Rate of Return Regulation Revisited

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Abstract

Utility companies recover their capital costs through regulator-approved rates of return on debt and equity. The US costs of risky and risk-free capital have fallen dramatically in the past 40 years, but these utility rates of return have not. We estimate the gap between what utilities are paid now, and what they would have been paid if their rate of return had followed capital markets, using a comprehensive database of utility rate cases dating back to the 1980s. We estimate that the current average return on equity is 0.5–4 percentage points higher than historical relationships would suggest, and consumers pay an average of \$2–8 billion per year more than they would otherwise. We then revisit the effect posited by Averch and Johnson (1962), estimating the consequences of this incentive to own more capital: a 1 percentage point increase in the return on equity increases new capital investment by about 5% in our preferred estimate.

JEL Codes: Q4, L5, L9
Keywords: Utility, Rate of Return, Regulation, Electricity, Natural Gas, Capital Investment

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1 Introduction

In the two decades from 1997 to 2017, real annual capital spending on electricity distribution infrastructure by major utilities in the United States has doubled (EIA 2018a). Over the same time period annual capital spending on electricity transmission infrastructure increased by a factor of seven (EIA 2018b). The combined total is now more than $50 billion per year. This trend is expected to continue. Bloomberg New Energy Finance predicts that between 2020 and 2050, North and Central American investments in electricity transmission and distribution will likely amount to $1.6 trillion, with a further $1.7 trillion for electricity generation and storage (Henbest et al. 2020).[1]

These large capital investments could be due to the prudent actions of utility companies modernizing an aging grid. However, it is noteworthy that over this time period, utilities have earned sizeable regulated rates of return on their capital assets, particularly when set against the unprecedented low interest rate environment post-2008. As the economy-wide cost of capital has fallen, utilities' regulated rates of return have not fallen nearly as much. The exact drivers for this divergence are unclear, though we rule out large changes in riskiness in section 3. Whatever the underlying cause, the prospect of utilities earning excess regulated returns raises an age-old concern in the sector: the Averch–Johnson effect. When utilities are allowed to earn excess returns on capital, they will be incentivized to over-invest in capital assets. The resulting costs from "gold plating" are then passed on to consumers in the form of higher bills. Capital markets and the utility industry have undergone significant changes over the past 50 years since the early studies of utility capital ownership (Joskow 1972, 1974). In this paper we use new data to revisit these issues. We do so by exploring two main research questions. First, what can we say about the return on equity utilities are allowed by their regulators? Second, how has this return on equity affected utilities' capital investment decisions?

To answer our research questions, we use data on the utility rate cases of all major electricity and natural gas utilities in the United States spanning the past four decades (Regulatory Research Associates 2021). We combine this with a range of financial information on credit ratings, corporate borrowing and market returns. To examine possible sources of over-investment in more detail we also incorporate data from annual regulatory filings on individual utility capital spending.

We start our analysis by estimating the size of the gap between the allowed rate of return that utilities earn and the correct return on equity. A central challenge here, both for the regulator and for the econometrician, is estimating the correct cost of equity. We proceed by considering a range of approaches to simulating the correct cost of equity based on the observed rates of return and available measures of capital market returns. For the most part, our simulations ask "if approved RoE rates hadn't changed relative to some benchmark index since some baseline year, what would they be today?" We examine a number of benchmark indexes. None of these are

1. North and Central American generation/storage are reported directly. Grid investments are only reported globally, so we assume the ratio of North and Central America to global is the same for generation/storage as for grid investments.

perfect comparisons; the world changes over time, and different benchmarks may be more or less appropriate. Taken together, our various estimation approaches result in a consistent trend of excess rates of return. We find that the weighted median of the approved return on equity is 0.5–4 percentage points too high.[2] Applying these additional returns to the existing capital base we estimate excess costs to US customers of $2–8 billion per year. The majority of these excess costs are from the electricity sector, though natural gas contributes as well.[3]

However, excess regulated returns on equity will also distort the incentives to invest in capital. To consider the change in the capital base, we turn to a regression analysis. Here we aim to identify how a larger RoE gap translates into over investment in capital. Identification is challenging in this setting, so we again employ several different approaches, with different identifying assumptions. In addition to a fixed effects approach, we examine an instrumental variables strategy. We draw on the intuition that when a rate case is decided a utility's RoE is *fixed* at a particular nominal percentage for several years. The cost of capital in the rest of the economy, and therefore the true RoE, will shift over time. We use these shifts in the timing and duration of rate cases as an instrument for changes in the RoE gap. We argue that the instrument is valid, after controlling for an appropriate set of fixed effects. Across the range of specifications used, we find a broadly consistent picture. In our preferred specification we find that an additional percentage point increase in the RoE gap leads to the allowed increase in capital rate base to be about 5 percent higher.

2 Background

Electricity and natural gas utility companies are regulated by government utility commissions, which allow the companies a geographic monopoly and, in exchange, regulate the rates the companies charge. These utility commissions are state-level regulators in the US. They set consumer rates and other policies to allow investor-owned utilities (IOUs) a designated rate of return on their capital investments, as well as recovery of non-capital costs. This rate of return on capital is almost always set as a nominal percentage of the installed capital base. For instance, with an installed capital base worth $10 billion and a rate of return of 8%, the utility is allowed to collect $800 million per year from customers for debt service and to provide a return on equity to shareholders. State utility commissions typically update these nominal rates every 3–6 years.

Utilities own physical capital (power plants, gas pipelines, repair trucks, office buildings, etc.). The capital depreciates over time, and the set of all capital the utility

2. Here we weight by the utilities' ratebase, so our results are not over-represented by very small utilities.

3. For comparison, total 2019 electricity sales by investor owned utilities were $204 billion, on 1.89 PWh of electricity (US Energy Information Administration 2020a). Natural gas sales to consumers are $146 billion on 28.3 trillion cubic feet of gas (These gas figures include sales to residential, commercial, industrial, and electric power, but not vehicle fuel. They include including all sales, not just those by investor owned utilities. US Energy Information Administration 2020b.)

owns is called the ratebase (the base of capital that rates are calculated on). Properly accounting for depreciation is far from straightforward, but we will not focus on that challenge in this paper. This capital ratebase has an opportunity cost of ownership: instead of buying capital, that money could have been invested elsewhere. IOUs fund their operations through issuing debt and equity, typically about 50%/50%. (For this paper, we focus on common stocks. Utilities issue preferred stocks as well, but those form a very small fraction of utility financing.) The weighted average cost of capital is the weighted average of the cost of debt and the cost of equity.

Utilities are allowed to set rates to recover all of their costs, including this cost of capital. For some expenses, like fuel purchases, it's easy to calculate the companies' costs. For others, like capital, the state public utilities commissions are left trying to approximate the capital allocation at a cost competitive capital markets would provide, if the utility was a competitive company, rather than a regulated monopoly. The types of capital utilities own, and their opportunities to add capital to their books, vary across states and time. Utilities in vertically integrated states might own a large majority of their own generation, the transmission lines, and the distribution infrastructure. Other utilities are "wires only," buying power from independent power producers and transporting it over their lines. Natural gas utilities are typically pipeline only – the utility doesn't own the gas well or processing plant.

In the 1960s and 70s, state public utilities commissions (PUCs) began adopting automatic fuel price adjustment clauses. Rather than opening a new rate case, utilities used an established formula to change their customer rates when fuel prices changed. The same automatic adjustment has not happened for capital costs, despite large swings in the nominal cost of capital over the past 50 years. We're aware of one state (Vermont) that has an automatic update rule; we'll discuss that rule in more detail in section 4.1, where we consider various approaches of estimating the RoE gap.[4]

The cost of debt financing is by no means simple, particularly for a forward-looking decision-maker who isn't allowed to index to benchmark values, but is easier to estimate than the cost of equity financing. The cost of debt is the cost of servicing historical debt, and expected costs of new debt that will be issued before the next rate case. The historical cost is known, and can serve a direct basis for future expectations. In our data, we see both the utilities' requested and approved return on debt. It's notable that the requested and approved amounts are very close for debt, and much farther apart for equity.

The cost of equity financing is more challenging. Theoretically, it's the return shareholders require on their investment in order to invest in the first place. The Pennsylvania Public Utility Commission's ratemaking guide notes this difficulty (Cawley and Kennard 2018):

4. At least one other state, California, had an automatic adjustment mechanism that has since been abandoned. Regulators at the California PUC feel that the rule, called the cost of capital mechanism (CCM), performed poorly. "The backward looking characteristic of CCM might have contributed to failure of ROEs in California to adjust to changes in financial environment after the financial crisis. The stickiness of ROE in California during this period, in the face of declining trend in nationwide average, calls for reassessment of CCM." (Ghadessi and Zafar 2017)

> Regulators have always struggled with the best and most accurate method to use in applying the [*Federal Power Commission v. Hope Natural Gas Company* (1944)] criteria. There are two main conceptual approaches to determine a proper rate of return on common equity: "cost" and "the return necessary to attract capital." It must be stressed, however, that no single one can be considered the only correct method and that a proper return on equity can only be determined by the exercise of regulatory judgment that takes all evidence into consideration.

Unlike debt, where a large fraction of the cost is observable and tied to past issuance, the cost of equity is the ongoing, forward-looking cost of holding shareholders' money. Put differently, the RoE is applied to the entire ratebase – unlike debt, there's typically no notion of paying a specific RoE for specific stock issues.

Regulators employ a mixture of models and subjective judgment. Typically, these formal models, as well as the more subjective evaluations, benchmark against other US utilities (and often utilities in the same geographic region). There are advantages to narrow benchmarking, but when market conditions change and everyone is looking at their neighbors, rates will update very slowly.

In figure 1 we plot the approved return on equity over 40 years, with various risky and risk-free rates for comparison. The two panels show nominal and real rates. Consistent with a story where regulators adjust slowly, approved RoE has fallen slightly (in both real and nominal terms), but much less than other costs of capital. This price stickiness by regulators also manifests in peculiarities of the rates regulators approve. Rode and Fischbeck (2019) notes the fact that regulators seem reluctant to set RoE below a nominal 10%.

That paper, Rode and Fischbeck (2019), is the closest to ours in the existing literature. The authors use the same rate case dataset we do, and note a similar widening of the spread between the approved return on equity and 10-year Treasury rates. That paper, unlike ours, dives into the financial modeling, using the standard capital asset pricing model (CAPM) to examine potential causes of the increase the RoE spread. In contrast, we consider a wider range of financial benchmarks (beyond 10-year Treasuries) and ask more pointed questions about "what should rates be today if past relationships held?" and "how much has this RoE gap incentivized utilities to own more capital?"

Using CAPM, Rode and Fischbeck (2019) rule out a number of financial reasons we might see increasing RoE spreads. Possible reasons include utilities' debt/equity ratio, the asset-specific risk (CAPM's β), or the market's overall risk premium. None of these are supported by the data. A pattern of steadily increasing debt/equity could explain an increasing gap, but debt/equity has fallen over time. Increasing asset-specific risk could explain an increasing gap, but asset risk has (largely) fallen over time. (They use the Dow Jones Utility Average as a measure of utility asset risk.) An increasing market risk premium has could explain an increased spread between RoE and riskless Treasuries, but the market risk premium has fallen over time. Appendix figure 8, reproduced from Rode and Fischbeck (2019), shows the evolution of asset risk and the market risk premium over time.

Prior research has highlighted the importance of macroeconomic changes, and that these often aren't fully accounted for in utility commission ratemaking (Salvino 1967; Strunk 2014). Because rates of return are typically set in fixed nominal percentages, rapid changes in inflation can dramatically shift a utility's real return. This pattern is visible in figure 1 in the early 1980s. Inflation has lower and much more stable in recent years,

Many authors have written a great deal about modifying the current system of investor-owned utilities. Those range from questions of who pays for fixed grid costs to the role of government ownership or securitization (Borenstein, Fowlie, and Sallee 2021; Farrell 2019). For this project, we assume the current structure of investor-owned utilities, leaving aside other questions of how to set rates across different groups of customers or who owns the capital.

Finally, we note that a utility's approved rate of return or return on equity might differ from the realized return. In this paper, we focus on approved values. Other recent work, e.g. Hausman (2019), highlights important differences between approved costs and realized prices that customers face.

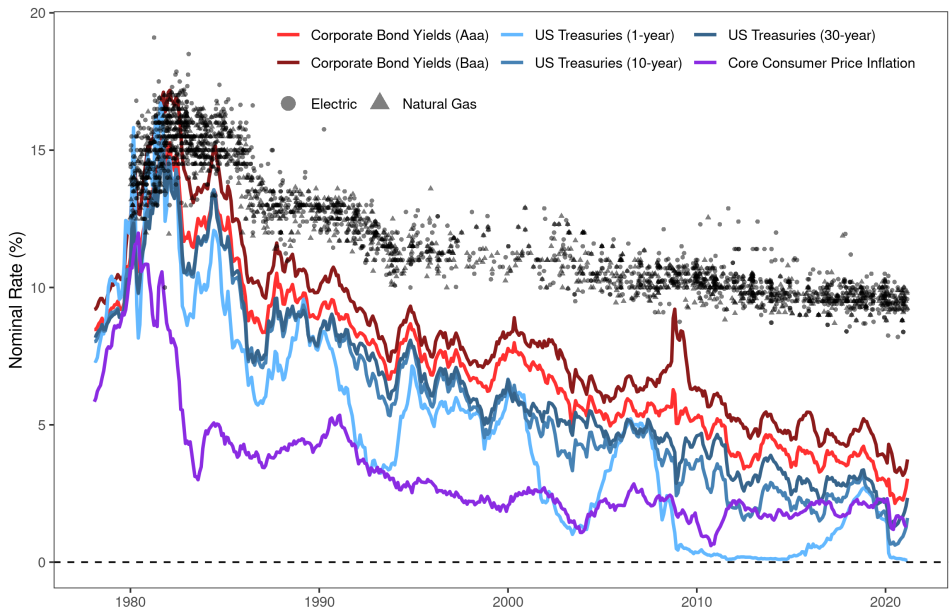
Table 1: Summary Statistics

Characteristic	N	Electric[1]	Natural Gas[1]
Rate of Return Proposed (%)	3,324	9.95 (1.98)	10.07 (2.07)
Rate of Return Approved (%)	2,813	9.59 (1.91)	9.53 (1.95)
Return on Equity Proposed (%)	3,350	13.22 (2.69)	13.06 (2.50)
Return on Equity Approved (%)	2,852	12.38 (2.40)	12.05 (2.24)
Return on Equity Proposed Spread (%)	3,350	6.72 (2.18)	6.95 (1.99)
Return on Equity Approved Spread (%)	2,852	5.62 (2.27)	5.68 (2.10)
Return on Debt Proposed (%)	3,247	7.48 (2.11)	7.47 (2.16)
Return on Debt Approved (%)	2,633	7.54 (2.06)	7.44 (2.16)
Equity Funding Proposed (%)	3,338	45 (7)	48 (7)
Equity Funding Approved (%)	2,726	44 (7)	47 (7)
Rate Case Duration (mo)	3,713	9.1 (5.1)	8.1 (4.3)
Rate Base Increase Proposed ($ mn)	3,686	84 (132)	24 (41)
Rate Base Increase Approved ($ mn)	3,672	40 (84)	12 (25)
Rate Base Proposed ($ mn)	2,366	2,239 (3,152)	602 (888)
Rate Base Approved ($ mn)	1,992	2,122 (2,991)	583 (843)

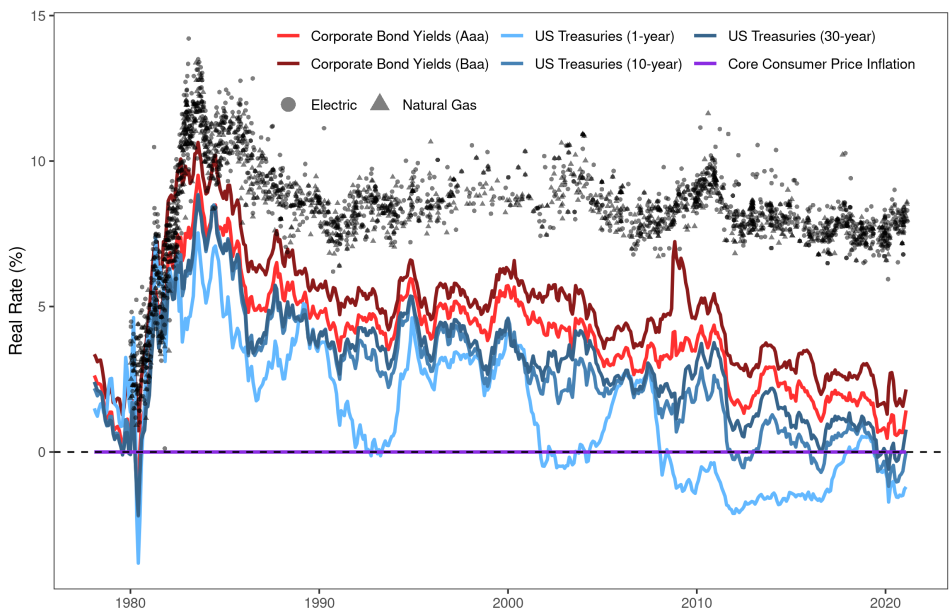
[1]Mean (SD)

Notes: This table shows the rate case variables in our rate case dataset. Values in the Electric and Natural Gas columns are means, with standard deviations in parenthesis.
Approved values are approved in the final determination, and are the values we use in our analysis. Some variables are missing, particularly the approved rate base. The RoE spread in this table is calculated relative to the 10-year Treasury rate.
Source: Regulatory Research Associates (2021) and author calculations.

Figure 1: Return on Equity and Financial Indicators



(a) Nominal



(b) Real

Notes: These figures show the approved return on equity for investor-owned US electric and natural gas utilities. Each dot represents the resolution of one rate case. Real rates are calculated by subtracting CPI. Between March 2002 and March 2006 30-year Treasury rates are interpolated from 1- and 10-year rates.
SOURCES: Regulatory Research Associates (2021), Moody's (2021a, 2021b), Board of Governors of the Federal Reserve System (2021a, 2021b, 2021c), and US Bureau of Labor Statistics (2021).

3 Data

To answer our research questions, we use a database of resolved utility rate cases from 1980 to 2021 for every electricity and natural gas utility that either requested a nominal-dollar ratebase change of $5 million or had a ratebase change of $3 million authorized (Regulatory Research Associates 2021). Summary statistics on these rate cases can be seen in table 1.

We transform this panel of rate case events into an unbalanced utility-by-month panel, filling in the rate base and rate of return variables in between each rate case. There are some mergers and splits in our sample, but our SNL data provider lists each company by its present-day (2021) company name, or the company's last operating name before ceased to exist. With this limitation in mind, we construct our panel by (1) not filling data for a company before its first rate case in a state, and (2) dropping companies five years after their last rate case. In contexts where a historical comparison is necessary, but the utility didn't exist in the benchmark year, we use average of utilities that did exist in that state, weighted by ratebase size.

We match with data on S&P credit ratings, drawn from SNL's *Companies (Classic) Screener* (2021) and WRDS' *Compustat S&P legacy credit ratings* (2019). Most investor-owned utilities are subsidiaries of publicly traded firms. We use the former data to match as specifically as possible, first same-firm, then parent-firm, then same-ticker. We match the latter data by ticker only. Then, for a relatively small number of firms, we fill forward.[5] Between these two sources, we have ratings data are available from December 1985 onward. Approximately 80% of our utility–month observations are matched to a rating. Match quality improves over time: approximately 89% of observations after 2000 are matched.

These credit ratings have changed little over 35 years. In figure 2 we plot the median (in black) and various percentile bands (in shades of blue) of the credit rating for utilities active in each month. We note that the median credit rating has not changed much over time. The distribution of ratings is somewhat more compressed in 2021 than in the 1990s. While credit ratings are imperfect, we would expect rating agencies to be aware of large changes in riskiness.[6] Instead, the median credit rating for electricity utilities is A−, as it was for all of the 1990s. The median credit rating for natural gas utilities is also A−, down from a historical value of A.

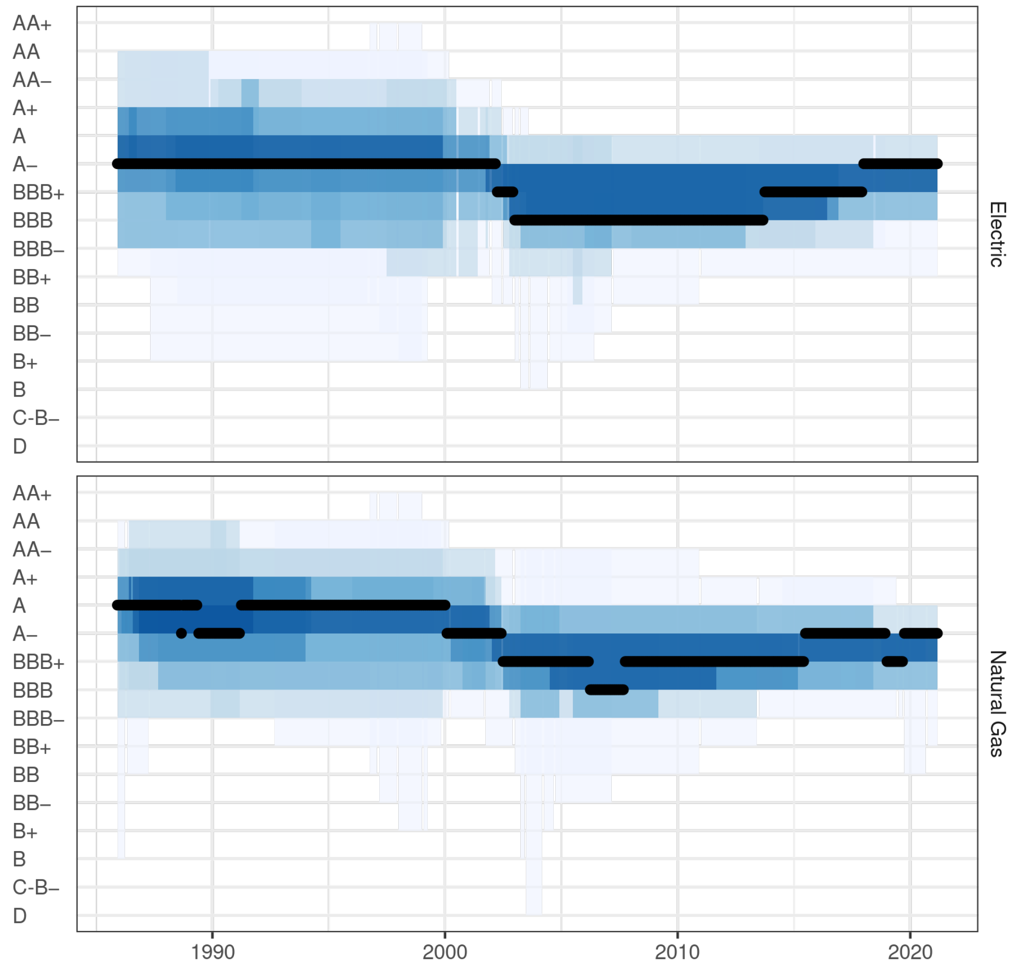
Beyond credit ratings, we also use various market rates pulled from FRED. These include 1-, 10-, and 30-year treasury yields, the core consumer price index (CPI), bond yield indexes for corporate bonds rated by Moody's as Aaa or Baa, as well as those rated by S&P as AAA, AA, A, BBB, BB, B, and CCC or lower.[7]

5. When multiple different ratings are available, e.g. different ratings for subsidiaries trading under the same ticker, we take the median rating. We round down in the case of an even number of ratings, both here and in figure 2.

6. For utility risk to drive up the firms' cost of equity but not affect credit ratings, one would need to tell a very unusual story about information transmission or the credit rating process.

7. Board of Governors of the Federal Reserve System (2021a, 2021b, 2021c), US Bureau of Labor Statistics (2021), Moody's (2021a, 2021b), and Ice Data Indices, LLC (2021b, 2021a, 2021f, 2021d, 2021c, 2021g, 2021e).

Figure 2: Credit ratings have changed little in 35 years

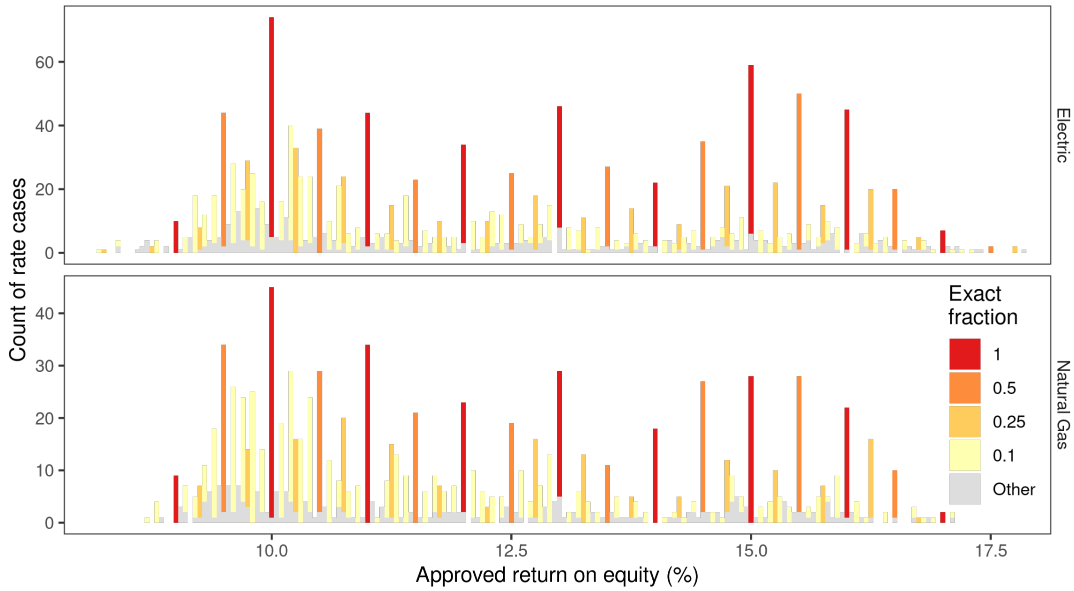


NOTE: Black lines represent the median rating of the utilities active in a given month. We also show bands, in different shades of blue, that cover the 40–60 percentile, 30–70 percentile, 20–80 percentile, 10–90 percentile, and 2.5–97.5 percentile ranges. (Unlike later plots, these *are not* weighted by ratebase.) Ratings from C to B– are collapsed to save space.
SOURCE: *Companies (Classic) Screener* (2021) and *Compustat S&P legacy credit ratings* (2019).

Matching these two datasets – rate cases and macroeconomic indicators – we construct the timeseries shown in figure 1. A couple of features jump out, as we mentioned in the introduction. The gap between the approved return on equity and other measures of the cost of capital have increased substantially over time. At the same time, the return on equity has decreased over time, but much more slowly than other indicators. We quantify these observations in section 5.

We note that there are other distortions or ad-hoc evaluations in the PUC process. Rode and Fischbeck (2019) note a hesitancy for PUCs to set RoE below a nominal 10% level. We replicate this finding. In addition, we also note a bias toward round numbers, where regulators tend to approve RoE values at integers, halves, quarters, and tenths of percentage points. This finding is demonstrated in figure 3. We believe the true, unknown, cost of equity is smoothly distributed. If for instance,

Figure 3: Return on equity is often approved at round numbers



Colors highlight values of the nominal approved RoE that fall exactly on round numbers. More precisely, values in red are integers. Values in dark orange are integers plus 50 basis points (bp). Lighter orange are integers plus 25 or 75 bp. Yellow are integers plus one of {10, 20, 30, 40, 60, 70, 70, 80, 90} bp. All other values are gray.
Histogram bin widths are 5 bp. Non-round values remain gray if they fall in the same histogram bin as a round value. In that case, the bars are stacked.

SOURCE: Regulatory Research Associates (2021).

a PUC rounds in a way that changes the allowed RoE by 10 basis points (0.1%), the allowed revenue on the existing ratebase for the average electric utility in 2019 would change by $114 million. (The median is lower, at $52 million.) Small deviations have large implications for utility revenues and customer payments, though we don't know if rounding has a systematic bias toward higher or lower RoE. Of course, RoE values that aren't set at round numbers might not be any closer to the correct RoE. We leave this round number bias, as well as the above-10% stickiness, for future research.

4 Empirical Strategy

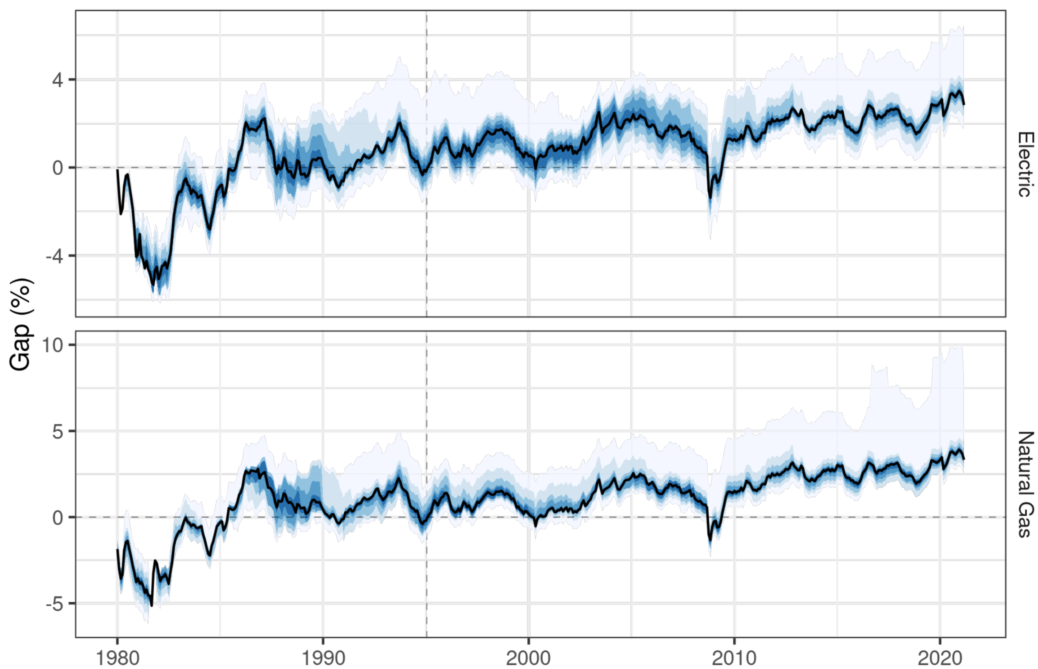
4.1 Return on Equity Gap

Knowing the return on equity (RoE) gap size is a challenge, and we take a couple of different approaches. None are perfect, but collectively, they shed light on the question. For each of the strategies we outline below (in sections 4.1.1, 4.1.2, 4.1.3, and 4.1.4) we plot the timeseries of the RoE gap. These are plotted in figures 4, 5, 6, and 7. Many of these strategies pick a specific time period as a benchmark. For all of these, we use January 1995. For the most part, our RoE gap results are flat over time (in the case of CPI) or steadily upward sloping (in the case of corporate bonds).

The choice of baseline date determines where zero is, so changing the baseline date will shift the overall magnitude of the gap. As long as the baseline date isn't in the middle of a recession, our qualitative results don't depend strongly on the choice.

In each plot, we present the median of our RoE gap estimates, weighting by the utility's ratebase (in 2019 dollars). Our goal is to show the median of ratebase dollar value, rather than the median of utility companies, as the former is more relevant for understanding the impact of the RoE gap. We also show bands, in different shades of blue, that cover the 40–60 percentile, 30–70 percentile, 20–80 percentile, 10–90 percentile, and 2.5–97.5 percentile (all weighted by ratebase).

Figure 4: Return on equity gap, benchmarking to Baa-rates corporate bonds



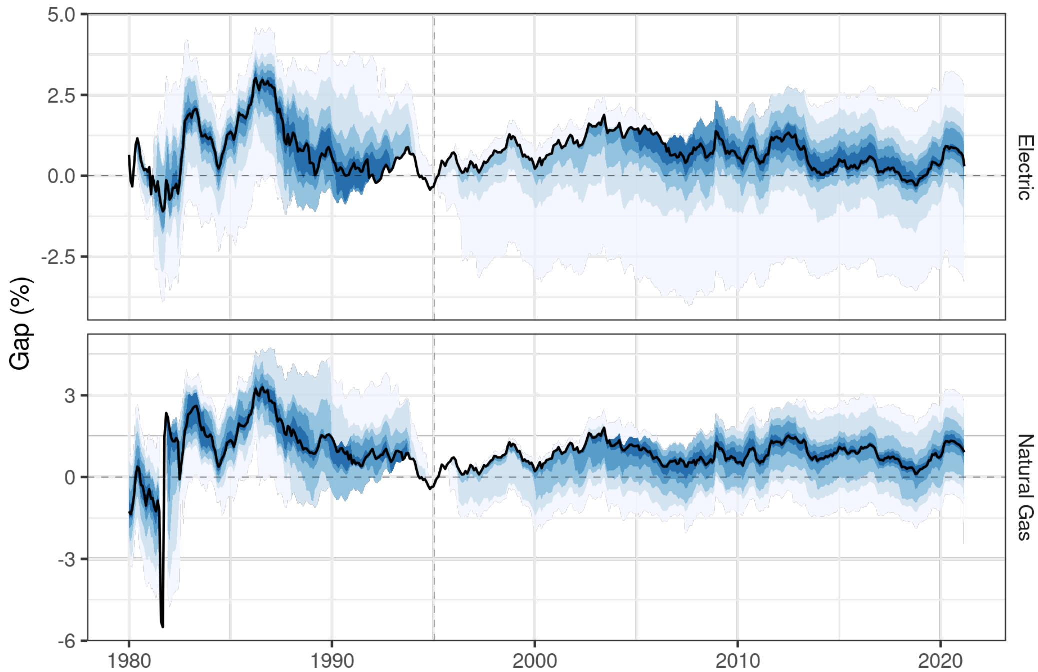
Base year is 1995. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total IOU ratebase. See calculation details in section 4.1.1.

4.1.1 Indexed to Corporate Bonds

We first consider a benchmark index of corporate bond yields, rated Baa by Moody's.[8] The idea here is to ask if the *average* spread against the Baa rating hadn't changed since the baseline, what would the RoE be today? The results are plotted in figure 4. Moody's Baa is approximately equivalent to S&P's BBB, which is at or slightly below our most of the utilities in our data. We use January 1995 as our baseline. Our findings are qualitatively the same for other dates, though the magnitude differs.

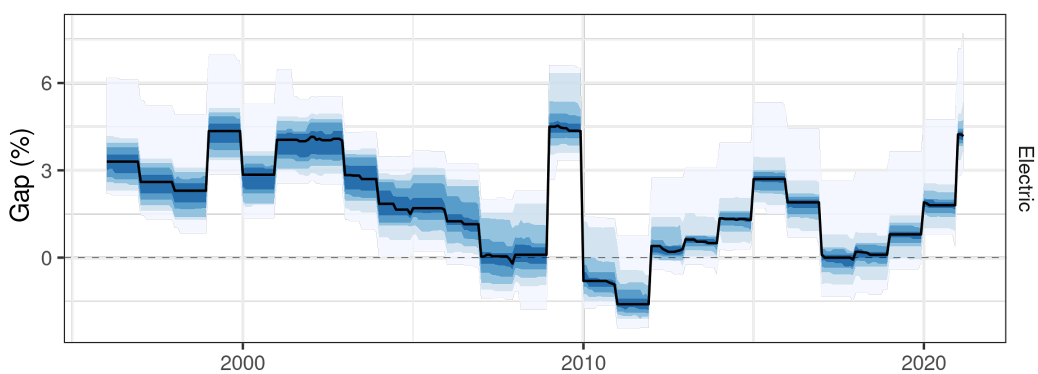
8. This index is one of two rating-specific corporate bonds indexes that's available for our entire study period. The other is Moody's Aaa.

Figure 5: Return on equity gap, using Vermont's update rule



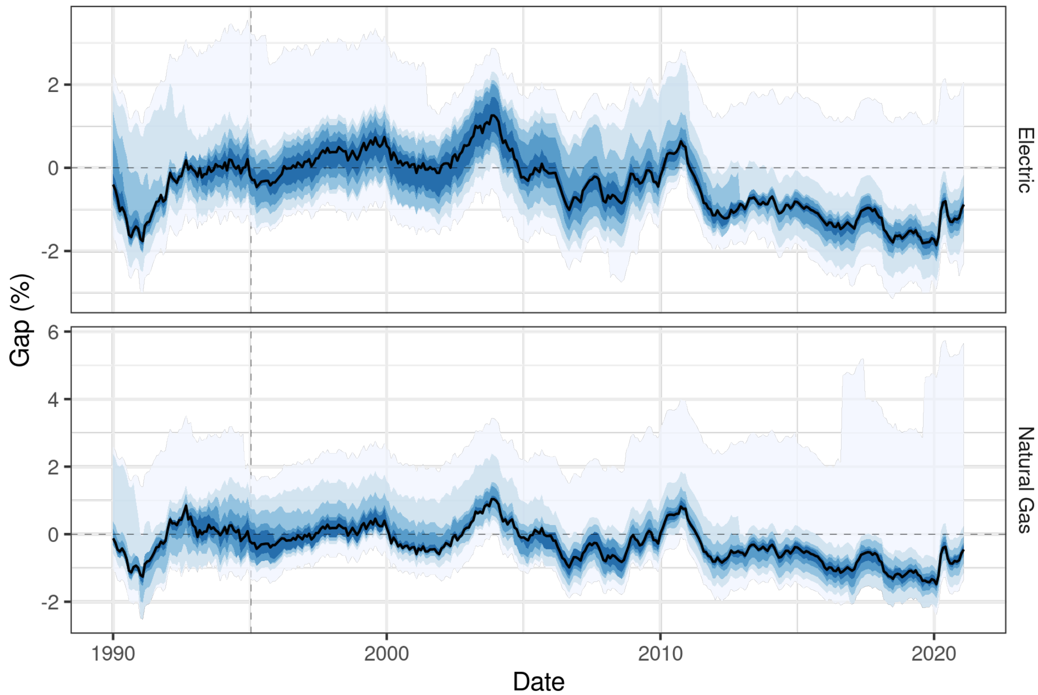
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total IOU ratebase. See calculation details in section 4.1.2.

Figure 6: Return on equity gap, compared to UK utilities



Base year is 1995. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total IOU ratebase. See calculation details in section 4.1.3.

Figure 7: Return on equity gap, benchmarking to CPI



Base year is 1995. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total IOU ratebase. See calculation details in section 4.1.4. Dates before 1990 are omitted for better axis scaling.

Making comparisons to debt instruments in this way, rather than benchmarking to some economy-wide cost of equity, means the measure of the RoE gap likely understates the gap. Rode and Fischbeck (2019) points out that (1) the market-wide equity risk premium has declined over the period and (2) the same is true for the utility sector.[9] Therefore, we would expect the mean spread against Baa bond yields to have declined, but instead, the spread has increased.

To calculate these results we first find the spread between the approved return on equity and the Moody's Baa rate for each utility in each state in each month. We then take the average at our baseline and simulate what that spread would be if the overall average spread hadn't changed. One advantage of this approach is that we can still allow utilities to move around in their relative rankings and RoE. For example if a particular utility gets riskier and has correspondingly high RoE, our measure allows for that change in individual riskiness.

4.1.2 Indexed to Treasuries

Our next measure uses the RoE update rule recently implemented by the Vermont PUC. This rule is the only one we're aware of, from any PUC, that currently

9. To the extent that observed utility stock returns are endogenous to the approved RoE, point #2 might be biased (Werth 1980).

does automatic updating. Define R' as the baseline RoE, B' as the baseline 10-year Treasury bond yield, and B_t as the 10-year Treasury bond yield in year t. The update rule says the RoE in year t is then:

$$R_t = R' + \frac{B_t - B'}{2}$$

In the graph, we set the baseline to January 1995. In reality the commission set the baseline period as December 2018, for their plan published in June 2019. (*Green Mountain Power: Multi-Year Regulation Plan 2020–2022* 2020). We simulate the gap between approved RoE and what RoE would have been if every state's utilities commission followed this rule from 1995 onward. (Pre-1995 values are not particularly meaningful, but we can calculate them with the same formula.) We plot results in figure 5.

4.1.3 International Benchmark

We also consider an international benchmark. Here we ask, "what if US utilities faced a return on equity that was the same as return on equity in the UK?" Unlike the previous cases, we're not considering some benchmark year. Instead, we're considering the contemporaneous gap between the US and UK. Of course many things are different between these countries, and it's not fair to say all US utilities should adopt UK rate making, but we've think this benchmark provides an interesting comparison. Our results are in figure 6.

4.1.4 Indexed to Inflation

We also consider a calculation where we benchmark against core CPI. The mechanics of this calculation are identical to the Baa comparison above, where we calculate the gap between approved RoE and what the RoE would be if the mean spread against core CPI were unchanged. In this analysis, we find a small negative gap: real approved values RoE have declined, but by less than other costs of capital.

4.2 Rate Base Impacts

Next, we turn to the ratebase the utilities own. A utility with a positive RoE gap will have a too-strong incentive to have capital on their books. In this section, we investigate the change in ratebase utilities request and receive. For our purposes, change in ratebase is more relevant than the total ratebase, as the change is a flow variable that changes from rate case to rate case, while the total ratebase is the partially-depreciated stock of all previous ratebase changes. We consider both the requested change and the approved change, though the approved value is our preferred specification. We estimate $\hat{\beta}$ from the following:

$$\log(RBI_{i,t}) = \beta RoE_{i,t}^{gap} + \gamma X_{i,t}\theta_i + \lambda_t + \epsilon_{i,t} \tag{1}$$

where an observation is a utility rate case for utility i in year-of-sample t. The dependent variable, $RBI_{i,t}$, is the increase in the rate base, and we take logs. (Cases where the ratebase shrinks are rare, but do happen. We drop these cases.) The independent variable of interest, $RoE_{i,t}^{gap}$, is the gap between the allowed return on equity and the true return on equity over the length of the rate case, where each rate case has a duration of D years.

$$RoE_{i,t}^{gap} = RoE_{i,t}^{allowed} - \frac{1}{D}\sum_{t}^{t+D} RoE_{i,t}^{correct} \tag{2}$$

Unlike section 4.1, for this analysis we care about differences in the gap between utilities or over time, but do not care about the overall magnitude of the gap. For ease of implementation, we begin by considering the gap as the spread between the approved rate of return and the 10-year Treasury bond yield. We do not expect the correct return on equity to be equal to the 10-year Treasury yield, but our fixed effects account for any constant differences. Future research will consider a richer range of gap calculations.

4.2.1 Fixed Effects Specifications

Our goal is to make causal claims about $\hat{\beta}$, so we are concerned about omitted variables that are correlated with both the estimated RoE gap and the change in ratebase. We begin with a fixed-effects version of the analysis. Our preferred version includes time fixed effects, λ_t, at the year-of-sample level and the unit fixed effects, θ_i, are at the utility company and state level.[10] Here, the identifying assumption is that after controlling for state and year effects, there are no omitted variables that would be correlated with both our estimate of the RoE gap and the utility's change in ratebase. The identifying variation is the differences in the RoE gap within the range of rate case decisions for a given utility, relative to the annual average across all utilities. These fixed effects handle some of the most critical threats to identification, such as macroeconomic trends, technology-driven shifts in electrical consumption, or static differences in state PUC behavior. In columns 1–3 of our results tables (3 and 4), we consider different specifications for our fixed effects.

In this case the identification hinges on looking at variation in the RoE gap within the range of rate case decisions for a given utility, relative to the annual average across all utilities. The identifying assumption is that after controlling for state, year, and company effects, there are no omitted variables that would be correlated with both our estimate of the RoE gap and the utility's change in ratebase. These fixed effects handle many of the stories one could tell, such as macroeconomic trends, technological shifts in electrical consumption, or static differences in state PUC behavior. However, there are certainly other avenues for omitted variables bias to creep in, so next we turn to an instrumental variables strategy.

4.2.2 Instrumenting with Rate case Timing and Duration

To try and further deal with concerns regarding identification, we examine an instrumental variables approach based on the timing and duration of rate cases.

10. Many utilities operate within only on state, but some span multiple. These company and state fixed effects are only partially nested.

Our IV analysis takes the idea that rates move around in ways that aren't always easy for the regulator to anticipate. So for instance if the allowed return on equity is set in year 0 and financial conditions change in year 2 such that the real allowed return on equity increases, then we would expect the utility to increase their capital investments in ways that are unrelated to other aspects of the capital investment decision. For this instrument to work, it needs to be the case that these movements in bond markets or the like are conditionally independent of decisions that the utility is making, except via this return on equity channel. We control for common year fixed effects, and then the variation that drives our estimate is that different utilities will come up for their rate case at different points in time.

5 Results

Table 2: RoE gap, by different benchmarks

A: Electric		Baa yield	VT rule	UK	CPI
Gap (%)	2000	0.796	0.21	3.17	0.531
	2020	3.26	0.485	2.03	−1.06
Excess payment ($bn)	2000	0.581	0.23	4.54	0.142
	2020	6.54	1.43	3.92	−2.61
B: Natural Gas					
Gap (%)	2000	0.969	0.142		0.704
	2020	3.9	1.15	1.89	−0.421
Excess payment ($bn)	2000	0.0896	0.0183		0.0212
	2020	2.14	0.658	0.975	−0.361

Note: Gap percentage figures are an unweighted average across utilities.
Excess payments are totals for all IOUs in the US, in billions of 2019 dollars per year, *for the observed ratebase*.
For cases where it's relevant (Baa yield, VT rule, and CPI), the benchmark date is January 1995. See text for details of each benchmark calculation.

Beginning with the RoE gap analysis from section 4.1, table 2 summarizes the graphs, using 2000 and 2020 as example points in time. The table highlights the RoE gap and the excess payment on the existing ratebase. Our results on the RoE gap can largely be guessed from a close inspection of figure 1. Approved RoE has not changed much in real terms (i.e. relative to core CPI), but the gap has increased between RoE and various financial benchmarks. Of our various imperfect estimates of the gap, we believe the Baa benchmark is the most credible. Totalling up the

2020 excess payments gives us \$8.7 billion in the Baa benchmark, or \$2.1 billion in the Vermont benchmark. The UK benchmark falls between these, at \$4.9 billion.

We also consider how the RoE gap affects capital ownership. Tables 3 and 4 show our regression results for proposed and approved values, respectively. Our preferred specification is column 4, the IV specification, in table 4. These results find that a 1 percentage point increase in the approved RoE gap leads to a 5.2% increase in the increase in approved rate base. These results have a strong first stage (Kleibergen–Paap *F*-stat of 69).

As a caveat, we note that an IOU can increase their capital holdings in two distinct ways. One option is to reshuffle capital ownership, either between subsidiaries or across firms, so that the IOU ends up with more capital on its books, but the total amount of capital is unchanged. The second option is to actually buy and own more capital, increasing the total amount of capital that exists in the state's utility sector. We do not differentiate between these two cases. Because we don't differentiate, we consider excess payments by utility customers, but we remain agnostic about the socially optimal level of capital investment.

Table 3: Relationship Between Proposed Rate of Return and Proposed Rate Base

	Fixed effects specs.			IV
Model:	(1)	(2)	(3)	(4)
Variables				
RoE gap (%)	0.0670***	0.0436*	0.0672***	0.0353
	(0.0134)	(0.0217)	(0.0151)	(0.0215)
Fixed-effects				
State	Yes	Yes	Yes	Yes
Year		Yes	Yes	Yes
Company			Yes	Yes
Fit statistics				
Observations	3,210	3,210	3,210	3,210
R^2	0.37	0.39	0.73	0.73
Within R^2	0.24	0.23	0.29	0.29
Wald (1st stage)				50.9
Dep. var. mean	63.69	63.69	63.69	63.69

Two-way (Year & Company) standard-errors in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

NOTES: The dependent variable in the first panel is log of the utility's proposed rate base increase. Columns 1–3 show varying levels of fixed effects. Column 4 is the IV discussed in section 4.2. Our preferred specification is column 4 of table 4. First-stage *F*-statistic is Kleibergen–Paap robust Wald test. All regressions control for an indicator of electricity or natural gas.

Table 4: Relationship Between Approved Rate of Return and Approved Rate Base

	Fixed effects specs.			IV
Model:	(1)	(2)	(3)	(4)
Variables				
RoE gap (%)	0.0551***	0.0752***	0.0867***	0.0523**
	(0.0200)	(0.0240)	(0.0225)	(0.0252)
Fixed-effects				
State	Yes	Yes	Yes	Yes
Year		Yes	Yes	Yes
Company			Yes	Yes
Fit statistics				
Observations	2,491	2,491	2,491	2,491
R^2	0.33	0.36	0.69	0.69
Within R^2	0.21	0.20	0.22	0.22
Wald (1st stage)				69.1
Dep. var. mean	38.63	38.63	38.63	38.63

Two-way (Year & Company) standard-errors in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: The dependent variable in the first panel is log of the utility's approved rate base increase. Columns 1–3 show varying levels of fixed effects. Column 4 is the IV discussed in section 4.2. Our preferred specification is column 4. First-stage *F*-statistic is Kleibergen–Paap robust Wald test. All regressions control for an indicator of electricity or natural gas.

6 Conclusion

Utilities invest a great deal in capital, and need to be compensated for the opportunity cost of their investments. Getting this rate of return, particularly the return on equity, correct is challenging, but is a first-order important task for state PUCs.

Our analysis shows that the RoE that utilities are allowed to earn has changed dramatically relative to various financial benchmarks in the economy. Across relevant benchmarks, we found that current rates are perhaps 0.5–4 percentage points too high, resulting in $2–8 billion in excess rate collected per year, given the existing ratebase.

We then turned to the Averch–Johnson effect, and estimated the additional capital this RoE gap generates. In our preferred specification, we estimate that an additional percentage point in the RoE gap leads to 5% higher rate base increases.

We hope that policymakers and regulators consider these changes and these benchmarks in future rate making and the role that a wider variety of metrics benchmarks and adjustments can play in utility rate cases. We close by echoing Rode and Fischbeck (2019) and the Vermont PUC. Just as PUCs adopted fuel adjustment clauses in the 1960s and 1970s, RoE adjustment clauses are a tool that would allow rates to automatically adjust to changing market conditions. It would, of course, be possible to change the formula from time to time, but by default, the PUC wouldn't need to, even as the cost of raising capital changes. If such a scheme was implemented, it would be necessary to think hard about the baseline rate. As we demonstrated, the approved RoE has grown over time, so the choice of baseline period is crucial.

Figure 8: Figures 8 and 9 from Rode and Fischbeck (2019), showing CAPM β and market risk premium

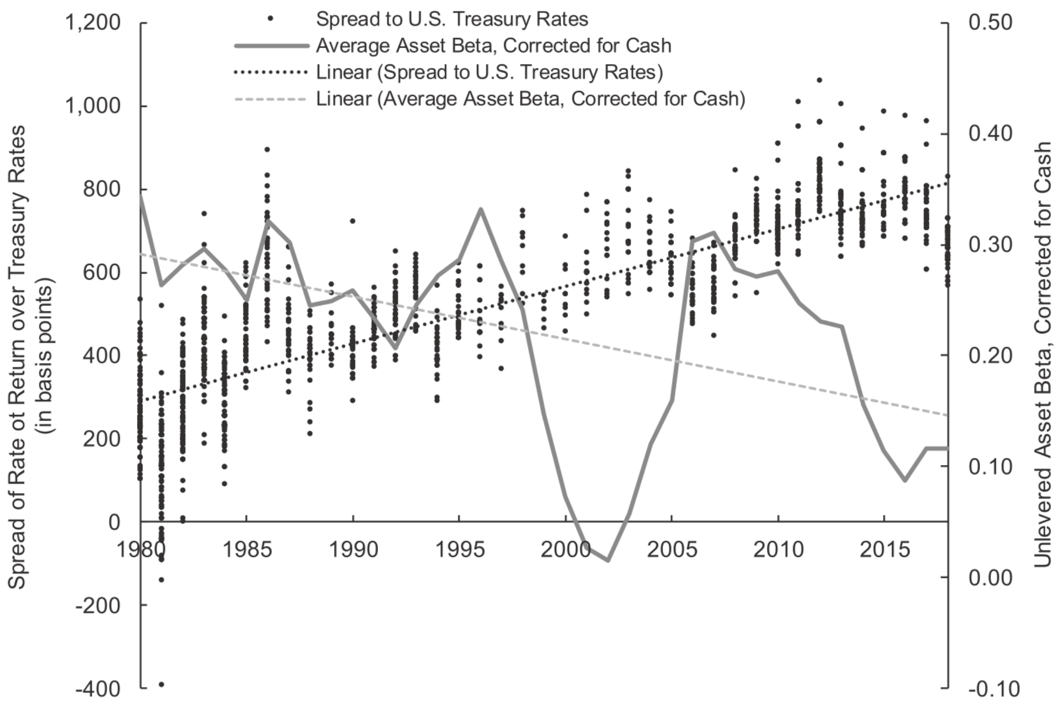


Fig. 8. Authorized return on equity premium vs. industry average asset beta.

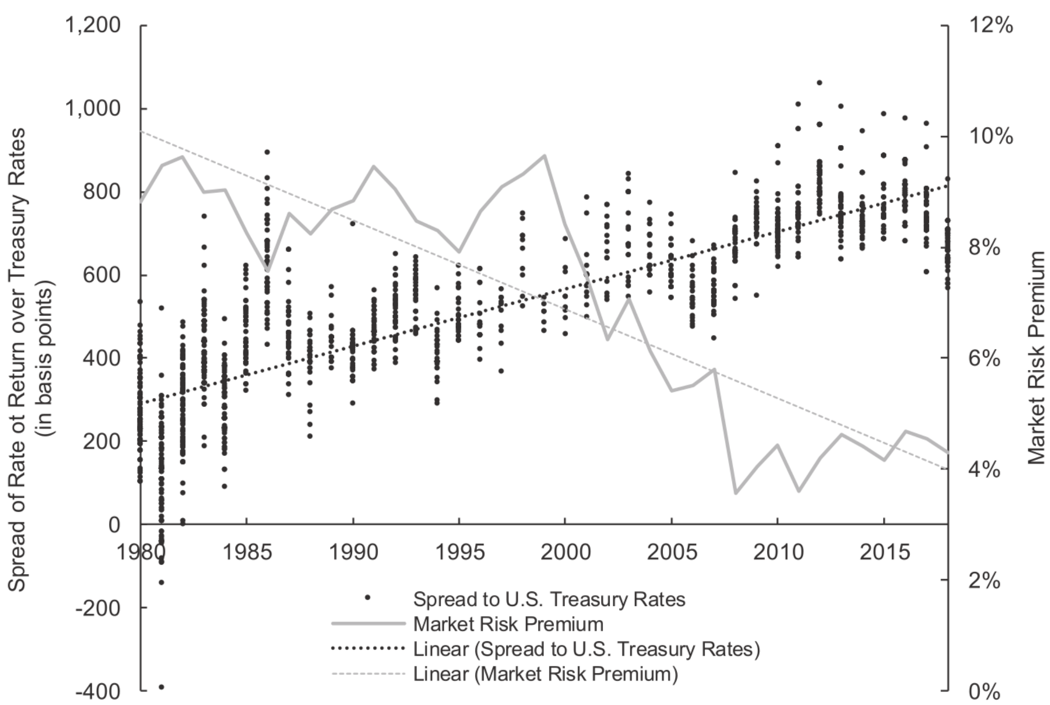


Fig. 9. Authorized rate-of-return premium vs. *ex ante* estimated market risk premium.

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