The Electricity Journal 32 (2019) 106630

Contents lists available at ScienceDirect

The Electricity Journal

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

Distributional impacts of the North Dakota gas flaring policy

Utkarsh Srivastava[a,*], David Oonk[b], Ian Lange[a,b], Morgan Bazilian[a,b]

[a] College of Earth Resource Sciences and Engineering (CERSE), Colorado School of Mines, United States
[b] Center for Science and Technology Policy (CSTPR), University of Colorado Boulder, United States

ARTICLE INFO

Keywords:
North Dakota
Gas flaring
Economic policy
Flaring regulation
Bakken

ABSTRACT

This paper considers whether the reform of North Dakota's natural gas flaring policy provided large operators a competitive advantage, leading to increased market concentration. North Dakota was the highest gas flaring and venting state in USA until it was taken over by Texas in 2015 coinciding with the implementation of its gas flaring policy in 2014. Two analyses are performed in North Dakota (and Wyoming, as a control) to compare the effect that the flaring policy had on the state's oil sector. The analyses show mixed evidence, larger firms gained an advantage leading to fewer smaller firms operating in the state. The paper concludes with highlighting possible further areas for research, and methodologies for acquiring more reliable data.

1. Introduction

The production of crude oil is accompanied with associated gases such as methane, H_2S, CO_2 and other greenhouse gases as they are co-located with the oil (Fawole et al., 2016) (Centre for Effective Government, 2013). The handling of such gases and emissions is generally regulated to assure environmentally safe operations. The increased use of fracking technology in the US has led to a boom in oil and gas production which led states and the federal government to consider regulations around natural gas flaring.

Natural gas (at roughly 35% of the portfolio) has surpassed coal to become the largest source of power generation in the United States (Energy Information Administration, 2019). Over a similar timeframe gas prices have sunk and maintained (with normal caveats) a price at or below $3/MMBtu for the last five years. As a result of these prices, infrastructure constraints, regulations, and company financial drivers, a large amount of associated gas is being flared in the tight oil formations in the Permian and Bakken. The US in 2018 was the world's fourth largest flaring country in the world, and the one with the largest rise over previous years (World Bank, 2019). This represents a vital resource for the electricity sector being squandered. In this paper, we consider some of the regulatory impacts on decisions to flare.

Oil and gas extraction (upstream) firms flare the produced gas from the oil wells because the handling and transportation cost of produced gas is larger than the value of the gas for wells far from gas pipelines. In basins like the Bakken (North Dakota) – unlike other basins – natural gas capture and transportation (midstream) infrastructure investments and construction have not equaled the growth of extraction. Even though transportation infrastructure has lagged, the majority of flaring occurs at wells already connected to storage infrastructure (North Dakota Industrial Commission, 2014). In essence, it is cheaper to flare the produced gas from crude oil wells than it is to store it and wait for transport (Swanson, 2014). In addition to the resource waste, the regularity and scale of flaring in the Bakken has drawn attention for its air quality and environmental impacts; for example, 'incomplete flaring', where not all the gas is burned emits methane, black carbon and ethane emissions (Gvakharia et al., 2017).

Due to the regular practice and resulting concerns, flaring has drawn the attention of regulators and industry groups. The North Dakota Industrial Commission (NDIC), the regulatory commission tasked with overseeing oil and gas extraction in the state introduced a gas flaring regulation policy (Commission Order 24665) in 2014 in the state of North Dakota (ND) to remedy the concern over gas flaring (North Dakota Industrial Commission, 2014). It aimed at reducing the flared volume of gas, number of wells flaring and duration of flaring from wells. The Order required upstream firms operating in ND to meet an aggregate gas capture requirement across all of its wells. Note that compliance is at the firm level and not the well level. While the policy intended to reduce natural gas flaring and associated impacts across the basin, it may have had an unequitable impact on smaller upstream firms (rather than larger upstream firms) because smaller firms would not have as many operating wells to spread the required reduction in flaring across the portfolio.

This paper will briefly consider how the introduction of the policy to reduce gas flaring has affected smaller upstream firms—those with fewer wells—when compared to larger upstream firms. Firms comply

* Corresponding author.
E-mail address: srivastava6002@gmail.com (U. Srivastava).

https://doi.org/10.1016/j.tej.2019.106630

with this regulation by undertaking the investment to hook the well up to gas gathering lines so that it can be processed (remove impurities, etc.) and sold. Smaller operators have fewer opportunities to come into compliance than larger operators due to the fact that they may have fewer options on which well is connected to gas gathering lines and thus may have to spend more to meet this regulation. Faced with the requirement to pay for gas gathering infrastructure, a smaller firm may decide to sell the well to another firm than continue operating the well. In essence, it is likely that smaller firms have higher compliance costs for this regulation.

To ensure the impacts estimated are not a result of over the time changes in the oil and gas industry (such as new technology or prices of oil), a difference-in-difference-like comparison was done with oil and gas operations in Wyoming (WY), which did not recently introduce a gas flaring restriction policy. In analyzing this policy between ND and WY, a Herfindahl-Hirschman index (HHI) calculation was performed for observing market concentration, and a probabilistic calculation for smaller vs bigger firm comparison. The last part inspects methodologies for better acquisition of flaring data using satellite-based technologies such as infrared imaging.

2. Background

The World Bank placed the United States as the 4th highest gas flaring nation in 2015, (World Bank, 2016) with an estimate of 424 Billion standard cubic feet (Bscf) of gas being flared annually - of which North Dakota contributes 156 Bscf (Energy Information Administration, 2018). The Global Gas Flaring Reduction Partnership (GGFR), which consists of oil companies, governments and international institutions working together to address the issue of gas flaring worldwide, plays an important role in determining the policies for curbing gas flaring. The NDIC introduced a regulation (Order 24665) (Lade and Rudik, 2017) in 2014, with the objective to reduce the volume of gas flared in the state (North Dakota Industrial Commission, 2014).

The natural gas flaring regulation in ND requires every firm working in the state to capture a certain percentage of the gas produced by their operations. Overtime capture requirements increase: 77% between January 2015 and March 2016; 80% between April 2016 and October 2016; 85% between November 2016 and October 2018; 88% between November 2018 and October 2020; and finally, 91% after November 2020. In addition the order imposes flaring restrictions and requires upstream firms to create Gas Capture Plans prior drilling, track and report their status, draft Improvement Plans if goals are not being met. Moreover, the order seeks to improve midstream firm planning decisions by mandating semi-annual midstream meetings and requiring upstream firms to provide production forecasts to midstream firms. (North Dakota Industrial Commission, 2014).

The hypothesis is that smaller firms, with fewer wells, will have more difficultly complying with this policy change due to the fewer wells available to hook up to the gas infrastructure, thus making the regulation more expensive for them. According to the policy, the percentage of gas to be captured is a percentage of the total gas produced by the firm rather than gas produced by individual wells. This gives an advantage to the bigger firms having larger number of wells as they can distribute the flaring amongst their high gas producing/expensive to hook up to the gas infrastructure wells. If smaller firms find that complying with the regulation is too expensive, they will sell their wells and exit the industry in ND.

By analyzing the well data from DrillingInfo[1], for both ND and WY before and after ND initiated the gas flaring policy, the effect of the policy can be observed, and conclusions can be made whether the policy has been biased towards the bigger operators resulting in market concentration in ND.

3. Methodology

To analyze if the small operators were being pushed out of the market due to the introduction of gas flaring policy in ND, two types of analysis were performed:

3.1. Herfindahl-Hirschman index calculation

The first analysis is to calculate a Herfindahl-Hirschman index (HHI). HHI is a measure of market concentration which is calculated by squaring the market share of each firm competing in a market and then summing the resulting numbers. It can range from close to zero to 10,000. The U.S. Department of Justice uses the HHI for evaluating potential merger issues (Department of Justice, 2018).

HHI calculation was done to calculate the market concentration before and after the introduction of the policy in ND. The data was obtained from Drillinginfo for both the states for 3 years before (2012–2014) and 3 years after (2015–2017) the gas flaring policy implementation.

3.2. Probability of firms exiting the market if they own less than 6 wells

The second analysis is to calculate the probability firms with less than 6 wells go out of business in both states after the regulation was introduced in ND. The probability for both states, ND and WY, was calculated by finding out the total number of wells per operator before and after the regulation was introduced in ND in 2015. This provides a difference-in-difference setup which will ensure that both temporal and spatial general trends are controlled for (Angrist and Pischke, 2009). To compare between small and large operators' probability for operators with less than 6 wells and more than 5 wells was calculated in both the states to make sure no other market condition was causing the operators to go out of the market.

4. Results

From the HHI index calculation, it was seen that market concentration in ND was increasing by 1% after the regulation while in WY it increased by 3%. This would imply that smaller firms had enough wells with relatively low compliance cost available to them so that they were not impacted by the form of the regulation. While the HHI is a useful metric for determining market share, it might not capture whether smaller firms are being disproportionately impacted by the flaring regulation. To get a better understanding of this specific issue, the next analysis was performed.

From the probability calculation, it was observed that operators with less than 6 wells were wells were 10% more likely to stop drilling wells in the state in ND relative to WY after the flaring regulations went into effect in ND. As one might expect, firms with less than 6 wells were 82% more likely to stop drilling wells in the state in ND compared to operators having more than 5 wells after the flaring policy went into effect. Similar calculation in WY showed that the small firms were 47% more likely to go out of business than larger firms. The increase in probability by almost twice may be an indicator that the policy introduced is causing the smaller operators to go out of business. The probability of bigger operators leaving the industry in the state was 5% in ND compared to 29% in WY. This shows that the policy and the other market conditions in ND are favoring the bigger operators.

From these two analyses, there is evidence that the gas flaring policy introduced in ND, although to reduce environmental pollution in the state, could have been disadvantageous to the smaller firms and favored the bigger firms with more wells. The policy could also be responsible towards concentration of wells to specific locations in the basin, based on availability of crude and gas pipelines, rather than optimum

[1] DrillingInfo 2018, accessed 18 September 2018, < https://app.drillinginfo.com/production/#/default > .

reservoir and geologic conditions. The effect on market concentration was not large but the probability of firms going out of business showed a large difference due to the introduction of the gas flaring policy in ND.

5. Further work

This paper highlighted some of the drawbacks of gas flaring policy in ND and shows some evidence of the policy being favorable to the bigger operators. A study performed by Gabriel E. Lade and Ivan Rudik in their paper *Costs of Inefficient Regulation: Evidence from Bakken* shows that policies to reduce flaring can have greater efficacy at lower cost to the operators if taxes are imposed instead of imposing cap on percentage of gas allowed to be flared (Lade and Rudik, 2017). This is due to the ability of operators whose wells are low cost to hook up to the gas infrastructure to capture more of their gas allowing operators with higher costs wells to hook up to the gas infrastructure to forgo gas capturing.

The state of ND has seen reduction in flaring of gas from 36% to around 11.2% which is a huge reduction from the previous years but still above the national average of 4.2% (Western Organization of Resource Council, 2017) (NDIC Director's cut report, 2015). Other model policies in states such as Texas and Colorado which issue permits for flaring of gas for limited number of days which help the state agencies keep a check on the amount of gas that will be getting flared (Railroad Commission of Texas, 2014) could be implemented by ND for future reductions. One alternative policy, suggested by Ron Ness of North Dakota Petroleum Council, would give tax cuts and exemptions to operators that find a way to capture produced gas alternatively (Western Organization of Resource Council, 2014). Potential technological innovations like reinjection of natural gas for later extraction (Hoffman et al., 2014) could become viable and encouraged through tax incentive polices. While progress has been made ND still has future flaring reduction potential either through additional regulation or tax incentives.

Another issue with reducing natural gas flaring and its associated impacts is with tracking and compliance, which may require novel and effective tools for assessing volume of gas flared. Better data acquisition of the volume of gas being flared can help in showcase the efficacy of policies since there can be manipulation in the reported volume of gas flared by operators due to policies in the region. One method already tested with a ∓ 9.5% accuracy is the Visible Infrared Imaging Radiometer Suite (VIIRS) (Elvidge et al., 2015). Such technologies can help assess the actual volume of gas being flared and the specific regions which need to be monitored for such activities as the data received from operators are not very reliable.

Such satellite-based data can help in identification of countries who have been able to reduce their gas flaring volume significantly. This would be instrumental in categorizing countries complying with UN policies aimed towards reduction of global gas flaring and prevention of greenhouse gas emissions (Elvidge et al., 2018) as well as reduce the CO_2 emission thus helping in reducing carbon footprint (Sedlar et al., 2019)

References

Angrist, Joshua D., Pischke, Jorn-Steffen, 2009. Mostly Harmless Econometrics: An Empiricists Companion. Princeton University Press, Princeton, New Jersey.

Centre for Effective Government, 2013. Oil and Gas Production a Major Source of Greenhouse Gas Emissions. Accessed January 21 2019. EPA Data Reveals. https://www.foreffectivegov.org/oil-and-gas-production-major-source-of-greenhouse-gas-emissions-epa-data-reveals.

Elvidge, Christopher D., Bazilian, Morgan D., Zhizhin, Mikhail, Ghosh, Tilottama, Baugh, Kimberly, Hsu, Feng-Chi, 2018. The potential role of natural gas flaring in meeting greenhouse gas mitigation targets. Energy Strat. Rev. 20, 156–162 ISSN 2211-467X.

Sedlar, Daria Karasalihović, Vulin, Domagoj, Jukić, Lucija, Smajla, Ivan, 2019. Possibility of decreasing CO2 emissions from flaring on a mature oil field. J. Petrol. Sci. Eng. 171, 1302–1308.

Department of Justice, 2018. HERFINDAHL-HIRSCHMAN INDEX. viewed 23 January 2019. https://www.justice.gov/atr/herfindahl-hirschman-index.

Elvidge, Christopher, Zhizhin, Mikhail, Baugh, Kimberly, Hsu, Feng-Chi, Tilottama, Ghosh, 2015. Methods for global survey of natural gas flaring from visible infrared imaging radiometer suite data. Energies 14 (9). https://doi.org/10.3390/en9010014.

Energy Information Administration, 2019. Natural Gas Generators Make up the Largest Share of Overall U.S. Generation Capacity. https://www.eia.gov/todayinenergy/detail.php?id=34172.

Energy Information Administration, 2018. Natural Gas Gross Withdrawals and Production. https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGV_mmcf_a.htm.

Gvakharia, A., Kort, E.A., Brandt, A., Peischl, J., Ryerson, T.B., Schwarz, J.P., Sweeney, C., 2017. Methane, black carbon, and ethane emissions from natural gas flares in the Bakken Shale, North Dakota. Environ. Sci. Technol. 51 (9), 5317–5325.

Hoffman, T., Sonnenberg, S., Hossein, K., 2014. The benefits of reinjecting instead of flaring produced gas in unconventional oil reservoirs. Unconventional Resources Technology Conference 1640–1647 Society of Exploration Geophysicists, American Association of Petroleum Geologists, Society of Petroleum Engineers.

Lade, Gabriel, Rudik, Ivan, 2017. Costs of inefficient regulation: evidence from the Bakken. NBER Working Paper No. w24139.

North Dakota Industrial Commission 2014, NDIC Department of Mineral Resources, accessed February 16, 2019,https://www.dmr.nd.gov/oilgas/directorscut/directorscut-2016-12-13.pdf.

Fawole, Olusegun G., Cai, X.-M., MacKenzie, A.R., 2016. Gas flaring and resultant air pollution: a review focusing on black carbon. Environ. Pollut. 216, 182–197.

Railroad Commission of Texas, 2014. Statewide Rule 32: Flaring/Venting of Produced Gas. Accessed February 16, 2019. https://www.rrc.state.tx.us/media/29135/statewide-rule-32-venting-and-flaring.pdf.

Swanson, A., 2014. America's Oil Boom is Visible from Space. The Washington Post October 20, 2014.

Western Organization of Resource Council 2014, The Flaring Boom, accessed February 16, 2019, http://www.worc.org/media/Flaring_Boom.pdf.

Western Organization of Resource Council, 2017. Flaring and Venting: Waste of a Nonrenewable Resource. Accessed February 16, 2019. http://www.worc.org/media/Flaring-and-Venting-July-2017.pdf.