilities are investments with large initial fixed costs, casual observation reveals that a large number of agents participate in the market.[3]

These assumptions allow us to write a model of optimal storage of gas where the agent (a storage firm) buys gas and stores it when prices are low, and sells gas when prices are high. The model is calibrated to match Italian and Danish storage data. Both of these countries have restrictions on the use of stored gas. Italy sets apart around 38% of its stored gas on a permanent basis, while Denmark imposes that stored gas must at all times be enough to cover the following 60 days of normal consumption. While large, Italy's storage capacity is smaller relative to total consumption than Denmark's, which comfortably meets its 60-day restriction.[4]

Our calibration for Italian and Danish data yields a cost of regulation of around 16% and 20% of discounted net present value of profits for the

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[1] I thank Marija Velkoski, several anonymous referees, and seminar participants at the University of Essex and University of Copenhagen.

[2] Externalities can also go the other way: Le Coq and Paltseva (2008) note that storage can induce moral hazard as agents consume gas in a less prudent way.

[3] See http://www.gie.eu.com/gse/storageprojects/database.php.

[4] The regulator could also act as a client and buy gas for strategic purposes, storing it in commercial sites.

0140-9883/$ – see front matter © 2010 Published by Elsevier B.V.
doi:10.1016/j.eneco.2010.04.008

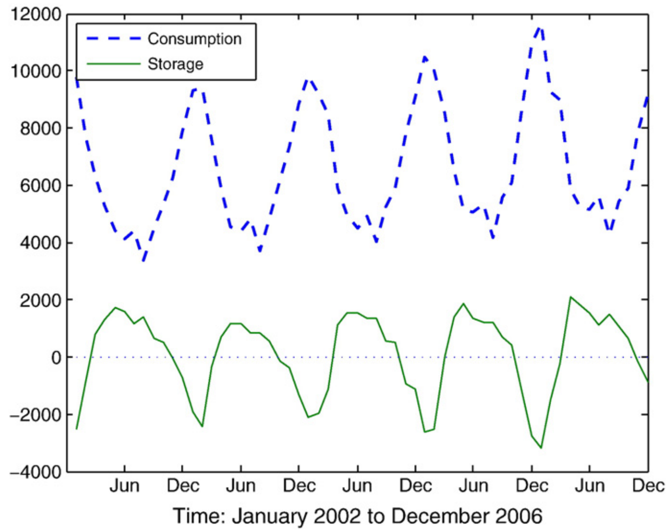

Fig. 1. Italian gas consumption and storage flows.

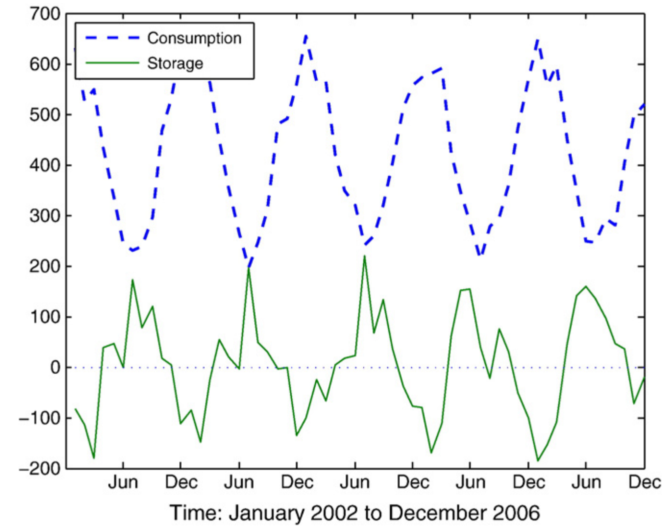

Fig. 2. Danish gas consumption and storage flows.

respective storage markets. These costs are due to the loss of seasonal arbitrage profit associated with the captured stock. We also find that the strategic storage restriction induces behavior that would virtually never be replicated by a private storage operator in an unconstrained market. In particular, during the first 6 months of the year unconstrained firms empty their reservoirs more rapidly than their regulated counterparts, suggesting the constraint may impose unnecessary distortions.

The current paper is a measurement and policy evaluation exercise on natural gas storage which focuses on modelling the cost side of strategic gas policy. To our knowledge there is no close analogue to this exercise in the literature. Our paper is not, however, a structural cost–benefit analysis of regulation with detailed measurement of benefits. Instead, the benefit side is summarized by the price process for gas which includes the event of a large disruption, and the reduced form approach we take allows us to do sensitivity analysis on it.[5]

We believe that given the events of 2008 in Georgia this is a work of current relevance. The model draws on work by Wright and Williams (1982a,b, 1991), Byers (2006), Thompson et al. (2009), Hall and Rust (2000) and Chaton et al. (2007a, b). These last authors study a problem where storage agents face the possibility of a large disruption and therefore build up a precautionary stock up to a given level and then optimally maintain it. They do not study seasonal arbitrage nor do policy evaluation which is the main focus of this paper. Casassus et al. (2005) study a general equilibrium model of oil as an intermediate input with storage aimed at replicating the asset pricing properties of commodities, but again the seasonal component is absent from their framework.

The paper proceeds with a presentation of Danish and Italian data and their seasonal properties. Section 3 introduces the problem using an example. Sections 4, 5 and 6, present, calibrate and simulate the main model. Section 7 extends the example from Section 3 to discuss model caveats and Section 8 concludes.

2. Data

The model is calibrated to match Italian and Danish data. Fig. 1 shows the large positive monthly Italian gas consumption and, closer to zero, the cyclical storage flow series which alternates between positive and negative flows (flows are measured as consumption less imports and production). The data is in millions of cubic meters, covering 60 months from January 2002 to December 2006, from the OECD.[6] In Figs. 1 and 2, storage flows are positive when injection is taking place, which is generally from April to October.

One of the key assumptions used in the paper is that of a competitive market. It is useful to look at Danish data to support this assumption:

The key difference is that Denmark exports gas, while Italy imports it.[7] Denmark explores its share of the Ormen Lange field, which in turn is connected to the U.K. market by pipeline. Since the U.K. market has a well functioning spot market for gas, and is further connected to the continental one via the interconnector, and since Denmark also has pipelines to the continent, it is safe to assume that competitive spot prices affect the marginal unit of gas stored in Denmark. The final logical step here is that, while we do not have information on spot trading in either Denmark or Italy, the behavior of flows in and out of storage is broadly similar in both countries, justifying the use of a competitive assumption to look at the data.

We will make use of this monthly from Natural Gas Information (2005, 2007) as well as of the daily data available directly from storage operators STOGIT (Italy), and DONG and Energinet (Denmark). There is one additional reason to look at both Danish and Italian data: they both have strategic storage requirements. That these requirements are different from each other in itself suggests a policy comparison.

2.1. Cyclical properties

A detailed look at the cyclical properties of the above data shows that Italian and Danish data are quite similar. Fig. 3 shows the average annual cycle of Italian and Danish gas consumption. The picture shows monthly values normalized by the highest monthly value.[8] Consumption has a single peak in January, and the two series are similar.

[5] Benefits (total market surplus) contain a possibly non-negligible component of externalities, the measurement of which is at best problematic. The market price is thus not a sufficient statistic for the benefit, but fluctuations in the market price still contain information about fluctuations in benefits.

[6] Italian production is small, flat, and steadily declining while imports and consumption are increasing and seasonal. A big part of the adjustment to the large consumption swings is met by seasonal imports rather than by storage. The year 2002 has a significant (unaccounted for) difference between flows computed as stock differences, and flows computed as consumption less production and imports. They should be the same as Italy exports almost zero gas.

[7] Denmark does not import gas. Its exports are seasonal and increase a little over the sample.

[8] They are shown relative to the highest monthly value which limits variation to the unit interval on the vertical axis. We average the 5 observations for each month, and divide the resulting 12 averages by their maximum.