



Measuring the effects of natural gas pipeline constraints on regional pricing and market integration[☆]



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ABSTRACT

Natural gas pipeline capacity sets physical limits on the quantity of gas that can be moved between regions, with attendant price effects. We find support for the hypothesis of integrated regional markets. Using data on daily pipeline flows and capacities in Florida and Southern California, we estimate reduced-form price effects of capacity constraints. We find that pipeline congestion increased realized citygate prices by at least 11% over the mean in Florida and by 6% over the mean in Southern California. We attribute the difference in price effects to more binding capacity constraints in the Florida pipeline network. Our estimates provide guidance for interstate pipeline investments.

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1. Introduction

An extensive network of pipelines provides essential infrastructure for the operation of the natural gas market in the United States. Sweeping regulatory reforms in recent decades have restructured the market for the transportation services provided by these pipelines. These reforms notwithstanding, pipeline capacity sets physical limits on the quantity of gas that can be moved from production fields to end users. The potential impacts of pipeline capacity constraints on natural gas markets have long been recognized (Lyon and Hackett, 1993; DeVany and Walls, 1996; Marmer et al., 2007; Brown and Yücel, 2008a). Market participants, industry analysts, and academic researchers have often asserted that breakdowns in market integration and periodically diverging prices result from binding pipeline capacity between particular hubs. In this paper, we use daily data on pipeline flows relative to capacity for markets in Florida and Southern California to obtain the first empirical estimates of

the impacts of pipeline constraints on wholesale prices in regional markets.

The U.S. network of natural gas pipelines is extensive and constantly expanding. Increasing supply of natural gas due to technological advances and the concomitant increase in the quantity of natural gas demanded, combined with the regulatory lags associated with the expansion of pipeline capacity, make understanding the impact of pipeline capacity constraints a pressing issue. Important reserve additions from unconventional sources have changed the natural gas map and have provided the impetus for substantial investment in new pipeline capacity. Some capacity increases are the result of retrofitting existing pipelines to increase flow, while other expansions involve building new pipelines to link new producing regions with consumers. Focusing on new and expanded interstate pipelines entering service in 2007–2012, 121 Bcfd (billion cubic feet per day) of capacity was added along 13,163 miles, at a nominal cost of investment of \$47.8 billion.¹ Those expansions increased the state-to-state capacity of natural gas pipelines by 15% and have accommodated consumption increases of 11%.

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¹ These estimates are derived from EIA natural gas pipeline projects available at <http://www.eia.gov/naturalgas/data.cfm>.

Not only do these investments cost billions of dollars, but they also entail substantial transaction costs. Makhholm (2012) explains how obsolescence associated with asset specificity affects the incentives to invest in new pipelines. Klein et al. (1978) describe how the potential for opportunistic behavior arising from appropriable quasi-rents affects transaction costs and the resulting contractual arrangements. These factors, combined with the fact that—given current market institutions—quasi-rents created by scarce pipeline capacity largely do not accrue to pipeline owners and investors, may reduce the incentives to invest in additional capacity.

The flexibility and complexity of the natural gas pipeline network largely determine whether regional natural gas markets interact to form a single smoothly functioning national market. We conduct a series of cointegration tests and fail to reject the hypothesis that wholesale natural gas markets in the United States generally function as a single well-integrated national market. Our period of analysis covers a more recent period than previous studies, and some of our results are qualitatively similar (Doane and Spulber, 1994; DeVany and Walls, 1993, 1996; Serletis and Rangel-Ruiz, 2004; Cuddington and Wang, 2006). Using daily prices from 14 regional markets over the period October 2006–August 2011, our results indicate that all market pairs are cointegrated, that the panel as a whole is cointegrated, and that possible regime shifts do not alter this result.

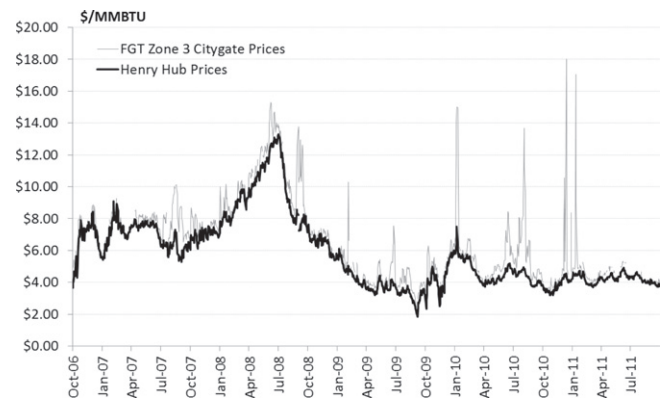
We then examine Florida and Southern California markets in more detail, using daily price and flow data to examine the price effects of limited capacity. Panels a and b in Fig. 1 display plots of regional wholesale market prices in Florida and Southern California, respectively, and the benchmark U.S. natural gas price at Henry Hub in Louisiana. From both of these plots, it is clear that the respective regional prices move together with the benchmark prices. It is also apparent—especially in Florida—that there are periods (typically brief) during which the regional price is substantially greater than the benchmark price.

In Florida, we find that the price is cointegrated with the Henry Hub price. We also estimate a reduced-form model of equilibrium Florida prices and find that, on average, pipeline congestion increased Florida wholesale prices by \$0.79/MMBtu over the sample period, which represents an increase of 11% relative to the mean price.²

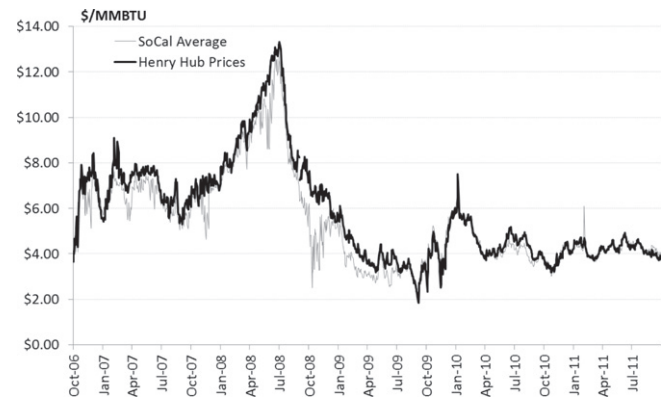
In Southern California, contrary to earlier studies, we find that prices are cointegrated with prices in other regional markets, suggesting that this region is currently integrated with the larger national market. Our estimate of the effect of binding pipeline constraints on Southern California prices is smaller than in Florida. At about \$0.32/MMBtu, the price increase is about 6% above the mean. The fact that there is only one full capacity day during the time span of our data, combined with other information presented below, suggests that capacity constraints in the Southern California market are less binding than those in Florida.

2. Background

Natural gas markets and pipelines in the United States have a long and important history, much of which is pertinent to understanding the current state of affairs.³ Briefly, prior to the 1980s,



(a) Henry Hub and Florida Daily Gas Prices



(b) Henry Hub and Southern California Daily Gas Prices

Fig. 1. Hub and regional market prices.

natural gas markets in the United States were regulated “from well-head to burnertip.” Starting in the late 1970s and culminating in 1992 with FERC Order 636, natural gas markets underwent sweeping changes, most of which were focused on deregulating segments of the market. Today, wholesale natural gas markets are characterized by many producers and marketers competing to provide gas to a multitude of consumers. Spot and futures markets are available at dozens of locations and over a broad range of time horizons, providing price discovery and allowing for indexed contracts. Although interstate pipelines are still subject to regulation, ready access to transportation services and the ability of shippers to buy and sell their contracted primary transportation services on short notice in a secondary market allows the movement of gas between regions with substantial flexibility (Dahl and Matson, 1998; Leitinger and Collette, 2002).

There are two strands of literature that are related to our empirical analysis. The first uses cointegration tests on prices to examine whether the reforms of natural gas markets that started in the 1970s have effectively resulted in the integration of regional markets into a single national market. Early studies in this area find that most markets became integrated fairly quickly during the post-deregulation periods they examined. Later studies by, for example, Marmer et al. (2007), Murry and Zhu (2008), and Brown and Yücel (2008a) find that the links between regional natural gas markets appear to have weakened over time. A common thread in these studies is that the markets that are not fully integrated are typically in California, the Rocky Mountains, and the Midwest. The explanation offered for this finding is typically that segmentation of natural gas markets is due to

² A price spike (or congestion rent) of \$0.79 is the most directly comparable estimate to our Southern California estimate. This estimate is also the most conservative estimate we obtain for Florida. Our other estimates of the magnitude of the congestion rents in Florida—obtained using more restrictive definitions of the threshold levels at which pipeline capacity becomes binding—are much larger, ranging as high as \$4.54/Mcf.

³ McGrew (2009) provides a comprehensive review of the legal and regulatory environment in which natural gas pipelines have evolved. Makhholm (2012) provides an institutional perspective on the history of pipelines. In Appendix A, we describe the regulatory and contractual landscape pertinent to our study.

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