Rate of Return Regulation Revisited

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Abstract

Utility companies recover their capital costs through regulator-approved rates of return. Using a comprehensive database of utility rate cases, we find a significant premium for regulated returns on equity relative to several capital cost benchmarks. We show that firms decide strategically when to initiate new rate cases, such that regulated returns respond more quickly to increases in underlying capital cost benchmarks than to decreases. Higher regulated returns incentivize utilities to own more capital: a one percentage point rise in return on equity increases capital assets by 3–4%. Overall we find excess costs to US consumers averaging $7 billion per year.

JEL Codes: Q40, L51, L94, L95

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1 Introduction

In the two decades from 1997 to 2017, real annual capital spending on electricity transmission and distribution infrastructure by major utilities in the United States has more than doubled (EIA 2018a, 2018b). The combined total is now more than $90 billion per year (IEA 2023). This trend is expected to continue, both in the US and globally, with investment forecast to double or even triple by the 2040s (ibid).

These large capital expenses are generally viewed as utility companies modernizing an aging grid and making the necessary upgrades to support the clean energy transition underway in much of the sector. However, it is noteworthy that over recent years, utilities have earned sizeable regulated rates of return on their capital assets, particularly when set against the unprecedented low interest rate environment of 2008–2022. When the economy-wide cost of capital fell, utilities' regulated rates of return did not fall nearly as much. This gap raises the prospect that at least some of the growth in capital spending could be driven by utilities earning excess regulated returns. The distortion this can create to capital investment incentives has long been identified as a potential problem in the sector (Averch and Johnson 1962). More broadly, setting a fair rate of return is one of the core challenges for natural monopoly regulation of the utility industry (Joskow 1972, 1974; Joskow and Rose 1989).

In this paper we use new data to revisit these central issues of excess returns, capital ownership, and the political economy of utility regulation. We do so by exploring three main research questions. First, to what extent are utilities being allowed to earn excess returns on equity by their regulators? Second, what possible mechanisms can explain the divergence between regulated returns and underlying capital costs? Third, how have excess returns on equity affected utilities' capital investment decisions and the costs paid by consumers?

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. These investor-owned utilities serve three quarters of US consumers, and the regulated utility company model they operate under is the dominant industry structure in most advanced economies. We combine our rate case data 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 on equity (RoE) that utilities earn and some measure of the cost of equity they face. A central challenge here, both for the regulator and for the econometrician, is estimating the cost of equity. We proceed by simulating the cost of equity using the capital asset pricing model (CAPM). Using a range of standard financial assumptions we find a premium in approved returns on equity ranging from one to five percentage points over the past three decades. As an additional check we also examine benchmarks against various measures of debt yields and a comparison with regulatory decisions in the United Kingdom. Here again we find similar evidence of a large utility return on equity premium. Importantly, even our highest benchmarks tend to come in below the allowed rates of return on equity that regulators set today. By calculating a range of cost of equity benchmarks we go further than prior research in this area and take a stance on the size of the RoE spread, rather than just its likely existence or trending direction (Azgad-Tromer and Talley 2017; Rode and Fischbeck 2019). This is important for our subsequent analysis of the implications for capital investment and excess consumer costs.

The existence of a persistent gap between the return on equity that utilities earn and some measure of the cost of capital they face could have a number of explanations. Our benchmarking against the CAPM and recent work by Rode and Fischbeck (2019) rules out a number of financial explanations for the observed RoE spreads, such as changes to utilities' debt/equity ratio, asset-specific risk, or the stock market's overall risk premium. We also document a lack of meaningful changes in utility credit ratings over this period suggesting there have not been large changes in the riskiness of the utility industry. We therefore focus on a range of non-financial mechanisms, such as political concerns, behavioral biases, and regulatory capture. Directly attributing the relative importance of these different factors is challenging. However, our findings still shed new light on potential mechanisms and policy remedies, including several issues that have not been previously studied.

We start by examining the role played by the structure of the rate case process. To do this we turn to the literature on asymmetric price adjustments. It has long been documented that positive shocks to firms' input costs can feed through into prices faster than negative shocks (Ball and Mankiw 1994). Oil and gasoline markets have been the most heavily studied to date (Bacon 1991; Borenstein, Cameron, and Gilbert 1997; Perdiguero-García 2013; Kristoufek and Lunackova 2015), although similar features have been identified across a wide range of economic sectors, from agricultural products to financial markets (Peltzman 2000; Frey and Manera 2007; Gwin 2009). This is the so-called "rockets and feathers" phenomenon. To test whether this dynamic arises in our regulatory context we estimate a vector error correction model for the relationship between utilities' approved return on equity and some benchmark "input" measure of the cost of capital (e.g. US Treasury bond yields). Here we do indeed find novel evidence of asymmetric adjustment. Increases to the benchmark cost of capital lead to faster upward adjustments to utilities' regulated return on equity, while decreases lead to relatively slow downward adjustments. Our findings are the first instance we are aware of where this phenomenon has been identified in regulatory decision-making, rather than just in market prices.

One possible explanation for the asymmetric adjustment we observe relates to the timing of when rate cases are initiated and thus how long they last. Regulators face an information asymmetry with the utilities they regulate when determining whether costs are prudent and necessary (Joskow, Bohi, and Gollop 1989). Utilities have a clear incentive to initiate a new rate case and push for rate increases by claiming they face a high cost of equity that their shareholders must be compensated for. Conversely, they have little incentive to initiate a new rate case and push for a lower RoE if their actual cost of equity falls. If regulators are too deferential to the demands of the utilities they regulate we would expect rates to become detached from underlying costs. Here we find new evidence of strategic decision-making by utilities. When the existing regulated rate of return is advantageous to a firm, rate cases become longer. When the reverse is true, rate cases become shorter. Systematic changes in rate case timing and duration appear to have contributed to the higher rates of return utility companies have managed to secure.

This finding raises the question of why regulators would allow the rate case process to function in a way that systematically benefits the utilities they regulate. Prior work has highlighted the relative lack of resources and financial expertise at public utility commissions, making it hard for them to push back against the substance and urgency of arguments made by utilities (Azgad-Tromer and Talley 2017; Ellis 2025). This is at least partly reflected in the simple rules-of-thumb regulators sometimes use in the ratemaking process (Michelfelder and Theodossiou 2013; Rode and Fischbeck 2019). Consistent with this, we find evidence of whole number rounding in the approved rates of return set by regulators – a striking result given that fractions of a percentage point can mean millions in additional costs recovered from consumers. Regulatory capture is another longstanding concern that could play a role here, with perceptions of a "revolving door" between regulatory commissions and the utility industry (Dal Bó 2006; Heern 2023; Ellis 2025). Using our rate case data, we see correlational evidence that when regulators take a firmer approach by fully litigating cases, they tend to approve lower rates of return.

A final explanation we examine is whether regulators simply have alternative political objectives that are misaligned with setting cost-reflective rates (Aspuru 2024). For instance, regulators may try to avoid the political costs of increases in the overall level of gas and electricity prices faced by consumers, rather than setting rates that reflect underlying economic costs (Joskow 1974; Hausman 2019). If this is the case, we might expect utilities to be able to secure higher regulated returns during periods where other non-capital costs are declining. In these situations utilities capital costs could rise while the overall price faced by consumers remains relatively low. We find some limited evidence for this phenomenon, with more generous returns on equity tending to be approved by regulators during periods of lower wholesale costs.

Whatever the underlying causes of the return on equity premium we observe, its existence has important implications for capital investment incentives and excess consumer costs. Beyond the direct effect on the capital costs utilities can recover, an age-old concern in the sector has been the way excess regulated returns incentivize utilities to over-invest in capital assets (Averch and Johnson 1962). If regulators set the approved rate of return above a utility's true cost of capital, they will have an incentive to increase the capital base that the rate of return is applied to. This can lead to inefficient over-investment in capital-intensive activities relative to alternatives that do not earn the utility a rate of return premium. The resulting costs from "gold plating" are then passed on to consumers in the form of higher bills. To explore whether this arises in our context we use a regression analysis to identify how a larger gap between a utility's allowed RoE and their actual cost of equity translates into over-investment in capital. We primarily use a within-utility approach (fixed effects and first differences). We also explore, but ultimately rule out, a number of instrumental variables approaches.

In our preferred specification, we find that increasing the RoE gap by one percentage point leads to a 3–4% percent increase in capital assets. We observe similar effects when looking at capital intensity per unit of electricity or gas delivered. In the electric sector the effect appears to be driven by increased distribution grid investment, more than generation or transmission investment. We do not find clear evidence of a corresponding increase in total operating costs. Our findings therefore provide new potential evidence for the Averch–Johnson effect in the utility sector (Vitaliano and Stella 2009; Kuosmanen and Nguyen 2020). This is of particular interest because to date the empirical evidence for this phenomenon has been viewed as quite weak (Joskow and Rose 1989; Joskow 2005).

Combining our measures of the excess equity returns utilities earn with the distortions to capital investment, we estimate the cost to consumers from excess rates of return averaged around $7 billion per year over the past three decades. There is uncertainty around this, and our range of CAPM benchmarks span excess costs averaging $3–11 billion per year, depending on the specification (all in 2019 USD). These excess costs have significant distributional effects, representing a sizable transfer from consumers to investors. This is an important perspective to keep in mind given that much of the discussion on the distributional impacts of energy utility prices has focused on inequities between different types of consumers, rather than between consumers and shareholders (Borenstein, Fowlie, and Sallee 2021; Cahana et al. 2023; Fetzer, Gazze, and Bishop 2024).

Importantly, the large majority of these excess costs are directly due to the return on equity gap. The additional capital from distorted investment incentives, on the other hand, has a relatively modest impact. As such, concerns about an Averch–Johnson distortion to investment incentives, while interesting, are a largely second order effect from perspective of the impact on consumers. Moreover, while excess equity returns may create an incentive to over-invest in capital assets, it does not mean that this will outweigh other inefficiencies that lead utilities to under-invest in capital. For instance, market power (Hausman 2024), regulatory and permitting barriers (Davis, Hausman, and Rose 2023), or a combination of moral hazard and asymmetric information (Lim and Yurukoglu 2018) are all inefficiencies that have been identified as reducing the incentives for utility companies to invest in new grid infrastructure.

More than four fifths of the excess costs we identify come from the electricity sector, which raises an important tension with environmental policy objectives. Ensuring that new capital investment can take place rapidly and in a cost-effective way is seen as critical to enabling the clean energy transition (Hirth and Steckel 2016; Gorman, Mills, and Wiser 2019). Increasingly utilities frame the equity returns they earn within this context. But higher regulated returns can also help keep polluting utility infrastructure operating for longer (Gowrisankaran, Langer, and Reguant 2024). Higher electricity prices hinder efforts to encourage electrification as well (Borenstein and Bushnell 2022). Regulators must therefore balance several competing goals to bear down on costs, encourage electrification, and bring forward new cleaner grid investments at an almost unprecedented scale and speed.

Addressing the inefficiencies in the regulatory process that we highlight remains a key challenge. Ultimately the process of determining utility cost of capital will continue to retain a significant degree of subjective judgment on the part of the regulators. With that in mind we conclude by covering the merits of potential reforms that can guard against certain biases. In particular, we discuss automatic update rules for the cost of equity, bolstering the financial expertise of regulators, and process changes to alter the timing and sequencing of regulatory proceedings.

2 Background

Electricity and natural gas utility companies are typically regulated by government utility commissions, which allow the companies a geographic monopoly and, in exchange, regulate the rates the companies charge. These public utility commissions (PUCs) are state-level regulators in the US. They set consumer rates and other policies to allow the utility companies they regulate to recover their costs. Three quarters of US customers are served by investor-owned utilities (IOUs) that are structured and regulated this way. The remainder are served by municipal or cooperative utilities, which we do not study here. The regulated investor-owned utility model is the dominant industry structure in most advanced economies.

A core activity that PUCs oversee is the rate case process. Here a utility company submits their proposed expenditures over some future time period (e.g. the next 3–5 years). The regulator then determines which expenditures it deems to be prudent and sets consumer rates such that the utility will be able to recover its projected costs. Regulators typically employ a "test year," a single 12-month period in the past or future that will be used as the basis for the rate case analysis. Expenses and costs in this test year, except those with automatic update provisions, are the values used for the entire rate case. A key challenge for the regulator during any rate case proceeding is deciding which costs are reasonable. For some expenses, like fuel purchases or labor expenses, it is relatively easy to calculate and evaluate the companies' costs. For others, like capital, the task is less straightforward.

Utilities own significant amounts of physical capital (power lines, substations, gas pipelines, repair trucks, office buildings, etc.). The types of capital utilities own also varies depending on market and regulatory conditions. Utilities that are vertically integrated 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 upstream gas well or processing plant. The set of all capital the utility owns is called the rate base (the base of capital that rates are calculated on).

The capital rate base has an opportunity cost of ownership: instead of buying capital, that money could have been invested elsewhere in the economy. Utilities fund their operations through issuing debt and equity, typically about 50%/50%. The weighted average cost of capital is the weighted average of the cost of debt and the cost of equity. During rate case proceedings state public utilities commissions must determine a reasonable level for the cost of capital a utility faces. They are therefore left trying to set a reasonable capital allocation and rate of return that approximates what capital markets would provide if the utility had been a competitive company rather than a regulated monopoly. 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.

The cost of debt financing is easier to estimate than the cost of equity financing. For historical debts, it is sufficient to use the cost of servicing those debts. For forward-looking debt issuance, the cost is estimated based on the quantity and cost of expected new debt. Issues remain for forward looking decisions – e.g. what will bond rates be in the future? – but these are *relatively* less problematic. In our data, we observe both the utilities' proposed rates of return and the final approved value. It's notable that the requested and approved rates 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 in order to invest in the utility. The Pennsylvania Public Utility Commission's ratemaking guide notes this difficulty (Cawley and Kennard 2018):

> 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. The RoE also conceptually applies to the entire rate base – unlike debt, there's typically no notion of paying a specific RoE for specific stock issues.[1]

Regulators employ a mixture of models and subjective judgment to set the return on equity. A common choice is the capital asset pricing model (CAPM), although other methods such as discounted cash flow are often used too. Utility companies will usually justify their requested values for the return on equity using these methods. Consumer advocate groups often do the same, with differences in the underlying assumptions often leading to substantial divergence in the return on equity that could be deemed appropriate. The regulator is then left to adjudicate these differences and determine a return on equity that is reasonable.

However, it is not obvious that regulator decisions closely follow these standard methods or incorporate important relevant information. Rode and Fischbeck (2019) rule out a number of financial reasons we might see an increasing RoE gap, including utilities' debt/equity ratio, the asset-specific risk (CAPM's β), or the market's overall risk premium. They find that none of these possibilities are supported by the data, and instead highlight a possible behavioral bias where regulators avoid allowing nominal RoE to fall below 10%. There is evidence broader macroeconomic changes often aren't fully included in utility commission ratemaking as well (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. Typically, regulators also rely on some degree of benchmarking against other US utilities (and often utilities in the same geographic region). There are advantages to this narrow benchmarking, but when market conditions change and everyone is looking at their neighbors, rates will update very slowly.

Another option when costs are likely to vary during the rate case period is to

1. For this paper, we focus on common stocks (utilities issue preferred stocks as well, but those form a very small fraction of utility financing).

have some form of automatic updating. In the 1960s and 70s, state public utilities commissions 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 costs changed. The same automatic adjustment has generally not been the norm for capital costs, despite large swings in the nominal cost of capital over the past 50 years. A few jurisdictions have introduced limited automatic updating for the cost of equity, and we discuss those approaches in more detail in section 4.1, where we consider various approaches of estimating the RoE gap.

Lastly, much has been written about modifying the current system of investor-owned utilities, with questions ranging from who pays for fixed grid costs to the role of government ownership or securitization (Farrell 2019; Borenstein, Fowlie, and Sallee 2021). For this paper 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.

3 Data

To answer our research questions, we use a database of all significant resolved utility rate cases from 1980 to 2022 for every electricity and natural gas utility (Regulatory Research Associates 2024).[2] We merge data from the Energy Information Administration (EIA) on the annual number of customers, quantity of electricity or gas supplied, and sales revenue for the utilities in our sample (Energy Information Administration 2024a, 2024b). Furthermore, we also combine annual financial data from the Federal Energy Regulatory Commission (FERC) for the electric utilities in our sample (Selvans et al. 2024). The EIA data is available from 1990 and the FERC data from 1994. For utilities operating in multiple states we allocate the national

2. The database includes any rate case where a utility either requested a nominal-dollar rate base change of $5 million or had a rate base change of $3 million authorized.

totals from FERC based on their quantity of electricity or gas delivered to end users in each state.

Summary statistics on our sample of rate cases can be seen in Table 1. Our primary variables of interest are the rates of return on equity, the rate base, and various measures of their capital assets or operating costs.[3] As noted earlier, it is striking there is a difference of around a full percentage point between the return on equity that utilities propose and regulators approve. This is in contrast to the other elements of the cost of capital process – such as the return on debt, equity funding share and rate base – where the value of approved by the regulator is generally very close to the value proposed by the utility.[4]

Table 1 also makes clear that we have matched data from FERC and EIA for somewhere between a third and two thirds of our sample, depending on the variable of interest. The FERC data only covers electric utilities, and includes a wealth of detailed information on assets, income, and expenditures broken down into their constituent parts (e.g. transmission, distribution, and generation). Despite the focus on electric utilities, for utilities that deliver both gas and electricity, there is some combined reporting of total assets and operating expenses that allows us to include some gas rate cases in the analysis that relies on this dataset.

Figure 1 plots the approved return on equity from our rate cases over the 40 year time period spanned by our sample. We also plot various risky and risk-free market rates for comparison. A couple of features jump out. The gap between the approved return on equity and other measures of the cost of capital has increased substantially

3. We focus here on proposed and approved regulated rates of return. It is possible that utility's actual rate of return or return on equity might differ from the approved regulated level. In general though, actual returns do tend to track allowed returns quite closely.

4. Given this observed high degree of correspondence for these three variables, we fill in any missing approved values where there is a non-missing proposed value, assuming the approved value is equal to the proposed value for the cost of debt, equity share, and rate base. This procedure allows us to identify values for almost 500 rate cases where the approved return on debt or equity share was missing, and around 300 rate cases where the approved rate base was missing. We then calculate the RoE from the filled values. This procedure allows us to identify values for almost 50 rate cases where the approved return on equity is missing.

Table 1: Summary Statistics

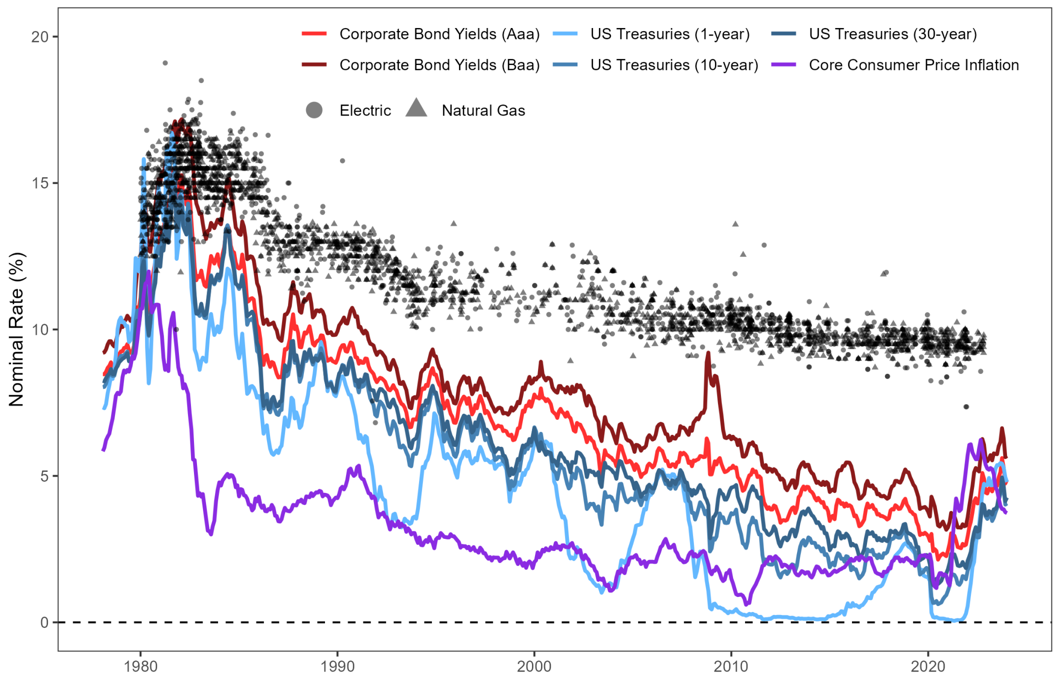
Characteristic	N	Electric	Natural Gas
Rate of Return Proposed (%)	3,589	9.93 (2.00)	9.94 (2.09)
Rate of Return Approved (%)	3,535	9.53 (1.92)	9.40 (1.95)
Return on Equity Proposed (%)	3,614	13.16 (2.70)	12.88 (2.50)
Return on Equity Approved (%)	3,552	12.28 (2.41)	11.87 (2.18)
Return on Debt Proposed (%)	3,581	7.43 (2.16)	7.29 (2.23)
Return on Debt Approved (%)	3,525	7.38 (2.13)	7.18 (2.20)
Equity Funding Proposed (%)	3,606	45 (7)	48 (7)
Equity Funding Approved (%)	3,547	44 (7)	47 (7)
Rate Increase Proposed ($ mn)	3,525	90 (142)	27 (44)
Rate Increase Approved ($ mn)	3,466	44 (92)	14 (27)
Rate Base Proposed ($ mn)	2,288	2,475 (3,705)	732 (1,023)
Rate Base Approved ($ mn)	2,270	2,427 (3,599)	742 (1,019)
Vertically Integrated	3,617	0.87 (0.33)	0.00 (0.00)
Customers (thous)	2,248	674 (932)	512 (792)
Quantity (TWh or Tcf)	2,260	16 (20)	99 (134)
Revenue ($ mn)	2,248	1,389 (1,999)	507 (629)
Operation Expense ($ mn)	1,535	1,280 (1,386)	459 (518)
Total Plant ($ mn)	1,535	8,770 (10,365)	1,787 (2,889)
Elec. Total Plant ($ mn)	1,166	8,256 (9,704)	- (-)
Elec. Dist. Plant ($ mn)	1,166	3,240 (4,337)	- (-)
Elec. Trans. Plant ($ mn)	1,166	1,405 (2,052)	- (-)
Elec. Gen. Plant ($ mn)	1,166	3,109 (4,183)	- (-)
Case Length (yr)	3,261	3.27 (4.01)	3.28 (3.42)

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 (2024), Energy Information Administration (2024a, 2024b), and Selvans et al. (2024), and author calculations.

over time. 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 is the key stylized fact that motivates our examination of the return on equity that utilities earn, the implications this may have for their incentives to invest in capital, and the costs they pass on to consumers.

For some components of our analysis we transform our data on rate case events

Figure 1: Return on Equity and Financial Indicators



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. Between March 2002 and March 2006 30-year Treasury rates are extrapolated from 1- and 10-year rates (using the predicted values from a regressing the 30-year rate on the 1- and 10-year rates).
Sources: Regulatory Research Associates (2024), Moody's (2021a, 2021b), Board of Governors of the Federal Reserve System (2021a, 2021b, 2021c), and US Bureau of Labor Statistics (2021). An inflation-adjusted version is presented in appendix Figure A.2.

into an unbalanced utility-by-month panel, filling in the rate of return variables in between each rate case. There are some mergers and splits in our sample, but our rate case data provider lists each company by its present-day company name, or the company's last operating name before it ceased to exist. With this limitation in mind, when we construct our panel we do so 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.[5]

Expanding our data in this way allows us to match with annual and monthly data that varies over the course of each rate case. This includes various market rates pulled from FRED, including 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.[6] Some of these were shown earlier in Figure 1. We also match credit rating, which we take from SNL's *Companies (Classic) Screener* (2021) and WRDS' *Compustat S&P legacy credit ratings* (2019). Utility company credit ratings have changed little over the last 35 years, suggesting there haven't been fundamental shifts in the riskiness of the sector during our sample period.

For much of the analysis we then aggregate our utility-by-month panel back to the original rate case level, averaging our various financial and macroeconomic indicators across each rate case. Here we conduct an initial descriptive regression analysis where we regress the approved return on equity on a range of characteristics of the utility, the regulator, and the case in question.

In Table 2 we see fairly consistent evidence that approved returns on equity tend to be higher for natural gas utilities and for vertically integrated firms. Conversely, approved returns on equity are lower for "wires-only" distribution utilities, and in

5. In contexts where a historical comparison is necessary, but the utility didn't exist in the benchmark year, we use the average of utilities that did exist in that state, weighted by rate base size.

6. 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).

Table 2: Relationship Between Approved Rate of Return and Various Utility and Regulator Characteristics

Model:	(1)	(2)	(3)	(4)
Variables				
Case Type = Transmission	-0.0406	0.0300	0.1105	0.3636*
	(0.2875)	(0.3141)	(0.3594)	(0.1818)
Case Type = VerticallyIntegrated	0.4190***	0.4367**	0.5245**	0.2717
	(0.1415)	(0.1795)	(0.2340)	(0.2509)
Decision Type = FullyLitigated	-0.3156***	-0.3168***	-0.2680***	-0.3473***
	(0.0801)	(0.1164)	(0.0669)	(0.0913)
Commissioners = Democrat	-0.1979	-0.0996	-0.2227	-0.3283
	(0.1389)	(0.2096)	(0.1562)	(0.2082)
Commissioners = Elected	0.1066	0.2308	0.6896*	0.8255
	(0.1304)	(0.1872)	(0.4027)	(0.6828)
Commissioners = Tenure (years)	-0.0374***	-0.0458***	-0.0118	-0.0181
	(0.0126)	(0.0161)	(0.0214)	(0.0223)
Service Type = NaturalGas	0.2564**	0.2142*		
	(0.1241)	(0.1237)		
log(Volume)		0.0529*		-0.0523
		(0.0297)		(0.0865)
Fixed-effects				
Year-month	Yes	Yes		
Year-month-Service Type			Yes	Yes
Company-Service Type			Yes	Yes
State-Service Type			Yes	Yes
Fit statistics				
Observations	3,384	2,068	3,384	2,068
R^2	0.86919	0.72462	0.92360	0.89955
Within R^2	0.04828	0.06409	0.03662	0.06403
Dependent variable mean	12.218	10.914	12.218	10.914

Clustered (State) standard-errors in parentheses
*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

NOTES: The dependent variable is approved RoE in percentage points. The omitted category for case type is Distribution. The omitted category for decision type is Settled. The omitted category for service type is electricity. The omitted category for political affiliation is Republican or Independent. The omitted category for appointment type is appointed. Columns 1–2 show results with only time fixed effects. Columns 3–4 include a rich set of time, company, state and service type fixed effects. Columns 2 and 4 incorporate data from EIA on the annual volume of gas or electricity provided by each utility, and are therefore limited to cases with a valid match from 1990 onwards.

rate cases where the proceeding was fully litigated. We also find some evidence that the composition of commissioners on the state regulator is correlated with outcomes. For instance, in some specifications a higher percentage of elected (vs appointed) commissioners is correlated with higher returns on equity. Having commissioners with longer tenures or more commissioners that identify as Democrats is correlated with lower returns on equity. Lastly, there is mixed evidence on whether larger utilities, as measured by their volume of energy delivered, tend to receive higher regulated returns on equity.

4 Empirical Findings

This section details our analysis strategy and results. Beginning with 4.1, we present estimates of the return on equity (RoE) gap using a variety of benchmarks. Section 4.2 examines potential mechanisms that can explain why the RoE gap has grown. Lastly, 4.3 estimates the impact of the RoE gap on capital investment and consumer costs.

4.1 Quantifying The Return on Equity Gap

Knowing the size of the RoE premium that companies receive is a challenge, and we take a couple of different approaches. Our primary approach draws on the capital asset pricing model (CAPM). The CAPM is widely used by regulators to support their decisions on utility equity returns. In principle the CAPM provides an objective way to quantify the expected returns for an asset given the risk of that asset and the returns available in the market over-and-above some risk-free rate. In practice its application remains open to a significant degree of subjective interpretation, in large part through the choice of values for its key parameters. As such, CAPM calculations can form part of the negotiation process between regulators and utilities, with the latter having a clear incentive to argue for assumptions that result in the CAPM producing higher estimates of the cost of equity.

We calculate predictions of the cost of equity for each utility using the standard CAPM formula: $RoE = R_f + (\beta \times MRP)$ where R_f is the risk-free rate, MRP is the market risk premium and β is the equity beta for the asset in question – namely each utility in our sample. Our assumed values for each of these parameters are broadly in line with published data (Damodaran 2022a) and values used by regulators at the federal level in the US, as well as those in other advanced economies such as the UK, Australia, and much of Europe (Australian Energy Regulator 2020; Economic Consulting Associates 2020; UK Regulatory Network 2020). The parameter values used by state PUCs in the US tend cause RoEs to fall at the higher end of the range we examine. We calculate the RoE gap by taking the contemporaneous difference between our CAPM estimate of RoE and each utility's allowed RoE. In appendix section B.1, we detail each of the CAPM parameters and the high degrees of freedom available in selecting each. We summarize the range of possible CAPM results in the Figure 2, where we present a central case, a high-RoE case, and a low-RoE case.

Our implementation of the CAPM approach points to persistent evidence of excess returns on equity in the past two decades. Our "central" case uses annual data on the risk-free rate, the β and market risk premium, meaning we are able to produce estimates from 1998 onwards. Here we see an RoE gap that generally lies in the 2–5 percentage point range over the past three decades. An RoE gap of up to 5 percentage points may seem very substantial, implying the regulated RoE is twice the reasonable cost reflective level. However, others have suggested the gap between the allowed RoE and the underlying cost of equity to be of a similar level using information on utility market-to-book ratios (Ellis 2025).

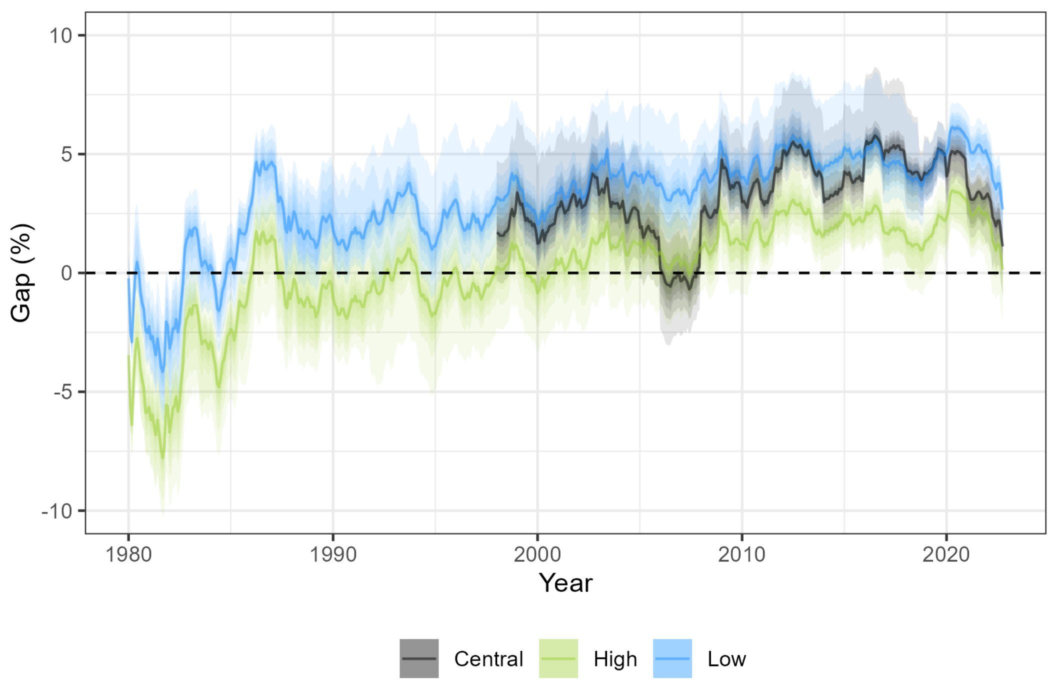
Our "high" version of the CAPM uses annual data on the risk-free rate, and then fixed assumptions for the β and market risk premium that are on the higher end of what has been historically used in the industry. As such, the resulting RoE gap is smaller, ranging from 0.5–2 percentage points over the past three decades. Allowed rates of return are therefore still above the predictions from our "high" CAPM case, although much more closely aligned with the current approach of US state PUCs. Notably though, projecting this same approach back in time appears to suggest that past allowed returns in the 1980s and 1990s were well below the estimated cost of equity. This seems implausible given the large capital expenditures the industry has continued to engage in over the last four decades.

Our "low" version of the CAPM uses annual data on the risk-free rate, and then fixed assumptions for the β and market risk premium that are on the lower end of what has been historically used in the industry. This is particularly true when looking at the practices of US regulators, which appear to utilize higher values than regulators in the UK, Europe, and Australia. As such, the resulting RoE gap is larger, ranging from 3–5 percentage points over the past three decades.

In addition to benchmarking against the CAPM, we also find a similar trend of widening RoE premiums when benchmarking against various measures of debt yields. While relatively simplistic, this kind of comparison draws on the intuition that the required return on equity should not stray too far from the required return on debt over time. Over the past three decades, the spread of RoE relative to 10-year US Treasury bonds or same-rated corporate bonds has increased by around 2–4 percentage points. This replicates the findings of others who have studied this issue by focusing on the spread against US Treasuries (Rode and Fischbeck 2019). Using an automatic update rule that adjusts at *half* the rate of changes in US treasury bond yields produces an RoE gap of 0–1 percentage points.[7] Over the same period, the spread relative to a utility's own approved return on debt has also grown by around 0–2 percentage points. Our debt yield benchmarks are discussed in more detail in appendix section B.2.

7. This draws on the approach taken by the Vermont PUC. Similar automatic update rules for RoE based on a proportion of the change in US Treasury bond yields have also been used in Canada and California.

Figure 2: Return on Equity gap, by different CAPM benchmarks (percentage points)



Notes: Gap percentage figures are a weighted average across utilities, weighted by rate base. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. “Central”, “High” and “Low” refer to different Capital Asset Pricing Model benchmarks. See section 4.1 for details of each benchmark calculation.

International comparisons can also be informative. To illustrate this we gather data on allowed returns on equity for gas and electric utilities in the United Kingdom. Here we find that approved RoE in the US has been around 0–4 percentage points higher than approved RoE in UK over the past three decades. A similar premium would likely emerge when comparing to utilities in other countries in Europe which have tended to approve similar rates of return to those we find for the UK. Of course there's no particular reason to think the UK regulator is setting the correct RoE, and there are good reasons to think that US PUCs should not simply adopt UK rates of return – there are many differences between the utility sector and investor environment in the US and UK. Even so, it is notable that other countries are able to attract sufficient investment in their gas and electric utilities while guaranteeing significantly lower regulated returns than are available in the US context. Our benchmark against UK regulatory decisions is discussed in more detail in appendix section B.3.

Overall, our analysis points to a substantial gap between US utilities' approved RoE and various benchmark measures of their underlying capital costs. To explain these large gaps, at least one of three things must be true: (1) historically, utilities were under-compensated for their capital costs, (2) today, utilities are over-compensated for their capital costs, or (3) the structure of utilities' capital costs – and their relationship with other capital markets – has changed dramatically over time. Of these options, (2) is likely the most plausible.

4.2 Potential Mechanisms

The existence of a persistent gap between the return on equity that utilities earn and various measures of the cost of capital they face could have a number of explanations. To try and understand plausible mechanisms we examine three lines of inquiry: (1) whether there are asymmetric adjustments to increases or decreases in underlying capital cost benchmarks; (2) whether utilities strategically time their rate cases to maximize equity returns; and (3) if regulators are motivated by overall prices rather than accurately setting the cost of equity.

4.2.1 Asymmetric Adjustment of Equity Returns

Many studies in several industries have documented that positive shocks to firms' input costs feed through into prices faster than negative shocks (Peltzman 2000; Frey and Manera 2007; Gwin 2009). This pattern has been most extensively studied in the gasoline sector – see Kristoufek and Lunackova (2015) and Perdiguero-García (2013) for reviews of the literature. Building on early work by Bacon (1991) and Borenstein, Cameron, and Gilbert (1997), there are now a wealth of studies examining how positive shocks to crude oil prices lead to faster increases in retail gasoline prices than negative shocks to crude oil prices lead to decreases in retail gasoline prices. This is the so-called "rockets and feathers" phenomenon. A range of explanations for this have been explored, most notably tacit collusion, market power, and the dynamics of consumer search.

In our setting we do observe that a change in some benchmark index (e.g. US Treasuries or corporate bonds) appears to feed through into the regulator-approved return on equity for utilities. This can be seen in Figure 1 where relatively short-run spikes in US Treasuries or corporate bond yields correlate with corresponding spikes in allowed returns on equity. US Treasury bond yields are also an important direct input to CAPM calculations used during the rate case process. Given the sluggish pace at which returns on equity have come down over the longer-term, especially when compared to various benchmark measures of the cost of capital, it therefore seems plausible to think that this pass-through relationship may function differently depending on whether it is a positive or a negative shock. To test this we follow the literature on asymmetric price adjustments and estimate a vector error correction model.

Early studies of asymmetric price adjustments tended to work with single time series of their variables of interest. In our case, we have a panel of rates of return that are divided up across utilities and states. In our main specification we conduct our analysis at the state level, as this allows us to have a balanced panel, while still maintaining the resolution of where decisions are being made: state public utility commissions. To do this, we collapse our company–state–month panel to a state-by-month panel. We do this by averaging the returns on equity from any rate cases decided in a given state in a given month, and then filling forward for any months where there are no new rate cases decided in a state. As a robustness check we also examine versions of the analysis at the original company–state-by-month panel level and find consistent results. See the appendix for further details.

To estimate the vector error correction model we first estimate the long-run relationship between the return on equity for unit i in period t ($RoE_{i,t}$) and a lagged benchmark index of the cost of capital ($Index_{i,t-1}$).[8] We include unit fixed effects, σ_i, in line with other studies of asymmetric adjustment in a panel setting (Asane-Otoo and Dannemann 2022). In our preferred specification our fixed effects are at the state level, and we then estimate an adjustment relationship common to all states.

$$RoE_{i,t} = \phi Index_{i,t-1} + \sigma_i + \varepsilon_{i,t} \tag{1}$$

In the second step we then run a regression of the change in RoE on three sets of covariates: (1) m lags of the past changes in RoE, (2) n lags of the past change in the index, and (3) the residuals from the long-run relationship, $\hat{\varepsilon}_{i,t}$, lagged from the previous period. To examine potential asymmetric adjustment, each of these three sets of covariates is split into positive and negative components to allow the

8. Here, we use 10-year Treasuries as the benchmark. We also conduct unit root tests. Because of the panel setting we use a panel unit root test developed by Maddala and Wu (1999). Our tests fail to reject non-stationarity in levels and reject non-stationarity in first differences.

coefficients for positive changes to differ from the coefficients for negative changes. Once again, we include unit fixed effects, σ_i.

$$
\begin{aligned}
\Delta RoE_{i,t} = & \sum_{j=1}^{m} \gamma_j^{+} \Delta RoE_{i,t-j}^{+} + \sum_{j=1}^{m} \gamma_j^{-} \Delta RoE_{i,t-j}^{-} \\
& + \sum_{j=1}^{n} \beta_j^{+} \Delta Index_{i,t-j}^{+} + \sum_{j=1}^{n} \beta_j^{-} \Delta Index_{i,t-j}^{-} \\
& + \theta^{+} \hat{\varepsilon}_{i,t-1}^{+} + \theta^{-} \hat{\varepsilon}_{i,t-1}^{-} + \sigma_i + \upsilon_{i,t}
\end{aligned}
\tag{2}
$$

To be clear, the asymmetric adjustment process we estimate using this model will mechanically find that in the long run, cost increases or decreases ultimately converge to the same level of pass-through to utility rates of return. In this way, our analysis here cannot directly explain persistent long-run gaps. However, this approach does still provide important insights into short- and medium-term dynamics in the regulatory process that, when repeated over time in multiple rate cases, may help explain the trends highlighted thus far.

We present the results of our analysis of asymmetric adjustment in Figure 3, where we plot the cumulative adjustment function. We simulate the impact on the utility rate of return from a one percentage point shock to the underlying benchmark index. In this case we conduct our analysis at the state level using approved rates of return and nominal 10-year US Treasuries as our benchmark rate. We plot the change in the nominal rate of return on equity over the subsequent six years.[9]

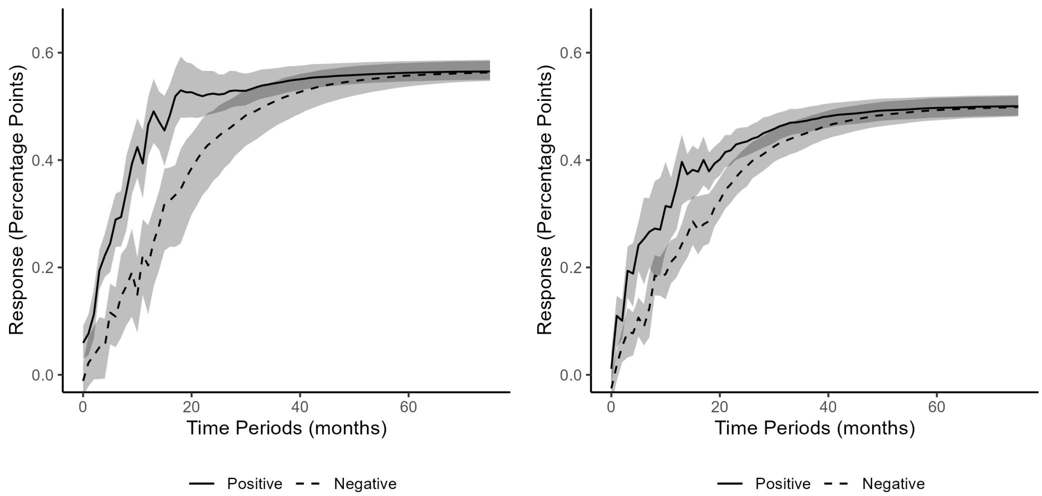
As can be seen in Figure 3, we find evidence of asymmetric adjustment. Rates of return adjust faster to a positive shock (solid line) than to a negative shock (dashed line). In the long run, both converge to a roughly 50% pass-through rate.[10]

9. To do this we rely on the methodology set out by Borenstein, Cameron, and Gilbert (1997) and use bootstrapping to derive 95% confidence intervals. We block bootstrap at the state level, using 1000 draws.

10. It is notable that the coefficient estimates we find for ϕ are generally close to the adjustment factors used in the automatic update rules employed by the Vermont PUC and California PUC (discussed earlier). This suggests these rules appear to largely formalize existing trends.

The degree of asymmetric adjustment appears strongest in the rates of return that utilities propose, but is still present to a notable extent in the rates of return that regulators ultimately approve. The extent of asymmetric adjustment is even more pronounced in the analysis conducted at the utility level which can be found in appendix Figure C.1.

Figure 3: Asymmetric Cumulative Adjustment Path following Shock to Benchmark Index



(a) Proposed Rates *(b) Approved Rates*

NOTES: Lines represents the cumulative adjustment path following a one percentage point change to the benchmark index. Solid line is for an increase in the index and dashed line is for a decrease. 95% confidence intervals are estimated via block bootstrapping on states, with 1000 replications. The plotted results use a benchmark index of 10-year US Treasuries. Analysis across the two panel columns is conducted with either proposed or approved rates of return. See calculation details in section 4.2.1.

4.2.2 Strategic Rate Case Timing

There is not an obvious economic reason why this kind of asymmetric adjustment should arise in this context, which leaves us with explanations focused on the political economy of the regulatory process itself. One mechanism that we explore relates to the timing of when rate cases are initiated and thus how long they last.

In principle many regulators conduct rate cases that are intended to last for a set amount of time. So if a state PUC sticks to a consistent 3 year schedule and a rate case proceeding is resolved at the start of 2012, the prices a utility can charge would be fixed until the start of 2015, and then a new rate case would begin.[11] In practice the timing and duration of rate cases frequently deviates from a regular schedule. Utilities generally have the discretion to initiate a new rate case filing, and providing the regulator agrees to proceed, firms may be able to systematically vary when they initiate new rate cases to their own benefit.

To examine this possibility we regress the RoE gap on the length of the rate case. We include fixed effects at the service type by month-of-sample, service type by company and service type by state level. The variation used for identification is therefore both within-state and within-utility. If there is strategic timing of when utilities initiate rate case we would expect to see a significant positive relationship between the RoE gap and rate case length.

Table 3 shows the results of this analysis. Here we do indeed see evidence of strategic timing. A one year increase in rate case length is associated with a 0.14 percentage point increase in the RoE gap. There are some potential outliers in the sample with particularly short or long gaps between rate cases. These outliers could reflect genuine rate case durations, or if there are rate cases missing from our sample these outliers could be erroneous values. However, limiting the sample to rate cases longer than one year and shorter than ten years reveals a similar-size effect.

11. The actual rate case proceeding (i.e. the deliberations between a new filing being submitted and the decision being resolved) generally lasts around 10 months on average. In this simple example one could imagine the utility filing to begin the process for its next rate case in early 2014. Revenue during the rate case period is still subject to any automatic adjustment clauses that may be in place.

4.2.3 Regulator Prioritizing Total Price Level

One further explanation for the emergence of the RoE gap could be that regulators have different priorities besides setting a capital-cost-reflective rate of return. In particular, there is evidence that regulators may instead be primarily concerned with the overall level of the energy prices that consumers face (Joskow 1974; Hausman 2019). Where this is the case, utilities may be able to have excessive rates of return approved for their capital costs where reductions in other cost drivers enable them to keep total prices low. This would also consistent with evidence that utilities increased transmission and distribution capital investments during periods of lower wholesale costs following the divestiture of their regulated generation assets (Cicala 2025).

To examine this possibility we could regress the RoE gap on the total average gas or electricity prices. Importantly, average total retail prices and the RoE gap are necessarily endogenous – a higher or lower RoE directly determines the capital costs that are then recovered through the overall retail price. As such, it is difficult to draw firm conclusions from examining the relationship with retail prices in this way. However, an alternative approach may be to look at how the RoE gap responds to wholesale prices instead. The capital costs incurred by the utility (e.g. to build and maintain the transmission and distribution grid) are largely distinct from the near-term wholesale cost of gas and electricity. Variations in wholesale costs are also generally passed on to consumers through automatic adjustment clauses. Rising wholesale costs will therefore increase the total prices paid by consumers, but should not necessarily directly affect a utility's cost of equity or capital costs more broadly.

Table 3 shows the results of regressing the RoE gap on wholesale prices.[12] For

12. For gas utilities we take their wholesale gas price to be the state-level citygate price. For electric utilities we do not have spatially disaggregated wholesale electricity price data extending back to the beginning of our sample period. As such we use state-level data on the input fuel price for in-state gas-fired power plants. Gas-fired power plants are often the marginal source of generation, and so

each service type (electric or natural gas), we include fixed effects for each month-of-sample, company, and state. The variation used for identification is therefore both within-state and within-utility. Here we do see a consistent negative relationship. A 1% increase in wholesale prices is associated with a 0.3 percentage point decrease in the RoE gap. This is suggestive evidence that regulators may set stricter rates of return when wholesale costs are relatively high, and more generous rates of return when wholesale costs are relatively low.

Table 3: Relationship Between RoE Gap, Rate Case Length, and Nominal Energy Prices

Model:	(1)	(2)	(3)	(4)
Variables				
Case Length (years)	0.1358***	0.1400***	0.1327***	0.1254***
	(0.0161)	(0.0265)	(0.0168)	(0.0235)
log(Wholesale Price (p/KWh))			-0.3167*	-0.2612*
			(0.1647)	(0.1453)
Fixed-effects				
Service Type-Year-Month	Yes	Yes	Yes	Yes
Service Type-Company	Yes	Yes	Yes	Yes
Service Type-State	Yes	Yes	Yes	Yes
Fit statistics				
Observations	3,203	2,475	2,807	2,206
R^2	0.90	0.91	0.91	0.92
Within R^2	0.19	0.07	0.18	0.07
Dependent variable mean	1.5	1.7	1.8	1.9
1 < Case Length < 10	No	Yes	No	Yes

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

NOTES: The table uses the gap between approved RoE and 10-year US Treasuries. The dependent variable is the RoE gap. Case length refers to the number of years a rate case lasts. Columns 1 and 3 include the entire sample. Columns 2 and 4 are limited to rate cases with durations shorter than ten years and longer than one year. Wholesale price refers to the average wholesale electricity or gas price for a given state. For electric utilities this is based on the input fuel price for in-state gas-fired power plants. For gas utilities this is the state-level citygate gas price. Columns 1–2 only have case length as the explanatory variable. Columns 3–4 have case length and wholesale prices as the explanatory variables.

there is a high degree of correlation between wholesale gas and electricity prices. We find similar results if we use input fuel prices for in-state coal-fired power plants instead.

4.3 Impacts on Capital Costs

We turn now to the capital assets that utilities are able to earn a rate of return on: the rate base. To the extent a utility's approved RoE is higher than their actual cost of equity, they will have a too-strong incentive to have capital on their books. The result is inefficient investment in capital and ultimately excess costs for consumers.

4.3.1 Capital Investment Incentives

The scope for rate of return regulation to distort utility capital investment incentives has long been theorized and studied (Averch and Johnson 1962). However, the empirical evidence for the Averch–Johnson effect has been viewed as quite weak, with most studies relying on cross-sectional comparisons, comparing regulated with deregulated states, relying on plant-level (rather than firm-level) data, or being limited by small sample sizes (Joskow and Rose 1989; Joskow 2005). We remedy these shortcomings by using a large dataset of rate cases that are necessarily at the firm-level, and by employing either a fixed effects or first differences approach that allows us to examine within-state and within-utility changes.

To investigate the change in utilities' capital assets and operating expenditures we start by estimating $\hat{\alpha}$ from the following first difference specification, where we regress our measure of capital assets on the estimated RoE gap.

$$\Delta \log(Cap_{i,t}) = \alpha \Delta RoE_{i,t}^{gap} + \lambda_t + \epsilon_{i,t} \tag{3}$$

Here an observation is a utility rate case for utility i in year-of-sample t. The dependent variable, $Cap_{i,t}$, is the value of utility plant recorded in the final year of the rate case. The ideal independent variable would be the gap between the allowed RoE and the utilities' costs of equity. Because the true value is unobservable, we use our measure of the $RoE_{i,t}^{gap}$. 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 focus on our benchmark against US treasuries, but we find very similar results when using our various other CAPM measures. Differences between the measures are largely absorbed by the first differencing and fixed effects.

Our goal is to make causal claims about α, so we are concerned about omitted variables that are correlated with both the estimated RoE gap and the change in rate base. Our regressions therefore include time fixed effects, λ_t, at the month-of-sample level. Our first differencing takes place at the service type, utility company, and state level. Fixed effects specifications that include these variables as unit fixed effects, σ_i, can be found in appendix table D.1. The identifying variation in our preferred specification is the difference in the RoE gap within the range of rate case decisions for a given utility and a given state, relative to the annual average across all utilities. We did also consider and rule out a number of instrumental variables strategies. These are documented in the appendix.

The first differencing and fixed effects handle many of the most critical threats to identification, such as macroeconomic trends, technology-driven shifts in electrical consumption, or static differences in state PUC and utility company characteristics. We also capture the fact that utilities that operate in multiple states still file rate cases with each state's utility regulator. Of course, potential threats to causal identification remain. One possibility is omitted variables – perhaps regulators in some states change their posture toward utilities over time, in a way that is correlated with both the RoE and the change in their capital assets and rate base. Another possibility is reverse causation – perhaps the regulator pushes for more capital investment (e.g. aiming to increase local employment) and the utility, facing increasing marginal costs of capital, needs a higher RoE.

Table 4 shows our results from regressing utility capital assets on the RoE gap. We find that a 1 percentage point increase in the approved RoE gap leads to a ~4% increase in capital assets (column 1). Because the return on equity is earned on the capital that makes up the rate base, utilities' incentive to increase their capital assets should differ from their incentive to increase their operating expenditures. When looking at the effect on operating expenses, we find no significant positive effect (column 2). This is consistent with theoretical predictions and provides new potential evidence for the Averch–Johnson effect, with a positive RoE gap leading utilities to shift toward more capital-intensive activities.

Table 4: Relationship Between Approved Rate of Return and Utility Capital, Opex, and Rate Base

	Capital	Op Ex	Rate Base
Model:	(1)	(2)	(3)
Variables			
RoE gap (%)	0.0340**	-0.0149	0.0262***
	(0.0123)	(0.0116)	(0.0092)
Fit statistics			
Observations	1,298	1,300	1,884
R^2	0.38	0.51	0.25
Within R^2	0.03	0.003	0.007
Dep. var. mean	8,253.6	1,180.4	1,999.8

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

NOTES: The table uses the gap between approved RoE and 10-year US Treasuries. Dependent variables are logs of nominal USD. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities, or combined electric and natural gas utilities. Column 1 refers to the total capital (utility plant) at the end of the rate case. Column 2 refers to the total opex (operating expenses) at the end of the rate case. Column 3 refers to the total rate base at the end of the rate case (i.e. the value approved in the subsequent rate case).

Studying the direct impact on the rate base is less straightforward because the rate base we observe for a given rate case is usually decided simultaneously with the return on equity. We therefore examine the impact of the RoE gap on the rate base approved in the *subsequent* rate case. Here we find a significant positive effect, with a 1 percentage point increase in the approved RoE gap leading to a ~3% increase in the approved rate base (column 3). This is similar to the effect we find for capital assets (column 1). In fact, there is a strong correspondence between our measure of capital assets (from the FERC data) and our data on the rate base (from the original rate case data). A 1% increase in capital assets is associated with a 0.4–0.7% increase in the rate base, depending on the choice of fixed effects. As such, we take our FERC-reported capital asset results as providing a good guide to the impact of the RoE gap on capital ownership.

In addition to looking at total capital assets and operating expenditures, we are also able to look in more detail for electric utilities at what is driving the observed effects. These results can be found in Table 5. Here we see the increase in capital assets appears to be most clearly driven by distribution grid investments. This makes sense given these make up the largest proportion of the assets that are likely to be subject to rate of return regulation. For transmission and generation plant we limit our sample to rate cases where the utility is regulated as a vertically integrated entity. This reduces the chance we are capturing merchant generation assets or transmission infrastructure regulated at the federal level. Here we do also see positive effects but they are less precisely estimated and so are not statistically significant. Lastly, the other remaining capital assets (e.g. office buildings, maintenance trucks, IT equipment) also see a positive significant effect, although these make up a much smaller proportion of total assets.

Consistent with the prior results, we also find no clear increase in total operating costs. This is primarily due to there being no change in generation costs as these make up the vast majority of operational costs.[13] For some of the smaller components of operating costs, such as distribution and other operating costs, we do see some evidence of an increase in response to the RoE gap. These additional operating costs could be a byproduct of utilities increasing their capital investments, which may in

13. In fact the negative coefficient we observe is consistent with the earlier analysis of the relationship between the RoE gap and wholesale prices.

Table 5: Relationship Between Approved Rate of Return and Electric Utility Capital and Opex by Expenditure Type

Model:	Total (1)	Dist (2)	Trans (3)	Gen (4)	Other (5)
Variables					
RoE gap (%)	0.0362**	0.0309***	0.0347	0.1095	0.0327*
	(0.0152)	(0.0100)	(0.0338)	(0.0657)	(0.0177)
Fit statistics					
Observations	978	981	673	738	969
R^2	0.44	0.56	0.34	0.46	0.41
Within R^2	0.03	0.04	0.009	0.03	0.01
Dep. var. mean	9,580.4	3,812.8	1,894.6	4,614.4	573.3

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

(a) Capital

Model:	Total (1)	Dist (2)	Trans (3)	Gen (4)	Other (5)
Variables					
RoE gap (%)	-0.0085	0.0466***	0.0356	-0.0146	0.0237*
	(0.0138)	(0.0162)	(0.0401)	(0.0198)	(0.0118)
Fit statistics					
Observations	905	905	683	685	905
R^2	0.58	0.37	0.47	0.71	0.40
Within R^2	0.002	0.02	0.005	0.004	0.01
Dep. var. mean	1,611.4	120.1	100.2	1,227.1	291.5

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

(b) Operating Expenses

Notes: The table uses the gap between approved RoE and 10-year US Treasuries. Dependent variables are logs of nominal USD. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities. Columns 1–5 in the top panel refer to capital assets (utility plant) broken down by type into total, distribution, transmission, generation, and other. Columns 1–5 in the bottom panel refer to operating expenses broken down by type into total, distribution, transmission, generation, and other. To ensure we focus on non-merchant capital assets regulated by PUCs, columns 3–4 limit the sample to utilities where the rate case is classed as vertically integrated. The specification used is the same as is used in Table 4.

turn come with associated operations and maintenance costs. In aggregate these non-generation operating costs are relatively small in scale.

Lastly, for all our various results we also examine versions that divide the outcome variable by the kWh of energy delivered. These measure the response in intensity terms – how the RoE gap affects capital ownership and operating costs per kWh delivered. Throughout we find similar results to those already set out here, and the full details can be found in the appendix. [14]

4.3.2 Excess Consumer Costs

Utilities engaging in excess capital investment and earning inflated equity returns has implications for consumer costs. Here we take into account our findings on the scale of the RoE premium utilities may be earning, and the way that premium distorts their capital investment decisions. As a caveat, we note that utilities 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 utility 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.

Across our various CAPM measures and using the existing rate base we find excess costs over the past three decades averaged $2.8–9.1 billion per year, with a central estimate of $6.2 billion per year.[15] The economic welfare loss is likely smaller than these excess cost measures – the excess capital provides non-zero benefit,

14. Appendix tables E.1 and E.2, correspond to our main tables 4 and 5. Appendix tables E.3 and E.4 present the per-kWh version of appendix tables D.1 and D.2.

15. We focus here on the last three decades to ensure comparability between benchmarks with differing levels of completeness in earlier years.

and the ultimate recipients of utility revenues place some value on the additional income.[16]

Accounting for the way the RoE gap can affect capital ownership increases our estimate of the excess cost to consumers using our CAPM measures to $3.1–10.6 billion per year, with a central estimate of $7.2 billion per year.[17] More than four fifths of these costs come from the electricity sector. A detailed breakdown of these costs across our different benchmarks can be found in Appendix G.

5 Conclusion

The utility sector is a capital-intensive industry, and a corporate utility structure requires investors in the industry be fairly compensated for the opportunity cost of their investments. Getting this rate of return correct, particularly the return on equity, is challenging, but is a task of first-order importance for regulators. In making their determinations, regulators must balance their mandate to keep costs down with the need to bring forward significant new capital investment to modernize an aging grid and deliver on the clean energy transition.

Our analysis shows that the return on equity that utilities are allowed to earn has changed dramatically relative to various financial benchmarks in the economy. We estimate that the current average approved return on equity is markedly higher than various benchmarks and historical relationships would suggest. These results are necessarily uncertain, and depending on our chosen benchmark the cost of equity premium utilities receive ranges from around half a percentage point to greater than four percentage points. Put another way, even our highest benchmarks come in below the allowed rates of return on equity that regulators set today.

16. The RoE gap will ultimately affect utility rates, including the costs of buying electricity, but the ultimate impact on consumption decisions will depend on each utility's rate structure. Analyzing these is outside the scope of this paper.

17. For comparison, total 2019 electricity sales by investor owned utilities were $204 billion, on 1.89 PWh of electricity (US Energy Information Administration 2020).

We link this divergence between the return on equity regulators approve and the cost of equity utilities face to inefficiencies and asymmetries in the rate case process. In a novel analysis, we find evidence that increases to benchmark measures of the cost of capital lead to faster rises in utility returns on equity than is the case for decreases. This is the so-called "rockets and feathers" phenomenon and could be indicative of regulators being more responsive to pressures from the utilities they regulate than from consumers' demands to keep prices down. We provide evidence this is at least partially driven by utility companies strategically varying the timing and duration of rate cases. We also highlight other potential mechanisms, including regulators being responsive to the overall level of prices rather than changes in underlying capital costs.

We then turned to the implications for capital investment incentives. Here we do indeed find new evidence that utilities alter their capital investments in response to the return on equity premium they are likely to earn on those assets. We estimate that an additional percentage point in the RoE gap leads to a ~3–4% increase in utility capital assets. For electric utilities this appears to be led by increased investments in their distribution assets. We find no clear impact of the RoE gap on utilities' operating expenditures. These findings are new potential evidence of the Averch–Johnson effect that has long been discussed in this industry.

Combining our preferred benchmark for the gap with our estimated impact on capital investment puts the excess rates collected from consumers at around $7 billion per year. The impact on overall welfare remains unclear – any excess capital investment presumably has some non-zero value. However, we take our measure of excess costs as providing insight into the degree to which the existing regulatory process may be leading to higher prices that lead to a significant transfer from consumers to shareholders.

If utilities are earning excess returns on equity, a key challenge is to identify what changes to the ratemaking process may help remedy this. Regulators have taken numerous steps over the past few decades to improve the way costs are passed through into rates. For instance, explicit benchmarking and automatic update rules were introduced for fuel costs decades ago. It seems plausible that they could also be used to help equity costs adjust more quickly to changing market conditions, and do so in ways that are less prone to the subjective negotiations and political considerations of the ratemaking process.

However, the cost of equity is unlikely to perfectly track any single benchmark in the same way as the cost of fuel. Also the automatic update rules for equity returns that have already been put in place by some PUCs have done little to prevent the trends we highlight.[18] As such, a significant degree of regulatory judgment is inevitable in this area.

A clear first step for improving the decisions regulators make over the cost of equity is to avoid some of the arbitrary "rules of thumb" that have been employed to date – see for instance, the surprisingly frequent practice of rounding the RoE to whole numbers documented in appendix figure F.1. Bolstering the financial expertise of regulators is a promising remedy here.[19] Seemingly objective methods like the capital asset pricing model cannot provide a definitive answer on the cost of equity. As we have documented, a range of plausible input assumptions can lead to widely divergent estimates of the cost of equity. When incorporating evidence from these methods regulators need to have the expertise to understand their limitations and push back on the assumptions utilities put forward when using them.

Given our findings on the ways utility companies may systematically alter the timing and duration of rate cases, public utilities commissions could remedy this by committing to a fixed rate case review schedule. Regulators need to be mindful that

18. For instance, 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)

19. Azgad-Tromer and Talley (2017) found that providing finance training to regulatory staff had a moderate effect on moving rates of return closer to standard asset pricing predictions.

when utility companies file for new rate cases (or request extensions to an existing one), they have clear incentives to make these decisions in an asymmetric manner that increases equity returns. Regulators should also ensure that when setting the rate of return their decisions are not unduly influenced by favorable reductions in other costs that are largely outside of a utility's control (e.g. wholesale costs).

Lastly, process reforms may also be beneficial. In most rate case proceedings, utilities submit their planned expenditures and then regulators decide whether they are prudent. This relies on the notion that utilities are best placed to forecast their detailed needs for labor, materials, and, equipment (e.g. numbers of new transformers needed and where). However, it is less clear that utilities should take the lead when it comes to the cost of equity, especially given that this is so dependent on wider market forces, the performance of peer companies, and general investor sentiment. For this component of utility costs, the regulator could conduct its own independent internal analysis of the cost of equity first, and then consult on their proposals. In this way it is the regulator that is anchoring the starting point of the discussion, not the utility.

Our findings have important implications beyond just the additional cost they place on consumers. From a distributional standpoint, higher rates create a transfer from ratepayers to utility stockholders. A high rate of return for *regulated* utilities may also lead to a reshuffling of which assets are owned by regulated versus non-regulated firms. Finally, efficiently pricing energy has important implications for environmental policy, particularly with regard to encouraging electrification which is a key component of efforts to tackle climate change. These are all fruitful avenues for further research.

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Online Supplemental Appendix

A Detail on Data and Summary Statistics

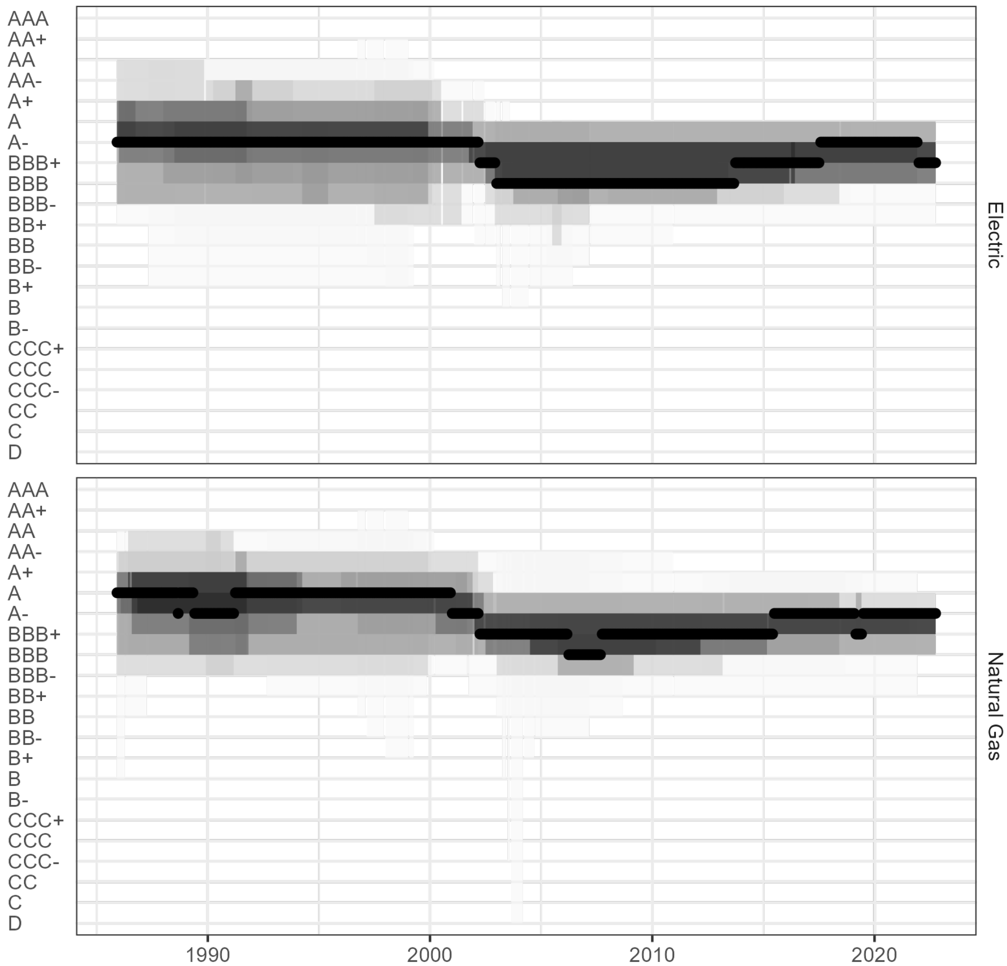
A.1 Credit Ratings Match

When matching credit ratings, we use *Companies (Classic) Screener* (2021) and *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.[1] Between these two sources, we have ratings data 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 A.1 we plot the median (in black) and various percentile bands (in shades of grey) of the credit rating for utilities active in each month. We note that the median credit rating has seen modest movements up and down over the past decades. 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. 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. 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.

1. 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 (to the lower rating) in the case of an even number of ratings.

Figure A.1: Utility Credit Ratings, 1985-2023



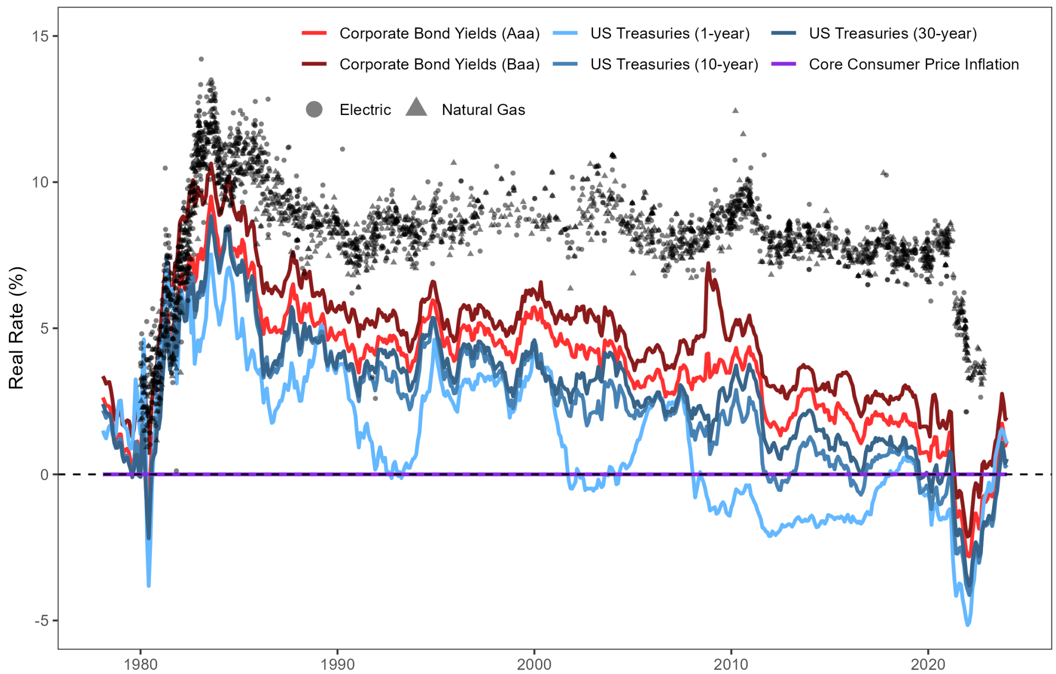
NOTE: Black lines represent the median rating of the utilities active in a given month. We also show bands, in different shades of grey, that cover the 40–60 percentile, 30–70 percentile, 20–80 percentile, 10–90 percentile, and 2.5–97.5 percentile ranges. (Unlike later plots, these *are not* weighted by rate base.) Ratings from C to B– are collapsed to save space.

SOURCE: *Companies (Classic) Screener* (2021) and *Compustat S&P legacy credit ratings* (2019).

A.2 Inflation-Adjusted Rates

In addition to the nominal values plotted in Figure 1, we also plot here the same data in real terms. Real values are calculated by subtracting core CPI.

Figure A.2: Return on Equity and Financial Indicators (Real Terms)



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 core CPI. Between March 2002 and March 2006 30-year Treasury rates are extrapolated from 1- and 10-year rates (using the predicted values from a regressing the 30-year rate on the 1- and 10-year rates).
SOURCES: Regulatory Research Associates (2024), Moody's (2021a, 2021b), Board of Governors of the Federal Reserve System (2021a, 2021b, 2021c), and US Bureau of Labor Statistics (2021).

B Detail on RoE gap benchmarks

B.1 Benchmarking to the Capital Asset Pricing Model

CAPM: Risk-free rate

The risk-free rate, R_f, is intended to capture the base level of returns from an effectively zero risk investment. Yields on government bonds are the common source for this information, although practitioners can differ over the choice of maturity (e.g. 10-year or 30-year) and the use of forecast future yields instead of past or current rates. These decisions can significantly affect the final cost of equity.[2] We use the contemporaneous yield on 10-year US Treasury bonds for our measure of the risk-free rate.

CAPM: Market risk premium

The market risk premium, *MRP*, captures the difference between the expected equity market rate of return and the risk-free rate.[3] This is generally calculated by taking the average of the difference in returns for some market-wide stock index and the returns for the risk-free rate. While this appears relatively straightforward, the final value can vary significantly depending on numerous factors. These can include: the choice of stock market index (e.g. S&P 500, Dow Jones etc.); the choice of averaging period (e.g. previous 10, 20, 50 years etc.); the return frequency (e.g. monthly, quarterly, or annual returns), and the method of averaging (arithmetic, geometric). These decisions can significantly affect the final cost of equity.[4] Our central case uses annual values for the market risk premium based on estimates that rely on both historical returns and an implied equity premium (Damodaran 2022b, 2022c, 2023). To capture the uncertainty in the market risk premium, our

2. For instance, in January 2018 the current yield on 10-year US Treasury bonds was 2.58%, the average yield from the past 2 years was 2.09%, and the forecast yield from Wolters Klewer (2022) for the next 2 years was 2.97%.

3. $MRP = R_m - R_f$, where R_m is the market return and R_f is the risk-free return.

4. For instance, in January 2018 using annual returns for the S&P 500 compared to the 10-year US Treasury bond and taking the arithmetic average over the past 5, 25, and 75 years produces market risk premiums of 14.8%, 5.2%, and 7.3% respectively (Damodaran 2022b).

"low" case assumes a constant *MRP* of 4.5 percent and our "high" case assumes a constant *MRP* of 7.5 percent. Our central case generally fluctuates between these two values.

CAPM: β

A firm's equity β, is a measure of systematic risk and thus captures the extent to which the returns of the firm in question move in line with overall market returns.[5] Regulated firms like gas and electricity utilities are generally viewed as low risk, exhibiting lower levels of volatility than the market as a whole. The calculation of β is subject to many of the same uncertainties mentioned above, including: the choice of stock market index; the choice of calculation period, and the return frequency.

It is also common to take β estimates from existing data vendors such as Merrill Lynch, Value Line, and Bloomberg. The choice of β depends on the bundle of comparable firms used and how they are averaged. Furthermore, these vendors generally publish β values that incorporate the so-called Blume adjustment to deal with concerns about mean reversion.[6] Because utilities generally have βs below one the adjustment serves to increase β and thus increase the estimated cost of equity produced by the CAPM calculation. Therefore, while the adjustment is plausible for many non-regulated firms, some authors have questioned its applicability to regulated firms like utilities (Michelfelder and Theodossiou 2013).

Lastly, the decision on setting β is complicated by the fact that βs calculated using observed stock returns are dependent on each firm's debt holdings and tax rate, which may differ from the particular utility being studied. To deal with this, an unlevered β can be estimated and then the corresponding levered β can be calculated for a specific debt-to-equity ratio, D/E, and tax rate, τ.[7] Here we take τ

5. β is calculated by estimating the covariance of the returns for the firm in question, R_i, and the market returns, R_m, and then dividing by the variance of the market returns: $\beta = Cov(R_i, R_m)/Var(R_m)$

6. The Blume Adjustment equation is: $\beta_{adjusted} = 0.333(1) + 0.667(\beta)$

7. The Hamada equation relates levered to unlevered β as follows: $\beta = \beta_{unlevered} \times \left[1 + (1 - \tau)\frac{D}{E}\right]$

to be the effective federal marginal corporate tax rate and we can directly observe the debt-to-equity ratio, D/E, in our data.

Our central case uses annual values for the utility industry β (Damodaran 2022d). We use the same $\beta_{\text{unlevered}}$ across utilities, and then calculate the β_{levered} for each company based on their observed debt to equity ratio. To capture the uncertainty in β, our "low" case assumes a constant $\beta_{\text{unlevered}}$ of 0.35 and our "high" case assumes a constant $\beta_{\text{unlevered}}$ of 0.4. Our central case generally lies between these two values and produces β_{levered} values mostly ranging from 0.6 to 0.9. The gap is plotted in appendix figures B.1, B.2, and B.3.

B.2 Benchmarking to Debt Yields

As an alternative to the CAPM approach we also consider measures based on benchmarking to wider measures of the cost of debt. The goal of these benchmarks is to answer the question: What would the RoE be today if the spread against the cost of debt had not changed since some baseline date? While relatively simplistic, this kind of approach draws on the intuition that the required return on equity should not stray too far from the required return on debt over time.

We consider a wide variety of debt measurements, including corporate bonds that share the same rating as the utility, the utilities' own return on debt, and two different updating rules based on US Treasury bonds. Throughout our analysis we use January 1995 as the baseline period. The date chosen determines where the gap between utilities' RoE and baseline RoE is zero. 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. Stated differently, the baseline year determines *when* the average gap is zero, but this is a constant shift that does not affect the overall trend. While January 1995 is not special, we note that picking a much more recent baseline would imply that utilities were substantially and continuously under-compensated for their cost of equity for many years of our early sample.

We first consider a benchmark index of corporate bond yields ("Corp") . Here we compare all utilities to the corporate bond index that is closest to that utility's own, contemporaneous debt rating.[8] To calculate the RoE gap we first find the spread between the approved return on equity and the bond index rate for each utility in each state in a baseline period. We then take this spread during the baseline period and apply it to the future evolution of the bond index rate to get an estimate of the baseline RoE. The RoE gap is the difference between a given utility's allowed return on equity at some point in time and this baseline RoE.

Our second bond benchmark adopts a similar approach to the first but benchmarks against US Treasuries ("UST"). The idea here is to ask: what would the RoE be today if the average spread against US Treasuries had not changed since the baseline date? This measure is calculated in exactly the same way as our first approach except the spread is measured against the 10-year Treasury bond yield in the baseline period, rather than the relevant corporate bond index.

For our third bond benchmark, we modify our benchmark against US Treasures by using an automatic update rule ("UST Auto") that adjusts at *half* the rate of changes in bond yields.[9] This is the approach used by Vermont since 2018. Similar approaches have been used in the past in California and Canada. Whether adjusting at 50% of the change in bond yields is the correct approach is unclear. For instance, Canada has used a 75% adjustment ratio in the past. What is clear is that even using this lower range, we still see a divergence between allowed equity returns today

8. We also examined a comparison against a single Moodys' Baa corporate bond index. Moody's Baa is approximately equivalent to S&P's BBB, a rating equal to or slightly below most of the utilities in our data (see Figure A.1). This avoids issues where utilities' bond ratings may be endogenous to their rate case outcomes. Using a single index also faces fewer data quality challenges. The findings using the single Moody's Baa bond index are broadly equivalent to those using a same rated bond index and our later approach using US Treasuries.

9. Define RoE' 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. RoE in year t is then: $RoE_t = RoE' + (0.5 \times (B_t - B'))$

and various bond yield benchmarks. Vermont PUC uses 10-year US Treasuries and set the baseline period as December 2018, for their plan published in June 2019. (*Green Mountain Power: Multi-Year Regulation Plan 2020–2022* 2020). In our case we also use 10-year Treasuries and set the baseline to January 1995. 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.[10] The gap is plotted in appendix Figure B.6.

The fourth bond benchmark we use is each utility's own regulator-approved return on debt. The idea here is to ask: what would the RoE be today if the average spread against the regulator-approved return on debt had not changed since the baseline date? Similar to the matched corporate bonds measure, this approach has the virtue of ensuring the benchmark accounts for the different risk characteristics of each utility, including how they change over time. The approved return on debt also appears to be a relatively transparent and uncontroversial aspect of the rate case process, with the regulator-approved value almost exactly matching the utility-proposed value. The gap is plotted in appendix Figure B.7.

B.3 Benchmarking to UK utilities

Finally, our last measure involves benchmarking against allowed returns on equity for gas and electric utilities in the United Kingdom. Here we consider the contemporaneous gap in nominal allowed RoE between the US and UK. Of course there's no particular reason to think the UK regulator is setting the correct RoE, and there are good reasons to think that US state PUCs should not simply adopt UK rates of return – there are many differences between the utility sector and investor environment in the US and UK. Even so, we think this benchmark still provides an interesting comparison.

10. Pre-1995 values are not particularly meaningful, but we can calculate them with the same formula.

The data on UK RoE are taken from various regulatory reports published by the Office of Gas and Electricity Markets (Ofgem).[11] The gap is plotted in appendix Figure B.8.

B.4 Results of RoE Gap Estimates

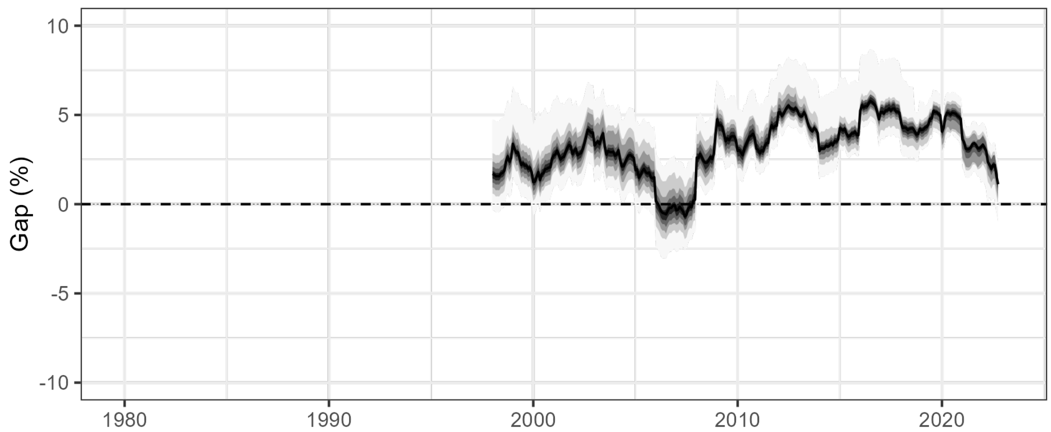
For each of the strategies we utilize, we plot the timeseries of the RoE gap. These are plotted in figures B.1 to B.8. In each plot, we present the median of our RoE gap estimates, weighting by the utility's rate base (in 2019 dollars). Our goal is to show the median of rate base dollar value, rather 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 grey, that cover the 40–60 percentile, 30–70 percentile, 20–80 percentile, 10–90 percentile, and 2.5–97.5 percentile (all weighted by rate base).

Table B.1 shows our RoE gap results broken out by gas and electric utilities.

Table B.2 shows our RoE gap results broken out by gas and electric utilities. Table D.2 shows our capital impact results for total capital assets across each of our RoE gap benchmarks.

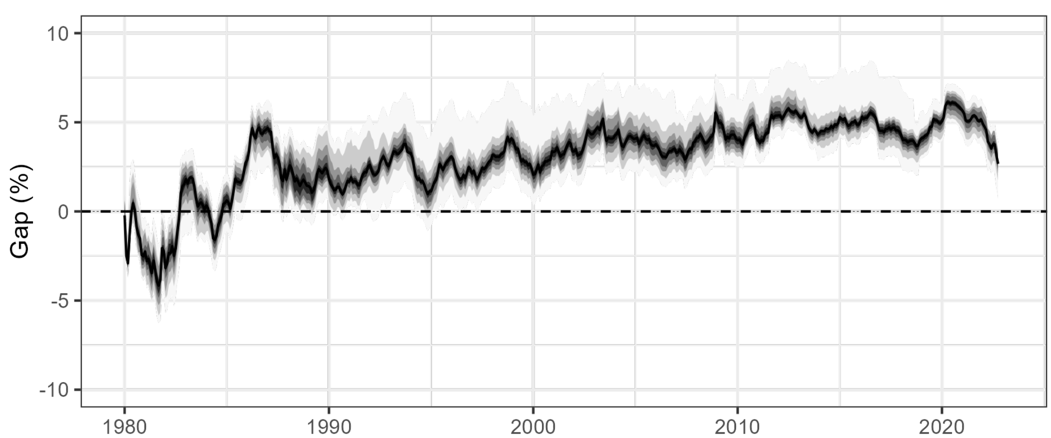
11. We were able to find information on allowed rates of return dating back to 1996. The relevant disaggregation into return on debt and return on equity was more readily available for electric utilities over this entire time period. For natural gas utilities we have this information from 2013 onwards. Importantly, UK rates are set in real terms and so we converted to nominal terms using the inflation indexes cited by the UK regulator.

Figure B.1: Return on equity gap, benchmarking to CAPM (central)



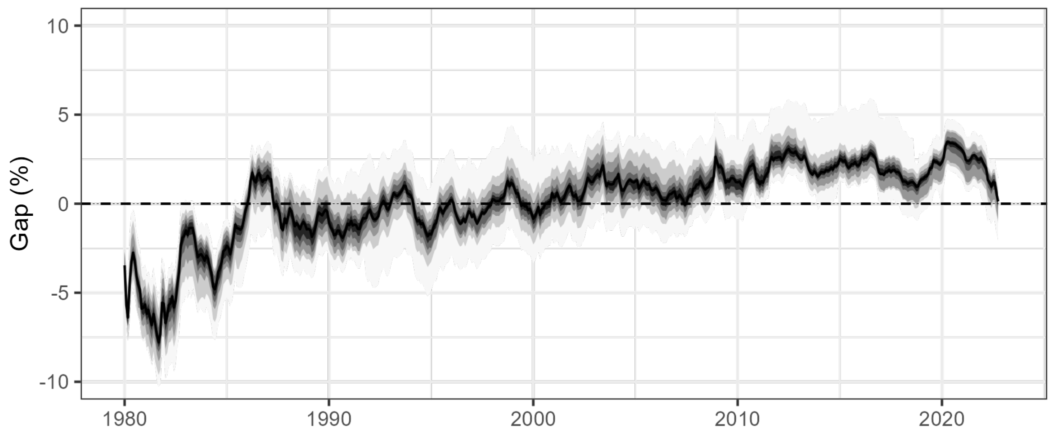
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.1. Note series begins in 1998 due to the coverage of the data sources used for the market risk premium and asset beta.

Figure B.2: Return on equity gap, benchmarking to CAPM (low)



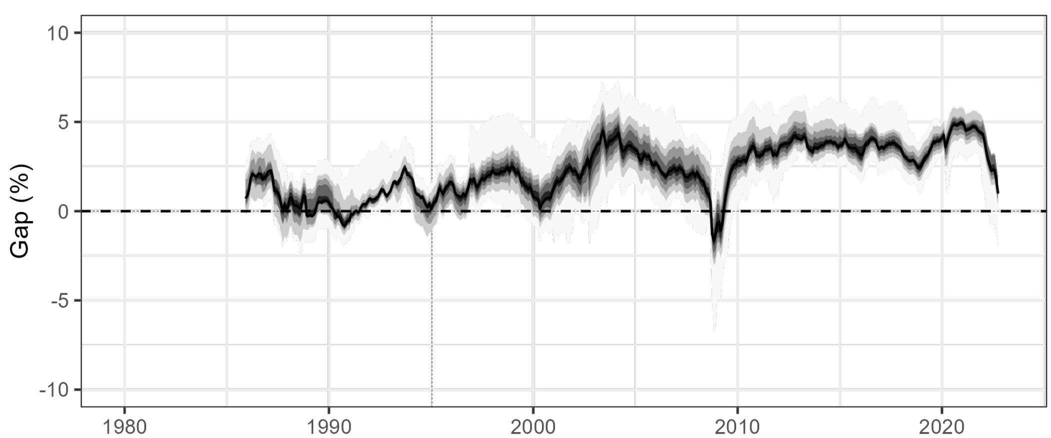
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.1.

Figure B.3: Return on equity gap, benchmarking to CAPM (high)



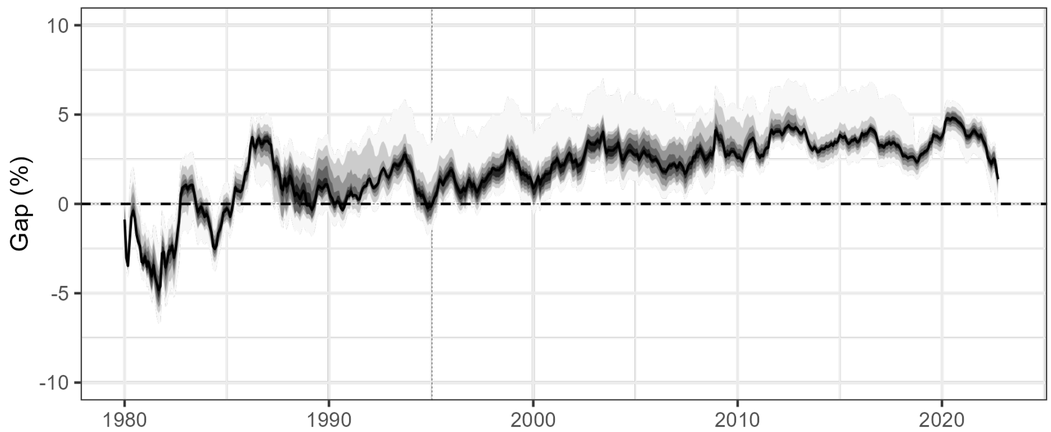
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.1.

Figure B.4: Return on equity gap, benchmarking to same-rated corporate bonds



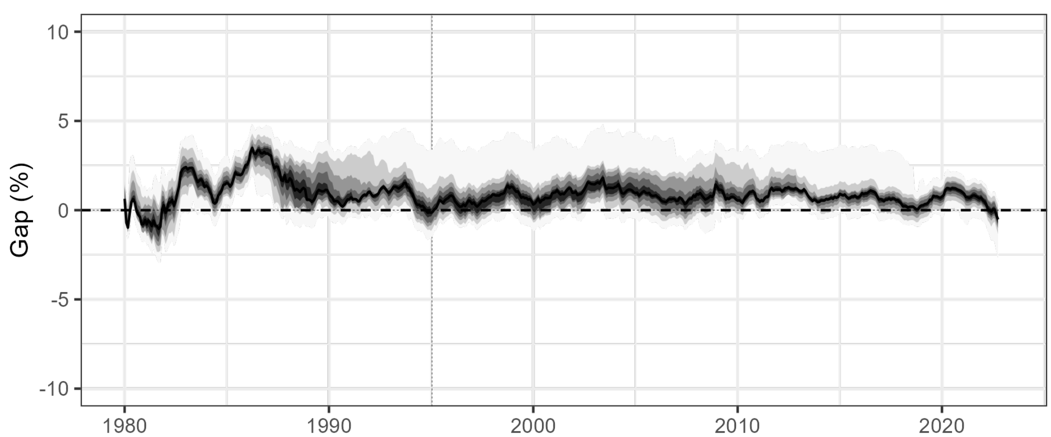
Base year is 1995. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. Series start date is limited by credit rating data. See calculation details in section B.2. Note series begins in 1986 due to the coverage of the data sources used for credit ratings.

Figure B.5: Return on equity gap, benchmarking to 10-year Treasuries



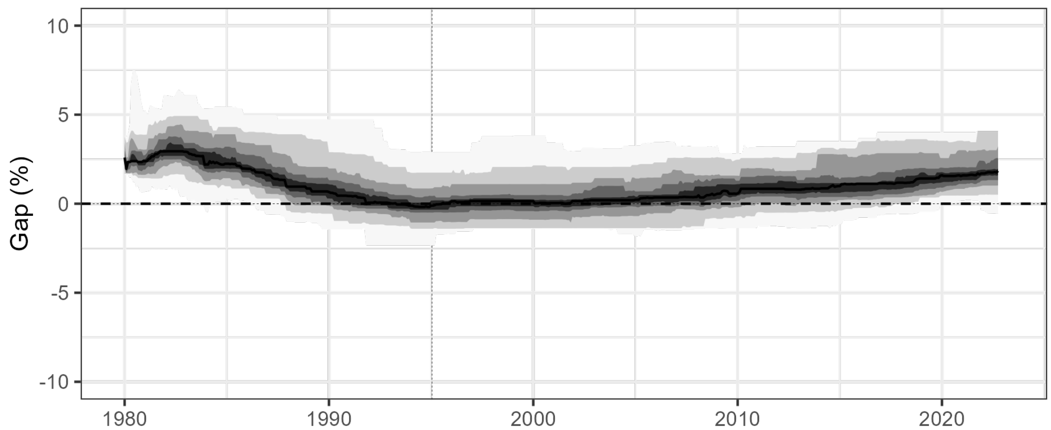
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.2.

Figure B.6: Return on equity gap, benchmarking to 10-year Treasuries (50% adjustment ratio)



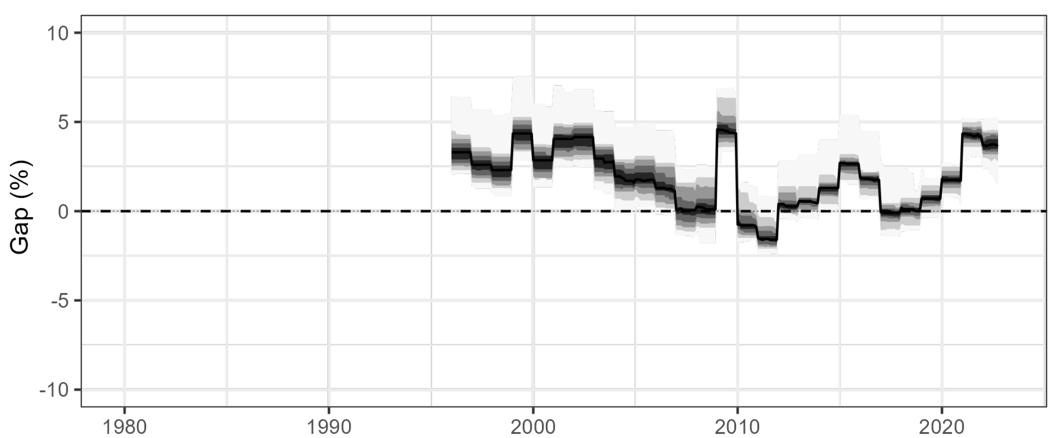
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.2.

Figure B.7: Return on equity gap, benchmarking to approved return on debt



Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.2.

Figure B.8: Return on equity gap, compared to UK utilities



Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section B.3. Note series begins in 1996 due to the coverage of the data sources used for UK regulatory decisions.

Table B.1: Return on Equity gap, by different benchmarks (percentage points)

	CAPM central	CAPM high	CAPM low	Corp	RoD	UST	UST Auto	UK
1982		−4.81	−1.27		3.15	−1.77	0.82	
1986		1.10	4.18	1.84	2.11	3.17	3.12	
1990		−1.39	1.63	−0.09	0.81	0.56	0.95	
1994		−1.08	1.90	0.71	−0.02	0.78	0.43	
1998	2.02	0.57	3.49	2.34	0.25	2.31	1.05	2.33
2002	3.50	0.83	3.86	2.24	0.28	2.82	1.24	4.05
2006	−0.22	0.53	3.45	2.40	0.51	2.28	0.79	1.45
2010	3.45	1.63	4.50	3.24	0.87	3.28	1.00	−0.57
2014	3.33	1.93	4.68	3.96	1.11	3.33	0.71	1.31
2018	4.18	1.08	3.91	2.92	1.50	2.65	0.22	0.10
2022	2.31	1.24	3.99	2.80	1.97	2.65	0.11	3.71

Note: Gap percentage figures are a weighted average across utilities, weighted by rate base. “CAPM” compares to various Capital Asset Pricing Model benchmarks. “Corp” compares to same-rated corporate bonds. “RoD” compares to same-utility regulator-approved return on debt. “UST” compares to 10-year US Treasuries. “UST auto” compares to 10-year Treasuries with 50% passthrough. “UK” compares to UK regulatory decisions. For cases where it’s relevant (Corp, RoD, and USTs) the benchmark date is January 1995. See section 4.1 for details of each benchmark calculation.

Table B.2: Return on Equity gap, by different benchmarks, by service type (percentage points)

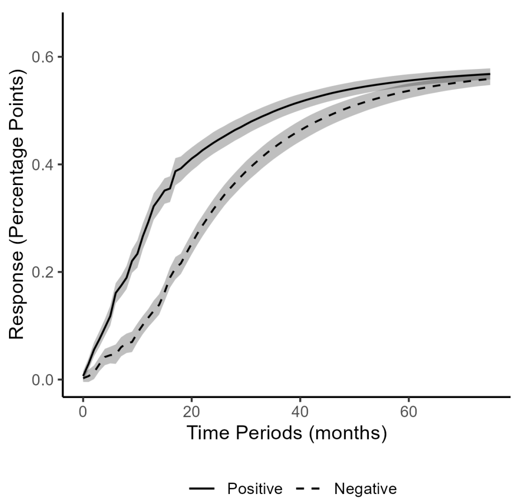
A: Electric	CAPM central	CAPM high	CAPM low	Corp	RoD	UST	UST Auto	UK
1982		−4.91	−1.33		3.19	−1.82	0.78	
1986		1.05	4.16	1.83	2.16	3.14	3.09	
1990		−1.46	1.60	−0.10	0.80	0.52	0.91	
1994		−1.10	1.91	0.69	−0.03	0.78	0.43	
1998	2.03	0.56	3.51	2.34	0.29	2.31	1.05	2.33
2002	3.54	0.82	3.90	2.24	0.33	2.84	1.25	4.05
2006	−0.20	0.55	3.50	2.43	0.55	2.31	0.81	1.45
2010	3.46	1.63	4.52	3.24	0.90	3.25	0.97	−0.57
2014	3.33	1.92	4.67	3.93	1.13	3.27	0.65	1.37
2018	4.17	1.05	3.89	2.90	1.51	2.58	0.15	0.15
2022	2.33	1.25	4.01	2.84	1.98	2.61	0.06	3.53
B: Natural Gas								
1982		−4.09	−0.90		2.81	−1.42	1.11	
1986		1.47	4.31	1.88	1.75	3.42	3.37	
1990		−0.90	1.85	−0.01	0.88	0.86	1.24	
1994		−0.92	1.82	0.99	0.00	0.80	0.45	
1998	1.97	0.68	3.35	2.32	−0.02	2.27	1.01	
2002	3.30	0.84	3.65	2.24	0.02	2.72	1.13	
2006	−0.30	0.43	3.17	2.18	0.30	2.16	0.67	
2010	3.37	1.62	4.40	3.29	0.74	3.42	1.13	
2014	3.36	1.99	4.68	4.14	1.00	3.61	0.99	1.04
2018	4.23	1.21	3.96	3.03	1.45	2.97	0.54	−0.13
2022	2.24	1.19	3.89	2.65	1.94	2.84	0.32	4.41

Note: Gap percentage figures are a weighted average across utilities, weighted by rate base. “CAPM” compares to various Capital Asset Pricing Model benchmarks. “Corp” compares to same-rated corporate bonds. “RoD” compares to same-utility regulator-approved return on debt. “UST” compares to 10-year US Treasuries. “UST auto” compares to 10-year Treasuries with 50% passthrough. “UK” compares to UK regulatory decisions. For cases where it’s relevant (Corp, RoD, and USTs) the benchmark date is January 1995. See text for details of each benchmark calculation. See Table B.1 for consolidated calculations.

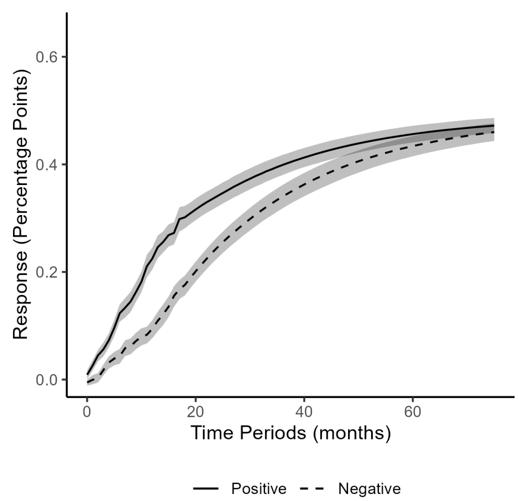
C Detail on Asymmetric Adjustment

Here we include additional information on the asymmetric adjustment analysis. The preferred specification presented in the main paper uses approved rates of return, a benchmark index of 10-year US Treasuries, and aggregates rate case decisions to the state level. We set the number of lags of the return on equity, m, and the index, n, to 18 months. Two key sources of variation in the results come from the use of proposed or approved rates of return, and the level of aggregation of the panel dataset. To illustrate this we present here robustness analysis across both proposed and approved rates and at three different levels of panel aggregation.

Figure C.1: Asymmetric Cumulative Adjustment Path following Shock to Benchmark Index at Company–State Level



(a) Proposed Rates



(b) Approved Rates

NOTES: Lines represents the cumulative adjustment path following a one percentage point change to the benchmark index. Solid line is for an increase in the index and dashed line is for a decrease. 95% confidence intervals are estimated via block bootstrapping on states, with 1000 replications. The plotted results use a benchmark index of 10-year US Treasuries. Analysis across the two panel columns is conducted with either proposed or approved rates of return. See calculation details in section 4.2.1.

Figure C.1 presents the same results as Figure 3 but with the analysis conducted at the original utility–state panel level. As with the state level results, unit root tests fail to reject non-stationarity in levels and reject non-stationarity in first differences. Using the original utility–state panel also does not radically alter the core findings, with the asymmetric adjustment clearly visible. In fact, because this approach captures both the state-level nature of PUC decision-making and the utility-level variation in how and when rate case decisions are made, we see a wider divergence and a slower pace of adjustment.

For further detail on the results, Table C.1 provides summary information on the different regression specifications. The coefficients are too numerous to be presented here, and are better summarized through their combined effect on the cumulative adjustments plotted in the earlier figures. Nevertheless, the table still provides useful information, including a number of *F*-tests on the different types of coefficients in the vector error correction model.

Table C.1: Asymmetric Adjustments in Return on Equity

Model:	(1)	(2)	(3)	(4)
Prop. or Appr.	Prop.	Appr.	Prop.	Appr.
Group (State)	Yes	Yes	Yes	Yes
Group (Company)			Yes	Yes
ϕ	0.5673	0.5024	0.5786	0.4908
$\sum \beta$+=$\sum \beta$- Fstat	5.848	19.15	5.765	8.139
$\sum \beta$+=$\sum \beta$- pval	0.0156	1.22×10^{-5}	0.0163	0.0043
$\sum \gamma$+=$\sum \gamma$- Fstat	0.4052	0.4598	0.1574	0.0953
$\sum \gamma$+=$\sum \gamma$- pval	0.5244	0.4977	0.6915	0.7575
θ+=θ- Fstat	4.922	13.16	4.489	23.61
θ+=θ- pval	0.0265	0.0003	0.0341	1.18×10^{-6}
Fit statistics				
Observations	21,597	21,597	107,178	107,178
R^2	0.07	0.10	0.02	0.02

Clustered (Year) standard-errors in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

NOTES: "Prop" refers to proposed rates of return and "Appr" refers to approved rates of return. "Group" refers to the level of panel aggregation used for the analysis, and fixed effects are always included at this level where relevant. β coefficients are those on the lagged differenced index terms. γ coefficients are those on the lagged differenced rate of return terms. θ coefficients are those on the error correction term. "Fstat" and "pval" refers to the results of an F-test on the relevant coefficients. ϕ refers to the long-run coefficient from the initial first step regression. See calculation details in section 4.2.1.

D Detail on Capital Impacts

In addition to our first difference specification, we also estimate $\hat{\alpha}$ from the following fixed effects specification.

$$\log(Cap_{i,t}) = \alpha RoE_{i,t}^{gap} + \delta X_{i,t} + \sigma_i + \lambda_t + \epsilon_{i,t} \tag{D.1}$$

As with the first difference setup, an observation is a utility rate case for utility i in year-of-sample t. The dependent variable, $Cap_{i,t}$, is the value of utility plant recorded in the final year of the rate case. We take logs and further isolate the change in the capital base by controlling for the value of utility plant in the first year of the rate case.

Table D.1 shows our results for capital assets. Across our fixed effects specifications (columns 1–4) we find broadly consistent results, with a 1 percentage point increase in the approved RoE gap leading to a ~2–4% increase in capital assets. Our first difference specification (column 5) is repeated here and yields comparable results.

Lastly, Table D.2 shows how our main results vary when using different measures of the RoE gap. Each column refers to one of the eight different benchmarks we calculate. In general we find largely comparable results to those using the gap relative to US Treasuries, although for some of the benchmarks the effect size is smaller and not significant.

Table D.1: Relationship Between Approved Rate of Return and Utility Capital

	FE				FD
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
RoE gap (%)	-0.0786	-0.0842	0.0977**	0.0437**	0.0340**
	(0.0474)	(0.0513)	(0.0402)	(0.0188)	(0.0123)
Fixed-effects					
Year-Month	Yes	Yes	Yes		Yes
Company	Yes	Yes	Yes		
State		Yes	Yes		
Service Type			Yes		
Service Type-Year-Month				Yes	
Service Type-Company				Yes	
Service Type-State				Yes	
Fit statistics					
Observations	1,511	1,511	1,511	1,511	1,298
R^2	0.86	0.88	0.97	0.99	0.38
Within R^2	0.008	0.010	0.05	0.03	0.03
Dep. var. mean	7,677.0	7,677.0	7,677.0	7,677.0	8,253.6

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

NOTES: The table uses the gap between approved RoE and 10-year US Treasuries. The dependent variable is log of the utility's total plant in millions of nominal USD. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities, or combined electricity and natural gas utilities. Columns 1–4 show results with varying levels of fixed effects. Column 5 shows the results with first differences. Our preferred specification is column 5 which uses the same specification as is used in Table 4.

Table D.2: Relationship Between Approved Rate of Return and Utility Capital by Rate of Return Benchmark (Absolute Totals)

Model:	CAPM Central (1)	CAPM Low (2)	CAPM High (3)	Corp (4)	RoD (5)	UK (6)	UST (7)	UST Auto (8)
Variables								
RoE gap (%)	0.0163**	0.0356***	0.0316***	0.0110	0.0073	0.0060	0.0340**	0.0166
	(0.0071)	(0.0122)	(0.0105)	(0.0087)	(0.0074)	(0.0112)	(0.0123)	(0.0143)
Fit statistics								
Observations	1,197	1,295	1,295	1,164	1,295	1,072	1,298	1,298
R^2	0.36	0.38	0.38	0.39	0.36	0.42	0.38	0.37
Within R^2	0.01	0.03	0.03	0.005	0.002	0.002	0.03	0.006
Dep. var. mean	8,571.9	8,266.8	8,266.8	8,676.1	8,266.8	9,509.0	8,253.6	8,253.6

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

Notes: The table uses approved RoE. The dependent variable is log of the utility's total plant, as reported to FERC, in millions of nominal USD at the end of the rate case. Columns 1–7 show varying cost of capital benchmarks. The specification used is the same as is used in Table 4.

E Detail on Capital Impacts per kWh

Here we present the same tables as in the main text but using per unit values rather than total values.

Table E.1: Relationship Between Approved Rate of Return and Utility Capital, Opex, and Rate Base (per kWh)

Model:	Capital (1)	Op Ex (2)	Rate Base (3)
Variables			
RoE gap (%)	0.0258**	-0.0230*	0.0092
	(0.0110)	(0.0113)	(0.0160)
Fit statistics			
Observations	1,298	1,300	1,258
R^2	0.34	0.40	0.30
Within R^2	0.009	0.005	0.0004
Dep. var. mean	0.8873	0.1149	0.1376

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

NOTES: The table uses approved RoE. Dependent variables are in $ per kWh. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities, or combined electricity and natural gas utilities. See notes for Table 4.

Table E.2: Relationship Between Approved Rate of Return and Electric Utility Capital and Opex by Expenditure Type and Vertical Integration (per kWh)

Model:	Total (1)	Dist (2)	Trans (3)	Gen (4)	Other (5)
Variables					
RoE gap (%)	0.0294**	0.0247**	0.0308	0.1018	0.0262
	(0.0133)	(0.0120)	(0.0301)	(0.0604)	(0.0181)
Fit statistics					
Observations	978	981	673	738	969
R^2	0.45	0.52	0.38	0.40	0.42
Within R^2	0.01	0.01	0.006	0.02	0.006
Dep. var. mean	1.081	0.3552	0.2475	0.6036	0.0660

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

(a) Capital

Model:	Total (1)	Dist (2)	Trans (3)	Gen (4)	Other (5)
Variables					
RoE gap (%)	-0.0125	0.0426**	0.0277	-0.0225	0.0198
	(0.0151)	(0.0206)	(0.0457)	(0.0173)	(0.0137)
Fit statistics					
Observations	905	905	683	685	905
R^2	0.47	0.42	0.45	0.54	0.41
Within R^2	0.002	0.02	0.003	0.006	0.004
Dep. var. mean	0.1581	0.0108	0.0124	0.1296	0.0259

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

(b) Operating Expenses

NOTES: Dependent variables are in $ per kWh. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities. See notes for Table 5.

Table E.3: Relationship Between Approved Rate of Return and Utility Capital (per kWh)

			FE		FD
Model:	(1)	(2)	(3)	(4)	(5)
Variables					
RoE gap (%)	-0.2391***	-0.2194***	0.0281	0.0414*	0.0258**
	(0.0521)	(0.0553)	(0.0193)	(0.0211)	(0.0110)
Fixed-effects					
Year-Month	Yes	Yes	Yes		Yes
Company	Yes	Yes	Yes		
State		Yes	Yes		
Service Type			Yes		
Service Type-Year-Month				Yes	
Service Type-Company				Yes	
Service Type-State				Yes	
Fit statistics					
Observations	1,511	1,511	1,511	1,511	1,298
R^2	0.72	0.80	0.96	0.98	0.34
Within R^2	0.03	0.04	0.003	0.009	0.009
Dep. var. mean	0.8681	0.8681	0.8681	0.8681	0.8873

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

NOTES: The table uses approved RoE. The dependent variable is log of the utility's total plant, in $ per kWh. This table only includes utilities that report through FERC Form 1 and so is limited to electric utilities, or combined electricity and natural gas utilities. See notes for Table D.1.

Table E.4: Relationship Between Approved Rate of Return and Utility Capital by Rate of Return Benchmark (per kWh)

	CAPM Central	CAPM Low	CAPM High	Corp	RoD	UK	UST	UST Auto
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
RoE gap (%)	0.0135	0.0268**	0.0236**	0.0025	0.0041	0.0041	0.0258**	0.0120
	(0.0084)	(0.0105)	(0.0091)	(0.0082)	(0.0080)	(0.0095)	(0.0110)	(0.0121)
Fit statistics								
Observations	1,197	1,295	1,295	1,164	1,295	1,072	1,298	1,298
R^2	0.29	0.35	0.35	0.35	0.34	0.45	0.34	0.34
Within R^2	0.004	0.01	0.01	0.0001	0.0004	0.0006	0.009	0.002
Dep. var. mean	0.9307	0.8834	0.8834	0.9052	0.8834	1.050	0.8873	0.8873

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

NOTES: The dependent variable is log of the utility's total FERC-reported plant in $ per kWh. See notes for Table D.2.

F Detail on Instrumental Variables

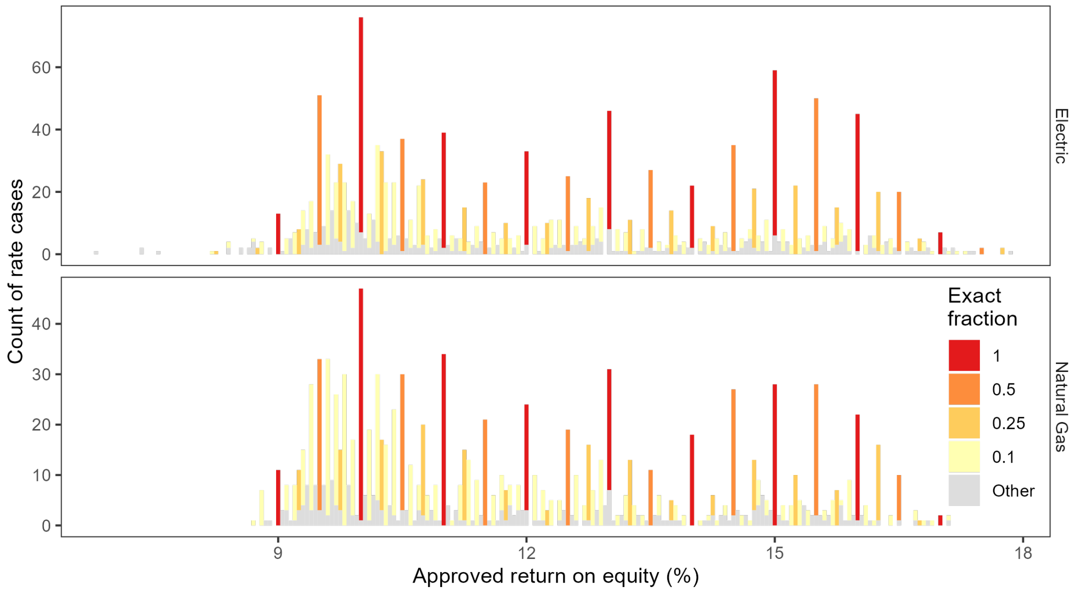
To try and further deal with concerns regarding identification, we explore a number of instrumental variables approaches. Ultimately, we do not consider these as one of our preferred results because of weak first stages.

The first IV strategy we consider is to exploit an apparent predilection toward round numbers, where regulators tend to approve RoE values at integers, halves, quarters, and tenths of percentage points. We believe the actual, unknown, cost of equity is smoothly distributed. There is therefore some unobserved RoE^* that is unrounded. The regulatory process often then rounds from RoE^* to the nearest multiple of 10 or 25 basis points (bp). We argue that this introduces an exogenous source of variation into the actual approved RoE. Our rounding IV does appear to be more plausibly exogenous given the arbitrary nature of the rounding phenomenon we observe. Unfortunately though the instrument does not produce a strong first stage. Here we show this based on rounding to 50 basis points but the same point holds for other rounding levels. We also include a specification that rounds to 500 basis points to capture the idea raised by Rode and Fischbeck (2019) that regulators seemed reluctant to set a nominal RoE below 10 percentage points in the later years of our sample. Additionally, an IV LATE monotonicity argument is hard to justify for this instrument.

Even so, the existence of such an arbitrary phenomenon in our setting is relevant, and can be seen clearly in Figure F.1. Small deviations created by rounding have large implications for utility revenues and customer payments. If for instance, a PUC rounds in a way that changes the allowed RoE by 10 basis points (0.1%), the allowed revenue on the existing rate base for the average electric utility in 2019 would change by $114 million (the median is lower, at $52 million).

Our second IV strategy focuses on the use of a single test year as the basis for determining the costs in a given rate case. In each rate case the regulator determines

Figure F.1: 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 (2024).

a test year that forms the basis for the costs estimated for the rate case period. The approach to determining this test year varies across states and over time. Some states use a historical year, while others use a future year. Some states use values from the final month of their chosen year, while others use values averaged over the entire year. The selection of the test year method may therefore lead to variation in the underlying cost assumptions, including the cost of equity, used for a given rate case. This variation with be a function of the method used and the time when each rate case is ultimately filed. If we assume the test year method is a largely arbitrary feature of different states' regulatory process, this may lead to plausibly exogenous variation in our return on equity gap. We therefore construct our instrument by focusing on the variation the test year method creates in the contemporaneous 10-year treasury bond yield that will factor into the rate case process. We first calculate the assumed yield if all rate cases used values averaged over an entire historical test year that is the last full year before a rate case is filed. We then calculate the assumed yield given the test year method rate cases actually use. Here we use information in our data on both the method used, the approach normally adopted by each state, and the end date of the test year chosen. We take the difference between these two assumed yields on 10-year treasuries as our instrument for the underlying cost of equity.

Again, this proposed instrument lacks power in the first stage, so ultimately we do not use it. All of these instruments are summarized in Table F.1.

Table F.1: First Stage Regressions for Various Instruments

Model:	(1)	(2)	(3)
Variables			
| IV Rounding (50bp) | × Sign = -1	-0.3105		
	(0.3106)		
| IV Rounding (50bp) | × Sign = 1	-0.3531		
	(0.3139)		
| IV Rounding (500bp) | × Sign = -1		0.0674	
		(0.1466)	
| IV Rounding (500bp) | × Sign = 1		0.3496***	
		(0.1277)	
IV Test Year			0.0305
			(0.0198)
Fixed-effects			
Year-Month	Yes	Yes	Yes
Company	Yes	Yes	Yes
State	Yes	Yes	Yes
Service Type	Yes	Yes	Yes
Fit statistics			
Observations	3,546	3,546	3,439
R^2	0.85	0.85	0.85
Within R^2	0.0008	0.02	0.0009
Dependent variable mean	6.0	6.0	6.0
Wald (joint nullity), stat.	0.84	4.2	2.4

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

NOTES: The dependent variable is the RoE gap (spread between approved RoE and 10-year US Treasuries). Column 1 shows the instrument using rounding (50 basis points). Column 2 shows the instrument using rounding (500 basis points). Column 3 shows the instrument using test year method.

G Detail on Excess Consumer Cost

Table G.1 summarizes our estimates of the excess cost for utility customers. Here we multiply the rate base by the RoE gap to come up with a measure of the additional payments made to cover the premium in equity returns. We present results that take the observed rate base as a given – the "fixed" row – and also present results that include the rate base with the additional increases estimated above – the "adjust" row. The increment from the "fixed" to "adjust" row is meaningful (billions of dollars in some specifications), but smaller than the gap documented in the "fixed" row.

To ensure these excess costs are calculated for all utilities in our sample, we must remedy the missing rate base data for some utilities, particularly in the earlier years of our sample.[12] To do this we extend the series using an estimate of the average growth rate for the rate base over time.[13]

Table G.1: Average annual excess costs, by different benchmarks (2019$ billion per year)

	CAPM central	CAPM high	CAPM low	Corp	RoD	UST	UST Auto	UK
Fixed	6.19	2.75	9.07	5.48	1.73	6.26	1.89	3.36
Adjusted	7.16	3.07	10.60	6.26	1.93	7.06	2.03	3.82

Note: Excess payments are totals for all investor-owned utilities in the US, in billions of 2019 dollars per year. To ensure comparability between benchmarks with differing levels of completeness, values are the average annual excess cost over the past three decades from 1992–2022. Missing rate base data for utilities in our sample was filled based on the estimated average growth rate of the rate base over time. The "fixed" row takes the observed rate base as fixed and estimates excess payments. The "adjust" row also accounts for changes in the rate base size, as estimated in Table 2 column 3. For cases where it's relevant the benchmark date is January 1995. See section 4.1 for details of each benchmark calculation.

12. Approved rate base data is available for 95% of utilities in 2020 and 65% of utilities in 2000.

13. We regress approved rate base on time, controlling for utility by state by service type fixed effects. Within each grouping of utility, state, and service type, we start with the first non-missing value and linearly extended backwards assuming the rate base changes from period to period according to our estimated growth rate.

Table G.2 shows our excess consumer cost results broken out by gas and electric utilities.

Table G.2: Excess costs, by different benchmarks and by service type (2019$ billion per year)

A: Electric	CAPM central	CAPM high	CAPM low	Corp	RoD	UST	UST Auto	UK
Fixed	5.11	2.22	7.53	4.56	1.45	5.11	1.51	3.09
Adjusted	5.91	2.48	8.79	5.21	1.63	5.75	1.62	3.51
B: Natural Gas								
Fixed	1.08	0.53	1.54	0.92	0.28	1.15	0.37	0.27
Adjusted	1.25	0.59	1.80	1.05	0.31	1.31	0.40	0.31

Note: Excess payments are totals for all investor-owned utilities in the US, in billions of 2019 dollars per year. To ensure comparability between benchmarks with differing levels of completeness, values are the average annual excess cost over the past three decades from 1992–2022. Missing rate base data for utilities in our sample was interpolated based on the estimated average growth rate of the rate base over time. The "fixed" row takes the observed rate base as fixed and estimates excess payments. The "adjust" row also accounts for changes in the rate base size, as estimated in Table 2 column 3. For cases where it's relevant the benchmark date is January 1995. See section 4.1 for details of each benchmark calculation.

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