PROPOSAL

Rate of Return Regulation, Infrastructure, and Environmental Externalities: Evidence from Natural Gas

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Abstract

We study inefficiencies, both private and social, arising from the rate of return regulations faced by natural gas local distribution companies. Preliminary evidence suggests that investment timing and amounts are influenced by the timing of rate case proceedings. Recently adopted cost recovery policies in some states have mitigated this effect. These results are important for understanding how companies operate under rate of return regulations. They are additionally important because investment and maintenance decisions impact two externalities: leaks of methane, a potent greenhouse gas, and pipeline explosions leading to injuries, loss of life, and property damage. In this proposal, we outline preliminary results and next steps.

Key Words: price regulation, natural gas, infrastructure, utilities, pipelines, methane leaks, pass-through

JEL: L95, L32, Q41, R53, D22, D42, H40

For almost a century, natural monopolies in the United States have faced rate of return regulation, a form of average cost pricing. While strong theoretical and practical reasons can justify this government intervention, inefficiencies frequently arise. Firms face fewer incentives to keep costs low, affecting their operations (Fabrizio et al., 2007), level of production (Davis and Wolfram, 2012), investment decisions (Fowlie, 2010), environmental compliance (Abito, 2014), and retail pricing structure (Davis and Muehlegger, 2010). Mechanisms considered in the literature have included managerial incentives as well as the Averch-Johnson effect. Recently, researchers have turned their focus to the political environment in which

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rate of return regulated companies are situated (Lim and Yurukoglu, 2015), harkening back to an earlier literature (Joskow, 1972, 1973).

In the proposed paper, we will examine the operations and maintenance activities as well as the investment activities of natural gas local distribution companies (LDCs). Over 1,300 LDCs provide natural gas services throughout the U.S. to residential, commercial, industrial, and electric power customers. They generally take one of two forms: (1) investor-owned utilities, facing state-level price regulations; (2) publicly-owned utilities, with rates set by municipal governments. The literature on LDCs has focused on their retail pricing decisions (Davis and Muehlegger, 2010; Borenstein and Davis, 2012), and there is little evidence on their operational decisions. This is worth investigating because of the potential for private cost inefficiencies of the sort the academic literature has found in the electricity industry.

We argue that an important additional reason to study operational decisions of LDCs is that they are the source of two externalities. First, leaking pipeline systems contribute to the emissions of methane, a potent greenhouse gas. Second, leaks from poorly maintained pipelines run the risk of combusting, a serious public safety issue. The San Bruno accident in California killed eight people, highlighting the dangers of aging pipelines – while that accident involved a large-diameter transmission line, approximately 10 fatalities per year occur from distribution pipeline accidents. We document that around 200 bcf of natural gas are leaked each year from LDCs. The private cost in 2013 of these leaks was 780 million dollars, but we estimate external costs of over 5.7 billion dollars – while the Henry Hub price in 2013 averaged around $3.8 per mcf, the externalities associated with global warming are around $28/mcf (Hausman and Kellogg, Forthcoming). Whereas some industry analysts have focused attention on private incentives to lower gas leak rates, clearly these are substantially below what a social planner would be willing to spend. Moreover, our preliminary results suggest that abatement costs are greater than the private benefits of abatement but below the full social benefit.

In this proposal, we outline exploratory results as well as planned next steps. Participating in this NBER workshop would certainly help us improve our analysis, and we would look forward to receiving suggestions from committee members and other participants.

1 Data

We collect data from the Energy Information Administration (EIA), the Department of Transportation, and SNL (a private provider of energy data) on LDC operations, including prices, sales quantities, pipeline materials, pipeline age, rate case dates, and expenditures on operations and maintenance and new capital. For space considerations, we do not describe them in depth here.

Our first contribution is a detailed understanding of leak rates data. For years, the EIA has collected data on natural gas leaked from both the transmission and distribution network. Industry reports have criticized the use of these data, claiming that any information on leaks is overwhelmed by accounting errors. We investigate the validity of this claim, finding that while the data are quite noisy, EIA's measure of leaks moves in expected ways with infrastructure quality. Specifically, the EIA-176 form has asked since 2002 for LDCs to report the volume in thousand cubic feet (mcf) of "Losses from leaks, damage, accidents, migration

and/or blow down within the report state." If a company had no known losses or leaks, it reported estimates based on engineering studies.[1] At the same time, a separate measure also captures leaks: the EIA tracks the difference between gas supply and disposition. Both supply and disposition are metered, so in principle any difference between them reflects gas that escaped the system. In the industry, this is known as "lost and unaccounted for gas," or "LAUF."[2]

However, both measures are imperfect. Until 2010, many companies failed to report losses from leaks, so the only available information was on LAUF. Moreover, for any individual company, researchers cannot observe whether the losses from leaks are from known leaks or from engineering estimates. Moreover, the LAUF measure is extremely noisy. First, for volume measurements to be consistent, a gas must be at a standard temperature and pressure. Respondents to the EIA-176 survey are instructed to correct all volumes to a standard temperature of 60 degrees and a standard pressure of 14.73 psia, but there may be errors in this calculation. Additionally, there are frequently timing differences between the periods over which supply is tracked and the periods over which disposition is tracked (depending on contractual arrangements such as billing cycles). There are also errors from meter inaccuracies and accounting mistakes. Finally, theft rather than leaks could account for lost gas, although this is presumably small.

Indeed, observed LAUF volumes must be imperfect, since 32% of them fall below zero. However, we posit that if reported leaks and LAUF respond in systematic ways to measures of infrastructure quality, then they are not purely noise. First, we aggregate the two measures to capture leaks that are both known and unknown.[3] We find that the percentage of gas leaked (and unaccounted for) varies with observed pipeline quality, as measured by both age and material. Industry reports have highlighted that some forms of steel pipeline (bare and unprotected, as opposed to coated and/or cathodically protected) as well as cast iron pipeline are very susceptible to cracking. Particular forms of plastic pipeline as well as coated and cathodically protected steel are more robust. Not surprisingly, older pipelines have also been a source of concern for pipelines. Almost five percent of distribution mains in the U.S. date back to 1939 or before.

When comparing across LDCs we find leaks increase significantly in pipeline age. Each additional year increases leaks by 0.019 percentage points, with a standard error of 0.006. To put this in perspective, the average pipeline age (weighted) is 27 years and the average leak rate is 1.8 percent, so the elasticity is 0.28. Moreover, leaks are decreasing in the portion of pipeline that is composed of either high-quality steel (coated and/or cathodically protected) or plastic. For each percentage point of high quality material, leaks decline by 0.03 percentage points. Alternatively, if an LDC were to change entirely from low-quality to high-quality material, leaks would decline by 3.3 percentage points, or almost twice the mean value. These results are robust across various specifications. Much of the identifying variation is cross-sectional, since pipeline upgrades are slow. As such, including LDC effects leads to very imprecise estimates; however the point estimates are qualitatively similar.

[1] Personal communication, EIA staff.

[2] Also, "LUAF," or "LAUG."

[3] For a small number of observations, 2% of the total, LAUF is exactly equal to the negative of known leaks, so that the aggregate is zero. For these observations, we use simply the leak variable, as a precise offsetting of the two is implausible.

Overall, we find that while the reported LAUF measure is noisy, it is highly correlated with measures of pipeline quality.[4]

2 Investment Timing

Next, we show that investment timing is related to rate case timing for investor-owned utilities. Either regulators or firms can call for a new rate case, although it is much more common for a firm to request a case. Preliminary results suggest that rate case years are associated with increased pipeline quality, decreased leak rates, increased O&M expenditures, and increased capital expenditures. While the pipeline quality and leak results are noisy, the spending results are statistically significant. There are two possible explanations. First, firms could call for a rate case when they expect their expenses to be exogenously high. Second, firms could pad expenses during rate cases to increase rates. To get at this distinction, we include dummies for both the period of an entire rate case as well as the period of the test year.[5] If only the first mechanism is at play, expenses should be associated with rate case years in general. If the second mechanism is at play, test years will matter more. Preliminary results suggest that the expectation mechanism is important.

Some industry reports have noted that LDCs may find it difficult to upgrade pipelines in a timely manner if they must wait for rate cases to be completed. This issue has come to the forefront in recent years, with the Department of Transportation mandating higher levels of pipeline quality than in the past. As a result, several states have implemented alternative mechanisms to recover expenses without calling a rate case, such as "pipeline replacement riders," which are temporary charges to customer bills. We are exploring whether these mechanisms are associated with pipeline age, leak rates, and spending. A possible instrument for the mechanism is whether a nearby state has adopted a similar mechanism.

3 Abatement Cost Estimation

Finally, we estimate the marginal cost of LAUF abatement and the marginal cost of new pipeline. We use several strategies. First, we look simply at the within-LDC correlation betweeen spending and leaks, as well as the within-LDC correlation between spending and pipeline age. Second, our previous results on rate case years as well as cost recovery mechanisms provides possible instrumental variables. For these to be valid IVs, they must not affect leak rates or pipeline age except through dollars spent on infrastructure. We find this exclusion restriction plausible.

With these estimates, we can compare the costs of pipeline upgrades to private and external benefits. Comparison to the private benefits will indicate whether there are inefficiencies in the current price-regulation regime. Comparison to the external benefits will indicate whether additional environmental policy is needed.

[4]One valid concern with reported measures of leaks is that the engineering estimates which some LDCs report could be a function of pipeline age or material quality. We are less concerned, however, when examining the sum total of leaks and unaccounted for gas – the latter relies on the difference between metered supply and metered gas, neither of which are engineering estimates.

[5]New rates are based off expenses incurred during the test year.

4 Conclusion

The economics literature on natural gas distribution operations is extremely limited. Our results so far give a clearer understanding of the issues with the available data, which we hope will aid other researchers in this area. More importantly, once we have completed results on investment timing and the marginal cost of abatement, we hope to shed light on financial incentives and barriers to leak repair. Our work will contribute to the economics literature on rate of return regulations as well as to current policy discussions about methane leaks, aging infrastructure, and pipeline safety.

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RE: DISCLOSURE STATEMENT

Organizers
Call for Proposals: The Future of Energy Distribution
National Bureau of Economic Research
1050 Massachusetts Avenue
Cambridge, MA 02138-5398

Dear Organizers:

This is a disclosure statement for the proposal, "Rate of Return Regulation, Infrastructure, and Environmental Externalities: Evidence from Natural Gas" (joint with Lucija Muehlenbachs) that we are submitting to the call for papers "The Future of Energy Distribution."

I have not received any financial compensation for this project nor do I have any financial relationships or other interests that relate to this research.

Sincerely,



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