Energy Institute WP 329R

Rate of Return Regulation Revisited

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Revised April 2024

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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 estimate that utilities' regulated returns on equity are significantly higher than several benchmark measures would suggest. We show that regulated returns on equity respond more quickly to increases in underlying capital costs than they do to decreases. We then provide evidence that higher regulated returns on equity lead utilities to own more capital. A one percentage point rise in return on equity increases capital investment by 2–4%. Overall we find excess costs to US consumers averaging $6 billion per year.

JEL Codes: Q40, L51, L94, L95

Keywords: Utility, Rate of Return, Regulation, Electricity, Natural Gas, Capital Investment

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1 Introduction

In the two decades from 1997 to 2017, real annual capital spending on electricity 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 expected to double or even triple by the 2030s and 2040s (ibid).

These large capital investments 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 utility 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 from 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.

Utilities over-investing in capital assets as a result of excess regulated returns is an age-old concern in the sector (Averch and Johnson 1962). The resulting costs from "gold plating" are then passed on to consumers in the form of higher bills. Capital markets and the utility industry have undergone significant changes over the past 50 years since the early studies of utility capital ownership (Joskow 1972, 1974). In this paper we use new data to revisit these issues. We do so by exploring four 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 this divergence? Third, how have excess returns on equity affected utilities' capital investment decisions? Fourth, what impact has this had on 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 (Regulatory Research Associates 2024). We combine this with a range of financial information on credit ratings, corporate borrowing, and market returns. To examine possible sources of over-investment in more detail we also incorporate data from annual regulatory filings on individual utility capital spending.

We start our analysis by estimating the size of the gap between the allowed rate of return 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 considering a range of approaches, including simulating the cost of equity using the capital asset pricing model (CAPM), benchmarking to various measures of debt yields, and comparing with regulatory decisions in the United Kingdom. None of these are perfect comparisons, but taken together, our various estimation approaches result in a consistent trend of excess rates of return. Over the past three decades our CAPM benchmarks find a premium in approved returns on equity ranging from one to five percentage points. There has been a similar increase in the spread against various debt measures, and a persistent premium relative to UK regulatory decisions. Importantly, even our most conservative benchmarks tend to come in below the allowed rates of return on equity that regulators set today.

The existence of a persistent gap between the return on equity that utilities earn and some measure of the cost of capital they face has been recognized for some time (Strunk 2014) and could have a number of explanations. Recent work by Rode and Fischbeck (2019) ruled out a number of financial reasons we might see increasing RoE spreads, such as changes to utilities' debt/equity ratio, asset-specific risk, or the stock market's overall risk premium. We also find no evidence of meaningful changes in utility credit ratings over this period. This leaves a range of non-financial factors that may play an important role, including behavioral biases, political goals, and regulatory capture.

These insights point to the broader challenges inherent in the ratemaking process. 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 push for rate increases and claim they face a high cost of equity that their shareholders must be compensated for. If regulators are too deferential to the demands of the utilities they regulate – perhaps due to insufficient expertise or regulatory capture (Dal Bó 2006) – we would expect rates to become detached from underlying costs. Utilities have little incentive to flag when their RoE is too high.

We explore this issue by drawing on the literature on asymmetric price adjustments. It has been documented in various industries that positive shocks to firms' input costs can feed through into prices faster than negative shocks (Bacon 1991; Borenstein, Cameron, and Gilbert 1997; Peltzman 2000). This is the so-called "rockets and feathers" phenomenon. We test this hypothesis by estimating a vector error correction model for the relationship between utilities' approved return on equity and some benchmark measures of the cost of capital (e.g. US Treasury bond yields). Here we do indeed find evidence of asymmetric adjustment. Increases to the benchmark cost of capital lead to faster upward adjustments to utilities' return on equity, while decreases lead to relatively slow downward adjustments. This is the first instance we are aware of where this phenomenon has been identified in regulatory decisions regarding financial measures such as the cost of capital.

Excess regulated returns on equity will distort the incentives for utilities to invest in capital. To consider the change in the capital base, we turn to a regression analysis. Here we aim to identify how a larger gap between a utility's allowed RoE and their actual cost of equity translates into over-investment in capital. Identification is challenging in this setting, so we again employ several different approaches, with different identifying assumptions. We primarily use a within-utility (fixed effects) approach, but we also explore a number of instrumental variables approaches. In our preferred specification we find that increasing the RoE gap by one percentage point leads to a 2–4% 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 find no evidence of a corresponding increase in operating costs. We therefore provide new potential evidence for the Averch–Johnson effect in the utility sector (Vitaliano and Stella 2009; Kuosmanen and Nguyen 2020).

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 $6 billion per year, with the majority of these costs coming from the electricity sector. There is uncertainty around this, and our range of CAPM benchmarks span excess costs averaging $2.5–8.9 billion per year over the past three decades, depending on the specification. This is equivalent to total cumulative excess costs of ranging from $75–267 billion (all in 2019 USD). These costs have important distributional effects, representing a sizeable transfer from consumers to investors. This is an important perspective to keep in mind given that much of the discussion of the distributional impacts of electric utility rates has focused on inequities between different types of consumers, rather than between consumers and shareholders (Borenstein, Fowlie, and Sallee 2021).

Increasing the price of electricity also has important implications for environmental policy and efforts to encourage electrification (Borenstein and Bushnell 2022). There is an important tension here. Ensuring that new capital investment can take place rapidly and in a cost-effective way is 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. Regulators must therefore balance their mandate to bear down on costs and encourage electrification with the push to bring forward new grid investments at an almost unprecedented scale and speed.

Addressing the inefficiencies we identify in the regulatory process 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 examining 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 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 utility commissions are state-level regulators in the US. They set consumer rates and other policies to allow investor-owned utilities (IOUs) a designated rate of return on their capital investments, as well as recovery of non-capital costs. This rate of return on capital is almost always set as a nominal percentage of the installed capital base. For instance, with an installed capital base worth $10 billion and a rate of return of 8%, the utility is allowed to collect $800 million per year from customers for debt service and to provide a return on equity to shareholders. State utility commissions typically update these nominal rates every 3–6 years.

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

Utilities are allowed to set rates to recover all of their costs, including this cost of capital. For some expenses, like fuel purchases, it's easy to calculate the companies' costs. For others, like capital, the state public utilities commissions (PUCs) are left trying to approximate the capital allocation at a cost that competitive capital markets would provide if the utility had been a competitive company rather than a regulated monopoly. The types of capital utilities own, and their opportunities to add capital to their books, 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 gas well or processing plant, but may still have a substantial rate base.

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 prices 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.

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 capital costs in this test year, except those with automatic update provisions, are the values used for the entire rate case.

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 test year? – but these are *relatively* less severe. In our data, we can calculate both the utilities' requested and approved return on debt. In our rate case 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. Put differently, the RoE is applied to the entire rate base – unlike debt, there's typically no notion of paying a specific RoE for specific stock issues.

Regulators employ a mixture of models and subjective judgment. A common choice is the capital asset pricing model (CAPM), although other methods such as discounted cash flow (DCF) 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 the recommendations one might expect from these standard methods. Using CAPM, Rode and Fischbeck (2019) examine possible causes for the increase in the spread between regulator-approved utility returns on equity and benchmark measures of the cost of capital, such as US treasuries. They rule out a number of financial reasons we might see increasing RoE spreads, 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 potential behavioral biases, such as a tendency to avoid allowing nominal RoE to fall below 10%.

Prior research has also highlighted the importance of macroeconomic changes, and that these often aren't fully included in utility commission ratemaking (Salvino 1967; Strunk 2014). Because rates of return are typically set in fixed nominal percentages, rapid changes in inflation can dramatically shift a utility's real return. 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.

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 (Borenstein, Fowlie, and Sallee 2021;

Farrell 2019). For this project, we assume the current structure of investor-owned utilities, leaving aside other questions of how to set rates across different groups of customers or who owns the capital.

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).[1] 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 their nationally reported 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.[2] 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

1. 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.

2. 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.

share and rate base – where the value of approved by the regulator is generally very close to the value proposed by the utility.[3]

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 final analysis.

We transform our data on rate case events 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, we construct our panel by (1) not filling data for a company before its first rate case in a state, and (2) dropping companies five years after their last rate case. In contexts where a historical comparison is necessary, but the utility didn't exist in the benchmark year, we use the average of utilities that did exist in that state, weighted by rate base size.

We then match with data on S&P credit ratings, drawn from SNL's *Companies (Classic) Screener* (2021) and WRDS' *Compustat S&P legacy credit ratings* (2019). 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. Beyond credit ratings, we also merge various market rates pulled

3. 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[1]	Natural Gas[1]
Rate of Return Proposed (%)	3,611	9.92 (2.00)	9.94 (2.09)
Rate of Return Approved (%)	3,557	9.53 (1.91)	9.40 (1.95)
Return on Equity Proposed (%)	3,636	13.15 (2.70)	12.88 (2.50)
Return on Equity Approved (%)	3,574	12.27 (2.40)	11.87 (2.18)
Return on Debt Proposed (%)	3,603	7.42 (2.16)	7.29 (2.23)
Return on Debt Approved (%)	3,547	7.37 (2.12)	7.18 (2.20)
Equity Funding Proposed (%)	3,628	45 (7)	48 (7)
Equity Funding Approved (%)	3,569	44 (7)	47 (7)
Rate Increase Proposed ($ mn)	3,547	90 (141)	27 (44)
Rate Increase Approved ($ mn)	3,488	44 (92)	14 (27)
Rate Base Proposed ($ mn)	2,301	2,466 (3,689)	732 (1,023)
Rate Base Approved ($ mn)	2,284	2,416 (3,583)	742 (1,019)
Customers (thous)	2,265	666 (928)	512 (792)
Quantity (TWh or Tcf)	2,277	16 (20)	99 (134)
Revenue ($ mn)	2,265	1,371 (1,991)	507 (629)
Operation Expense ($ mn)	1,545	1,275 (1,382)	459 (518)
Total Plant ($ mn)	1,545	8,714 (10,338)	1,787 (2,889)
Elec. Total Plant ($ mn)	1,176	8,162 (9,659)	NA (NA)
Elec. Dist. Plant ($ mn)	1,176	3,225 (4,322)	NA (NA)
Elec. Trans. Plant ($ mn)	1,131	1,453 (2,066)	NA (NA)
Elec. Gen. Plant ($ mn)	1,073	3,402 (4,260)	NA (NA)
Case Length (yr)	3,283	3.23 (4.00)	3.28 (3.42)

[1]Mean (SD)

Notes: This table shows the rate case variables in our rate case dataset. Values in the Electric and Natural Gas columns are means, with standard deviations in parenthesis. Approved values are approved in the final determination, and are the values we use in our analysis. Some variables are missing, particularly the approved rate base. The RoE spread in this table is calculated relative to the 10-year Treasury rate.
SOURCE: Regulatory Research Associates (2024), Energy Information Administration (2024a, 2024b), and Selvans et al. (2024), and author calculations.

from FRED. These include 1-, 10-, and 30-year Treasury yields, the core consumer price index (CPI), bond yield indexes for corporate bonds rated by Moody's as Aaa or Baa, as well as those rated by S&P as AAA, AA, A, BBB, BB, B, and CCC or lower.[4]

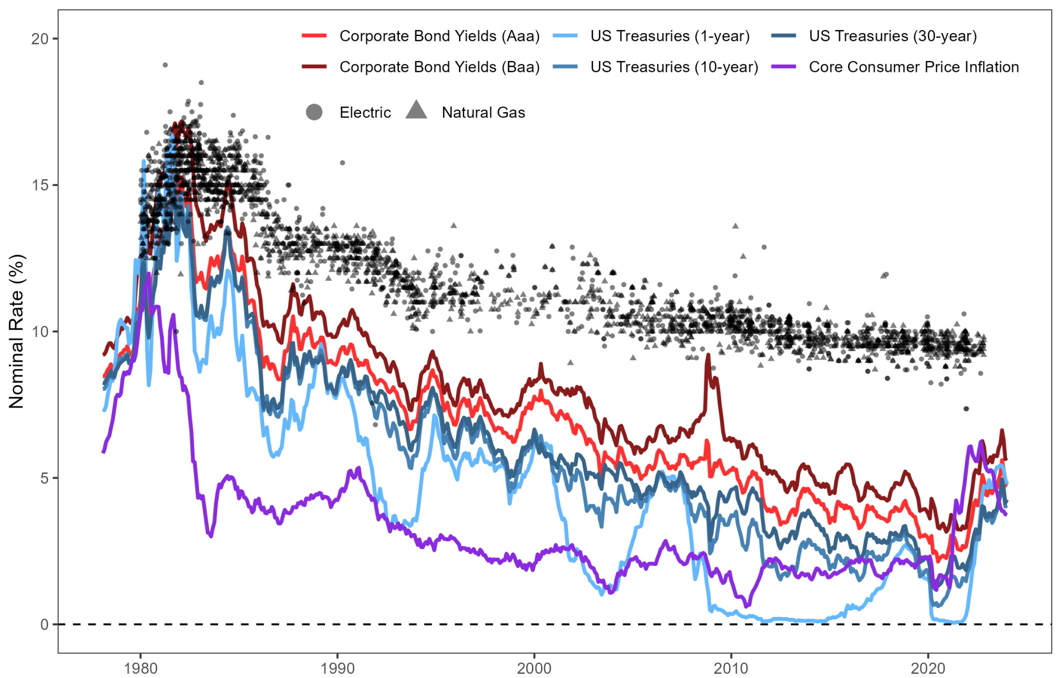
4. Board of Governors of the Federal Reserve System (2021a, 2021b, 2021c), US Bureau of Labor Statistics (2021), Moody's (2021a, 2021b), and Ice Data Indices, LLC (2021b, 2021a, 2021f, 2021d, 2021c, 2021g, 2021e).

Matching these two datasets – rate cases and macroeconomic indicators – we construct the timeseries shown in figure 1. Here we plot the approved return on equity over 40 years, with various risky and risk-free 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 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.

To further examine some of the factors that appear to be associated with utilities being awarded higher regulated returns, we aggregate back up to the rate case level and conduct an initial descriptive regression analysis. Here 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" transmission and distribution utilities, and in 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, a higher percentage of elected (vs appointed) commissioners does appear to be correlated with higher returns on equity. Lastly, larger utilities, either as measured by their rate base or their volume of energy delivered, tend to receive higher regulated returns on equity.

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 3.

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

Model:	(1)	(2)	(3)	(4)
Variables				
Case Type = Transmission	-0.5339**	-0.5250**	-0.4696*	-0.4921
	(0.2096)	(0.2461)	(0.2584)	(0.4251)
Case Type = VerticallyIntegrated	0.4054***	0.4631***	0.4318***	0.3572***
	(0.1124)	(0.1083)	(0.1225)	(0.1240)
Decision Type = FullyLitigated	-0.2700***	-0.2702***	-0.2503***	-0.3174***
	(0.0589)	(0.0619)	(0.0585)	(0.0686)
Service Type = NaturalGas	0.2701**	0.3185***	0.3305***	0.1532*
	(0.1038)	(0.0975)	(0.1143)	(0.0789)
Commissioners = Democrat		-0.2126*	-0.2001	-0.2721
		(0.1265)	(0.1249)	(0.1649)
Commissioners = Elected		0.6939**	0.6922**	0.8275
		(0.3402)	(0.3187)	(0.5505)
Commissioners = Tenure (years)		-0.0118	-0.0128	-0.0188
		(0.0207)	(0.0202)	(0.0203)
log(Rate Base)			0.0371**	
			(0.0169)	
log(Volume)				0.0366*
				(0.0203)
Fixed-effects				
Year-month	Yes	Yes	Yes	Yes
State	Yes	Yes	Yes	Yes
Fit statistics				
Observations	3,551	3,405	3,316	2,084
R^2	0.89105	0.88931	0.89575	0.80147
Within R^2	0.03325	0.04044	0.04117	0.05606
Dependent variable mean	12.108	12.215	12.184	10.915

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 for the full sample of rate cases. Columns 3–4 incorporate data on the composition of different state PUCs. Column 4 incorporates data from FERC and EIA on the characteristics of different utilities, and is limited to cases with a valid match from 1994 onwards.

4 Empirical Strategy

4.1 The Return on Equity Gap

Knowing the size of the return on equity (RoE) premium that companies receive is a challenge, and we take a couple of different approaches. None are perfect, but collectively, they shed light on the question.

4.1.1 Benchmarking to the Capital Asset Pricing Model

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, alongside other methods such as discounted cash flow. 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, even 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 equity returns for each utility using the standard CAPM formula.

$$RoE = R_f + (\beta \times MRP)$$

Here 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 in the UK, Europe, Australia, and at the federal level for the US (Australian Energy Regulator 2020; Economic Consulting Associates

2020; UK Regulatory Network 2020). The parameter values used by state PUCs in the US tend 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.

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.[5] 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.[6] 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.[7] 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

5. 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%.

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

7. 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).

2022b, 2022c, 2023). To capture the uncertainty in the market risk premium, our "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.[8] 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.[9] 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.[10] Here we take τ

8. 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: $\beta = Cov(R_i, R_m)/Var(R_m)$

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

10. 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 5, 6, and 7.

4.1.2 Benchmarking to Bond 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 first consider a benchmark index of corporate bond yields. Here we compare all utilities to the corporate bond index that is closest to that utility's own, contemporaneous debt rating.[11] 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

11. 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 4). 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.

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.

The choice of the baseline period influences the gap. 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. The gap is plotted in appendix figure 8.

Our second measure adopts a similar approach to the first but benchmarks against US Treasuries. 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.

Our third measure continues with using US Treasuries but does so using an RoE update rule. This rule is consistent with the approach taken by the Vermont PUC, and similar approaches have been used in the past in California and Canada. Relative to some baseline period the automatic update rule adjusts the RoE at half the rate that the yield on the 10-year US Treasury bond changes over that time period.[12] The 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

12. 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 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.[13] The gap is plotted in appendix figure 10.

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 11.

4.1.3 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 many things are different between these countries. There's no particular reason to think the UK regulator is setting the correct RoE, and it's not fair to say all US utilities should adopt UK rate making, but we think this benchmark provides an interesting comparison. The data on UK RoE are taken from various regulatory reports published by the Office of Gas and Electricity Markets (Ofgem). 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

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

and so we converted to nominal terms using the inflation indexes cited by the UK regulator. The gap is plotted in appendix figure 12.

4.2 Asymmetric Adjustment

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. One possibility is that utilities are able to present arguments that regulators find more compelling or urgent than the arguments from consumer advocates. One indication of this pattern is strongly asymmetric adjustments to increases or decreases in underlying costs. The asymmetric adjustment process we estimate will mechanically find that in the long run, cost increases or decreases have the same magnitude, so in this way, they do not explain very persistent gaps, but they do provide some insight to how the regulatory process plays out.

It has been documented in many industries that positive shocks to firms' input costs can feed through into prices faster than negative shocks. 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 and market power or 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. We have also already discussed the sluggish pace at which returns on equity have come down over the longer-term when compared to various benchmark measures of the cost of capital. It therefore seems plausible to think that this 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.

Many studies of asymmetric price adjustments 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 utilities commissions. To do this, we collapse our company–state panel to a state 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. We then include state fixed effects throughout our analysis, and estimate a set of adjustment coefficients common to all states. As a robustness check we also examine versions of the analysis at the original company–state panel level and find consistent findings. 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 ($Index_{i,t-1}$).[14] We also include unit fixed effects, σ_i, which in our preferred specification are at the state level.[15]

14. 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.

15. 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.

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

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. [16] To examine potential asymmetric adjustment, each of these three sets of covariates is split into positive and negative components to allow the coefficients for positive changes to differ from the coefficients for negative changes. Once again, we include unit fixed effects, σ_i.

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

Statistical tests on these coefficients can reveal whether positive or negative shocks to the underlying index produce a more rapid adjustment in the dependent variable. However, a more intuitive way of presenting the results is by plotting a cumulative adjustment function. This shows how rates of return respond to a shock to the underlying benchmark index. 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. The results are shown in figure 2.

4.3 Capital Impacts

Next, we turn to the rate base the utilities own. To the extent a utility's approved RoE is higher than their actual cost of equity, they will have a too-strong incentive

16. Here we set m and n to 18 months.

to have capital on their books (the Averch–Johnson effect). In this section, we investigate the change in utilities' capital assets and operating expenditures. We estimate $\hat{\alpha}$ from the following, where we regress our measure of capital assets on the estimated RoE gap, various controls, and fixed effects.

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

where an observation is a utility rate case for utility i in year-of-sample t. The dependent variable, $Cap_{i,t}$, is the value of utility plant recorded in the final year of the rate case. Here 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. 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 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. We therefore focus on a fixed-effects approach where we include time fixed effects, λ_t, at the month-of-sample level and unit fixed effects, σ_i, at the service type, utility company, and state level. Utilities that operate in multiple states still file rate cases with each state's utility regulator. Our state fixed effects account for constant differences across states, including any persistent differences in the regulator. Depending on the granularity of our included fixed effects, the identifying variation is the difference in the RoE gap within the range of rate case decisions for a given utility, relative to the annual average across all utilities.

The 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. 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.

To address these concerns, we explored a number of instrumental variables strategies as additional robustness checks to our core fixed effects approach. These include instruments based on the timing and duration of rates cases, an observed bias from regulators towards setting returns on equity at round numbers, and the policy used by different regulators to determine the test year used in a rate case. Unfortunately in each case these instruments were insufficient in terms of their first-stage explanatory power or because of concerns about violations of the exclusion restriction, and so our preferred specification remains the fixed effects approach set out above. Further details can be found in the appendix.

5 Results

5.1 Return on Equity Gap Results

Beginning with the RoE gap analysis from section 4.1, we find there has generally been a positive gap between utilities' allowed return on equity and various measures of their estimated cost of capital. Our results on the RoE gap show this has increased over time and are summarized in table 3. To explain these large gaps, 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.

Table 3: Return on Equity gap, by different benchmarks (percentage points)

	CAPM central	CAPM high	CAPM low	Corp	RoD	UK	UST	UST Auto
1982		−4.84	−1.30		3.15		−1.80	0.81
1986		1.09	4.17	1.86	2.10		3.16	3.11
1990		−1.40	1.62	−0.07	0.81		0.56	0.94
1994		−1.08	1.90	0.63	−0.02		0.78	0.43
1998	2.02	0.57	3.48	2.34	0.25	2.33	2.31	1.05
2002	3.50	0.82	3.86	2.23	0.28	4.05	2.82	1.23
2006	−0.21	0.54	3.46	2.41	0.52	1.47	2.29	0.80
2010	3.45	1.63	4.50	3.25	0.87	−0.58	3.29	1.00
2014	3.33	1.92	4.67	3.96	1.10	1.31	3.32	0.70
2018	4.18	1.07	3.90	2.91	1.50	0.09	2.65	0.21
2022	2.28	1.22	3.95	2.72	1.97	3.72	2.61	0.09

Note: Gap percentage figures are a weighted average across utilities, weighted by rate base. "Corp" compares to same-rated corporate bonds. "RoD" compares to same-utility return on debt. "UST" compares to 10-year US Treasuries. "UST auto" compares to 10-year Treasuries with 50% passthrough. 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.

Our implementation of the CAPM approach points to persistent evidence of excess returns on equity in the past two decades. Our "central" case has an RoE gap that generally falls in the 2–4 percentage point range over the past three decades.

Our "high" version of the CAPM uses assumptions for the risk-free rate, 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 assumptions for the risk-free rate, 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. Looking back to the 1980s and 1990s though, the RoE gap becomes smaller, with predictions of the cost of equity from our "low" CAPM version only showing a 2 percentage point gap against allowed rates of return.

With regard to our benchmarks that index to changes in market measures of the cost of debt the RoE gap has generally increased over time. Over the past three decades since 1995, the spread relative to 10-year US Treasury bonds or same-rated corporate bonds has grown to around 2–4 percentage points. Over the same period, the spread relative to a utility's own approved return on debt has grown to around 0–2 percentage points. Clearly this kind of approach is relatively simplistic, and it is not obvious that the cost of equity should necessarily move in a one-for-one manner with changes in bond yields. Using an automatic update rule that adjusts at *half* the rate of changes in bond yields, produces an RoE gap against US treasuries of 0–1 percentage points. 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 and various bond yield benchmarks.

Lastly, when comparing against UK utilities we see a premium that fluctuates from around 0–4 percentage points 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. 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, it is striking that other countries are able to attract sufficient investment in their gas and electric utilities while guaranteeing lower regulated returns than are available in the US context.

5.2 Asymmetric Adjustment Results

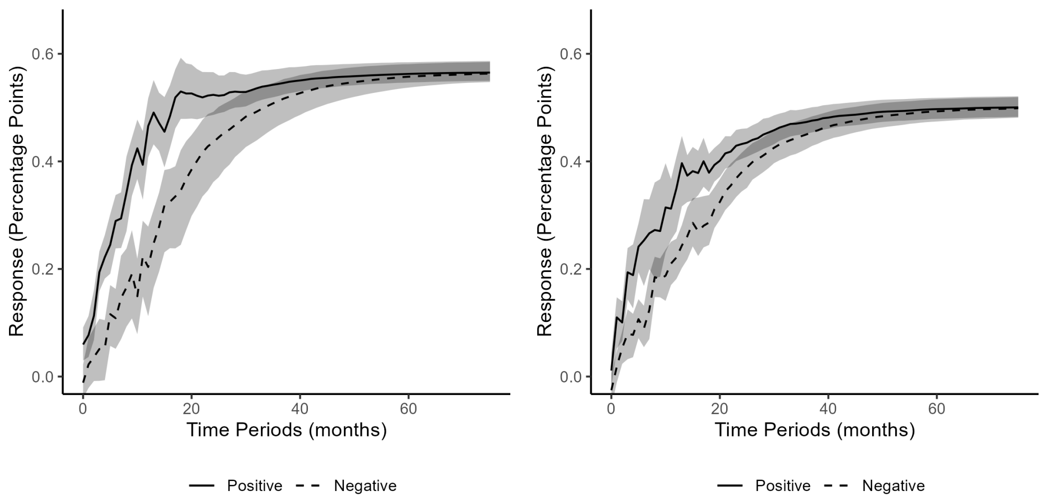
Given the evidence that utilities are potentially earning a premium in their return on equity, a natural question that arises is what mechanisms might cause this to arise. To explore this we turn to examining if there is asymmetric adjustment of allowed return on equity to underlying benchmark measures of the cost of capital. Figure 2 provides the results of this analysis. Here 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. The change in the nominal rate of return on equity is then plotted over the subsequent six years.

As can be seen in figure 2, we do 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.[17] 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. This pattern is consistent with the incentives firms

17. As noted previously this convergence to the same long-run pass through rate is an assumption within the vector error correction model, and so our findings highlight divergences in the pace of this adjustment in the short- and medium-term.

face to increase their allowed return on equity where the opportunity arises (i.e. when benchmark indices rise), and avoid decreases to their allowed return on equity when it may be justified (i.e. when benchmark indices fall). The extent of asymmetric adjustment is even more pronounced in the analysis conducted at the utility level which can be found in appendix figure 13.

Figure 2: 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.

5.3 Capital Impact Results

We next consider how the premium that utilities may be earning through their return on equity affects capital ownership. Table 4 shows our results from regressing utility capital assets on the RoE gap. We use capital assets at the end of the rate case period, controlling for the amount at the start of the rate case period. 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. All subsequent results therefore focus on our preferred fixed effects specification.

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

	Fixed effects specs.			
Model:	(1)	(2)	(3)	(4)
Variables				
RoE gap (%)	0.0229**	0.0253***	0.0370***	0.0238**
	(0.0090)	(0.0086)	(0.0115)	(0.0108)
Fixed-effects				
Year-Month	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	1,326	1,326	1,326	1,326
R^2	0.99	0.99	0.99	0.99
Within R^2	0.94	0.94	0.76	0.50
Dep. var. mean	8,106.1	8,106.1	8,106.1	8,106.1

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 $. 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 varying levels of fixed effects. Our preferred specification is column 3 of table 4.

Because the return on equity is earned on the capital that comprises a utility's rate base, utilities incentive to increase their capital assets should differ from their incentive to increase their operating expenditures. Table 5 shows our results from examining the impact of the RoE gap on utility capital assets, operating expenses, and approved rate base. The significant positive effect we find for capital assets is not replicated when looking at operating expenses. This is consistent with theoretical predictions and potential evidence for the Averch–Johnson effect, with a positive RoE gap leading utilities to a shift toward more capital-intensive activities.

Table 5: Relationship Between Approved Rate of Return and Utility Capital, Opex, and Rate Base

Model:	Capital (1)	Op Ex (2)	Rate Base (3)
Variables			
RoE gap (%)	0.0370***	0.0048	0.0187
	(0.0115)	(0.0157)	(0.0155)
Fit statistics			
Observations	1,326	1,329	1,711
R^2	0.99	0.98	0.95
Within R^2	0.76	0.64	0.45
Dep. var. mean	8,106.1	1,167.4	1,943.9

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 in millions of $. 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. 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). The fixed effects correspond to the specification used for column 3 in table 4. All specifications control for the value of the dependent variable at the start of the 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 lead of the rate base by using the approved rate base in the subsequent rate case. Shown in table 5, we find a positive effect, although it is noisier so is not statistically significant. However, there is a very 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 6. Here we see the increase in capital assets appears to be largely 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. Generation plant, on the other hand, sees no appreciable change in investment, in keeping with the fact that this is much more likely to be subject to merchant operation and therefore not included in the rate base.

Consistent with the prior results, we also find no clear increase in operating costs. The potential exception to this is the weakly significant positive effect on distribution operating costs. These additional costs could plausibly be a byproduct of utilities increasing their distribution capital investments. In aggregate these distribution operating expenditures are small relative to other operating expenditures. In particular, operating expenditures are dominated by generation costs (largely fuel for power plants) and administrative costs, with distribution and transmission operating expenses making up the remainder. Operating expenses for generation plants are an example of a variable we think should not respond to the RoE gap. Fuel expenses definitely do not get put into a utility's rate base, and are generally passed through directly to consumer rates through automatic adjustment clauses. Here we do indeed so no clear relationship between the RoE gap and this component of utilities' operating expenditures.

Table 6: 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 (%)	0.0174	0.0203**	0.0236	-0.0126	0.0240
	(0.0114)	(0.0097)	(0.0182)	(0.0156)	(0.0159)
Fit statistics					
Observations	996	1,001	910	834	985
R^2	0.99	0.99	0.98	0.99	0.99
Within R^2	0.51	0.67	0.54	0.24	0.52
Dep. var. mean	9,431.3	3,759.6	1,840.7	4,133.1	563.9

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 (%)	-0.0081	0.0262*	-0.0333	-0.0113	0.0109
	(0.0111)	(0.0148)	(0.0239)	(0.0161)	(0.0105)
Fit statistics					
Observations	922	922	912	917	922
R^2	0.99	0.98	0.96	0.98	0.98
Within R^2	0.36	0.40	0.19	0.31	0.46
Dep. var. mean	1,596.9	119.0	101.9	1,094.5	288.6

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 in millions of $. 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 the total capital assets (utility plant) broken down by type into total, distribution, transmission, generation and other. Columns 1–5 in the bottom panel refer to the total operating expenses broken down by type into total, distribution, transmission, generation and other. The fixed effects correspond to the specification used for column 3 in table 4.

5.4 Excess Consumer Cost Results

Our final analysis moves to quantify the 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.

Table 7 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 many 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.[18] To do this we interpolate using an estimate of the average growth rate for the rate base over time.[19]

Across our various CAPM measures and using the existing rate base we find

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

19. 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 interpolate backwards assuming the rate base changes from period to period according to our estimated growth rate.

Table 7: Average annual excess costs, by different benchmarks (2019$ billion per year)

	CAPM central	CAPM high	CAPM low	Corp	RoD	UK	UST	UST Auto
Fixed	5.20	2.33	7.64	4.53	1.52	2.87	5.30	1.65
Adjusted	5.97	2.52	8.87	5.11	1.59	3.23	5.93	1.71

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.

excess costs over the past three decades averaged $2.3–7.6 billion per year.[20] The economic welfare loss is likely smaller than these excess cost measures – the excess capital provides non-zero benefit, and the ultimate recipients of utility revenues place some value on the additional income.[21]

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 $2.5–8.9 billion per year. This is equivalent to total cumulative excess costs of $75–267 billion over the 1992-2022 period. Our preferred central CAPM estimate puts excess costs at $6 billion per year. The majority of these costs come from the electricity sector.[22]

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

21. 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.

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

6 Conclusion

The utility sector is a capital-intensive industry, and a corporate utility structure requires investors in the industry need to 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 modernize an aging grid and deliver on the clean energy transition. Clean electricity technologies, and the grid to transport that electricity, will require significant capital investment. Paying additional returns on those capital expenditures will increase costs to ratepayers, and may slow future investment in this capital-intensive 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 approved average 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 most conservative benchmarks come in below the allowed rates of return on equity that regulators set today.

We link this divergence between the return on equity regulators approve and the cost of equity utilities face to an apparent asymmetric adjustment of rates in response to changes in market measures of the cost of capital. 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 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 ~2–4% 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 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 $6 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 an important check on the extent 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 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.[23] 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 evidence we find of whole number rounding, or the reluctance to set rates below a nominal 10% that Rode and Fischbeck (2019) highlight.

Bolstering the financial expertise of regulators is another promising path forward.[24] 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.

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 possess the same unique level of insight 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.

23. 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)

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

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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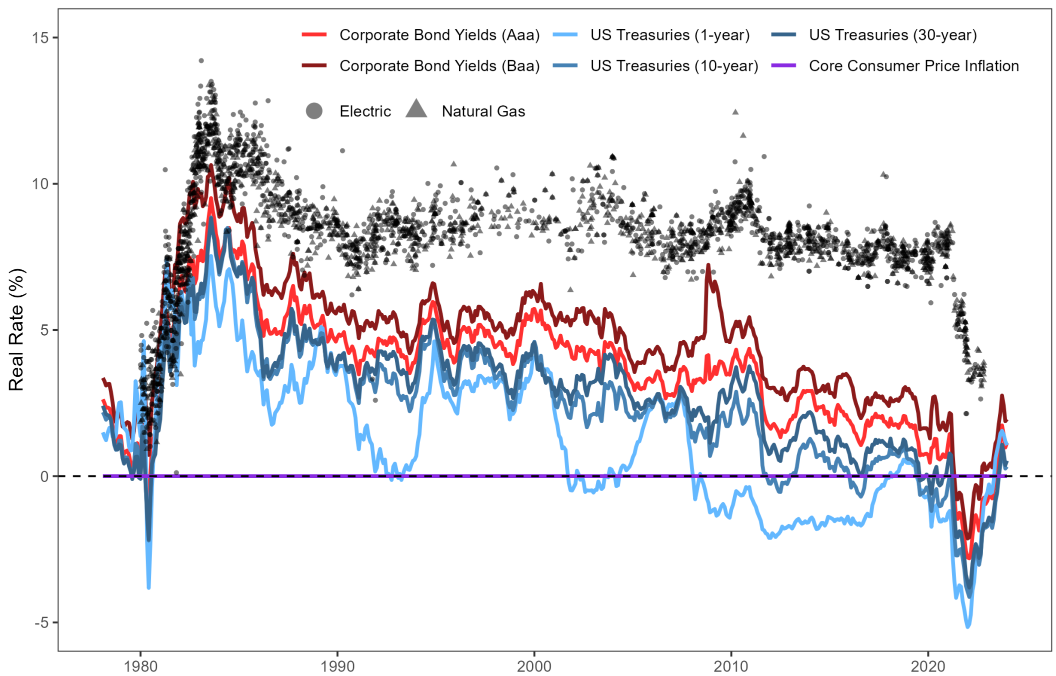
Online Appendix

A Detail on Summary Statistics and Data Construction

A.1 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 3: 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).

A.2 Credit Ratings Match

When matching credit ratings, using *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.[25] 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.

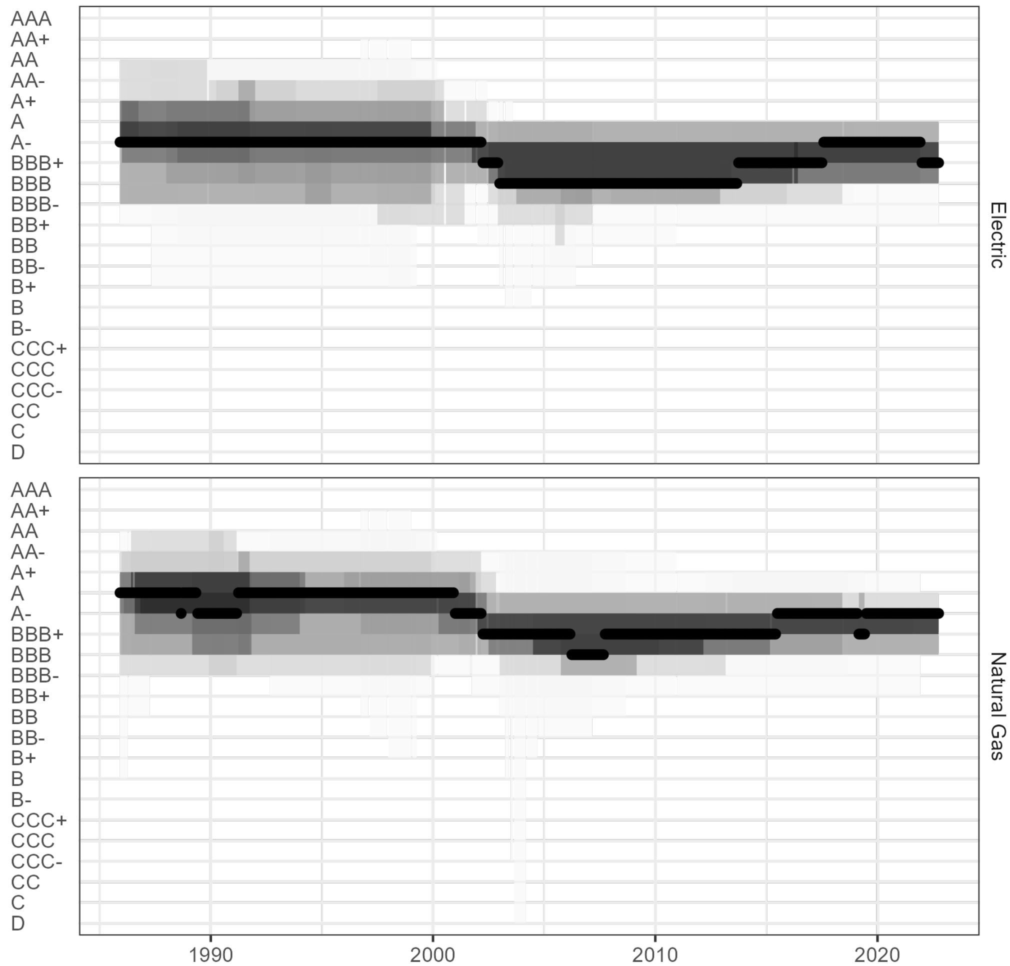
These credit ratings have changed little over 35 years. In figure 4 we plot the median (in black) and various percentile bands (in shades of grey) of the credit rating for utilities active in each month. We note that the median credit rating has seen modest movements up and down over the past decades. 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.

B Detail on RoE gap benchmarks

For each of the strategies we utilize, we plot the timeseries of the RoE gap. These are plotted in figures 5 to 12. In each plot, we present the median of our RoE gap

25. 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 4: Utility Credit Ratings, 1985-2023



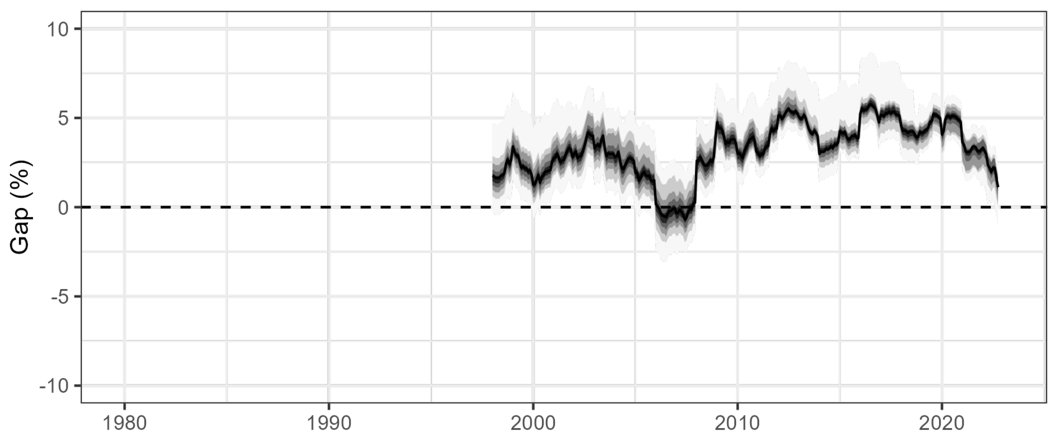
Note: Black lines represent the median rating of the utilities active in a given month. We also show bands, in different shades of grey, that cover the 40–60 percentile, 30–70 percentile, 20–80 percentile, 10–90 percentile, and 2.5–97.5 percentile ranges. (Unlike later plots, these *are not* weighted 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).

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).

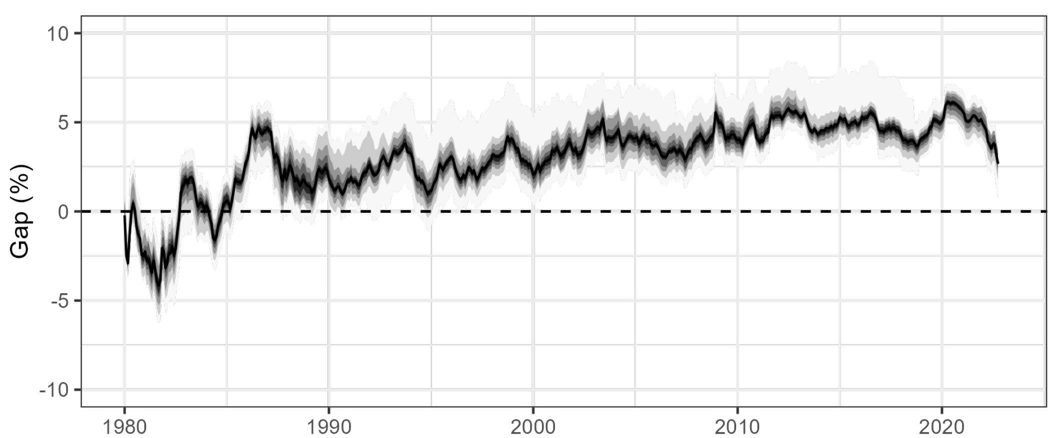
Table 8 shows our RoE gap results broken out by gas and electric utilities. Table 9 shows our capital impact results for total capital assets across each of our RoE gap benchmarks.

Figure 5: Return on equity gap, benchmarking to CAPM (central)



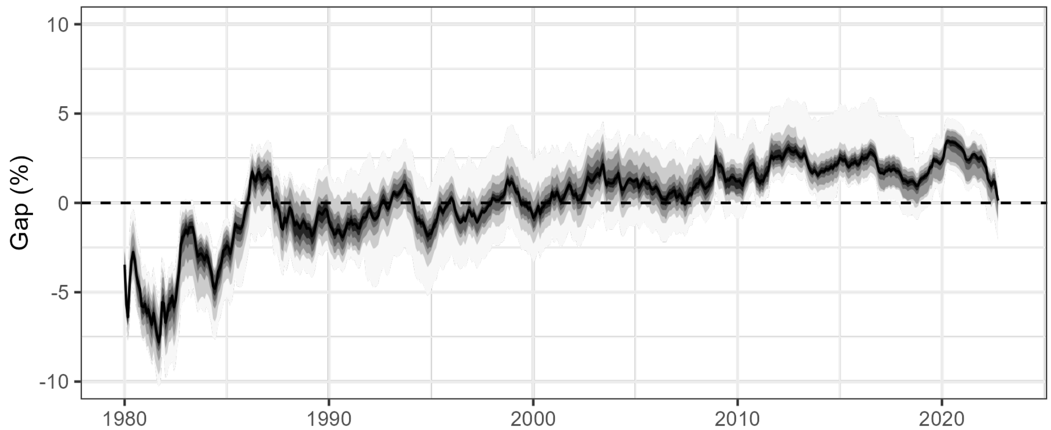
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section 4.1. Note series begins in 1998 due to the coverage of the data sources used for the market risk premium and asset beta.

Figure 6: Return on equity gap, benchmarking to CAPM (low)



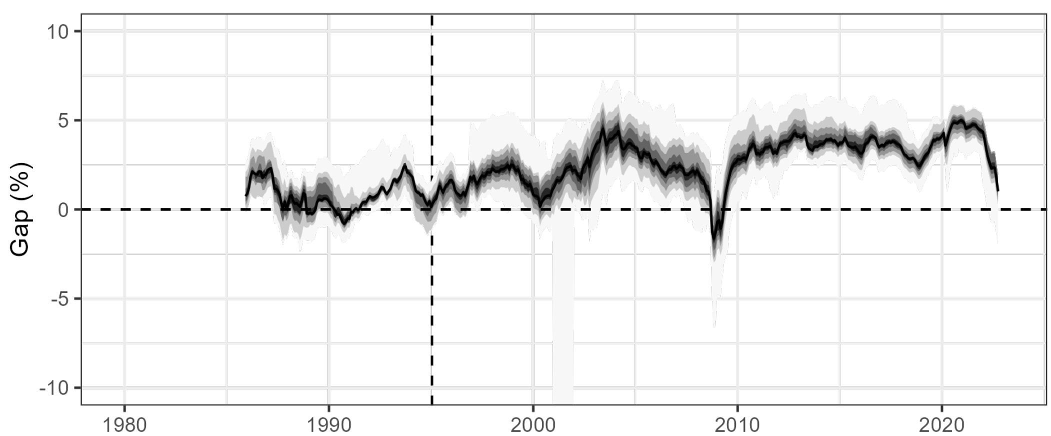
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section 4.1.

Figure 7: Return on equity gap, benchmarking to CAPM (high)



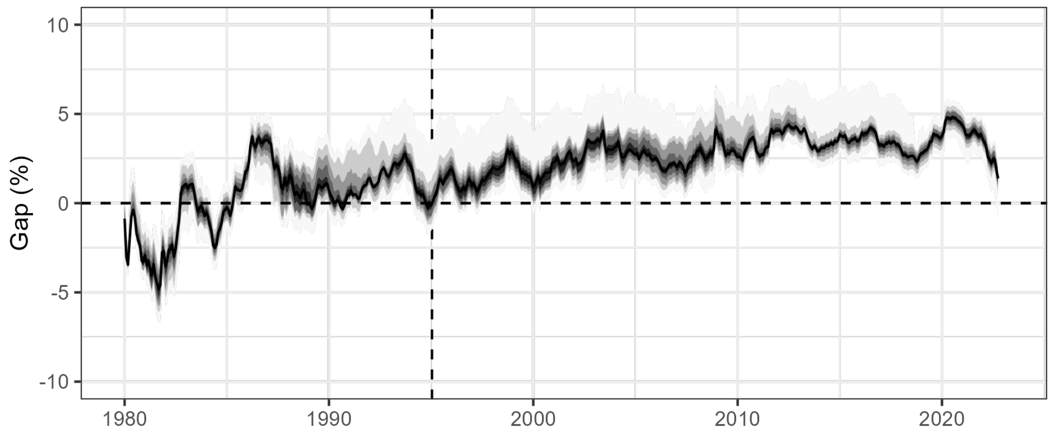
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section 4.1.

Figure 8: Return on equity gap, benchmarking to same-rated corporate bonds



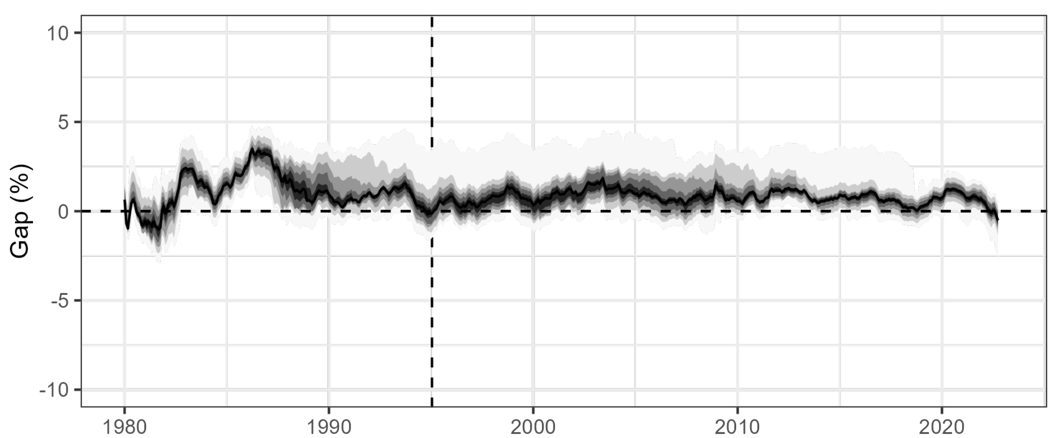
Base year is 1995. Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. Series start date is limited by credit rating data. See calculation details in section 4.1. Note series begins in 1986 due to the coverage of the data sources used for credit ratings.

Figure 9: Return on equity gap, benchmarking to 10-year Treasuries



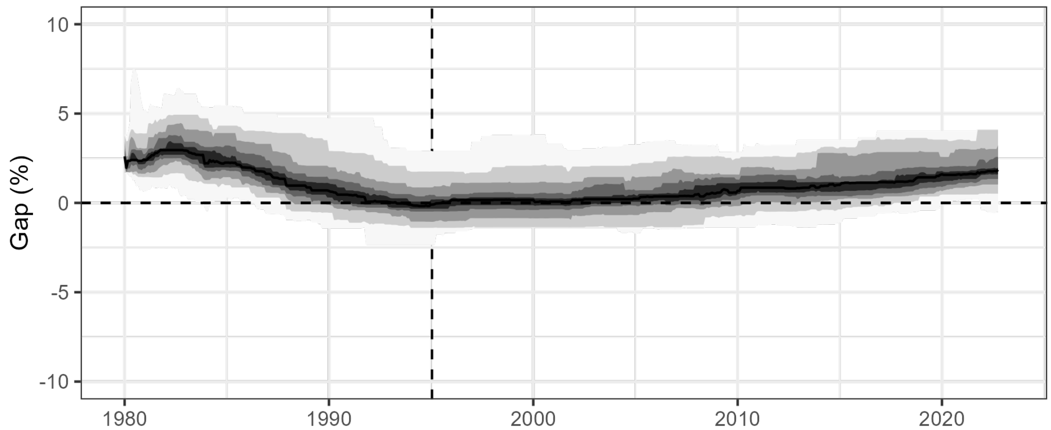
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section 4.1.

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



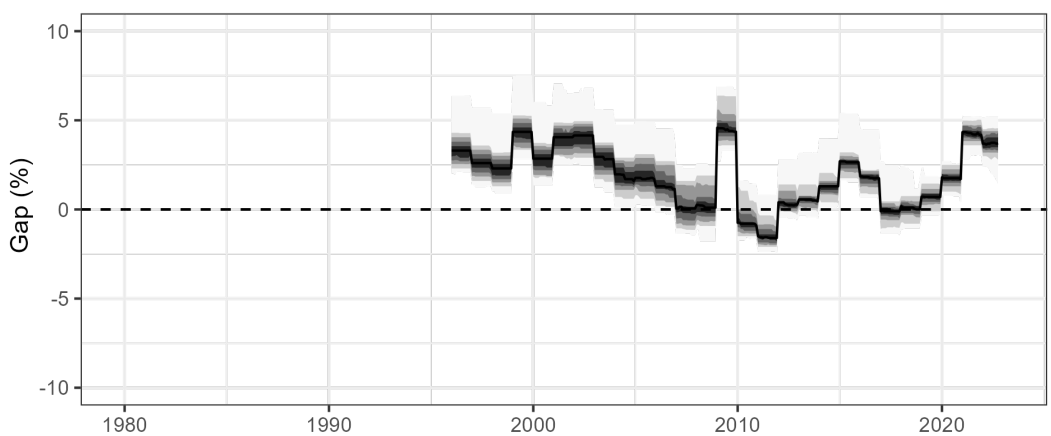
Line represents median; shading represents ranges that cover the central 20, 40, 60, 80, and 95% of total investor-owned utility rate base. See calculation details in section 4.1.

Figure 11: 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 4.1.

Figure 12: 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 4.1. Note series begins in 1996 due to the coverage of the data sources used for UK regulatory decisions.

Table 8: Return on Equity gap, by different benchmarks, by service type (percentage points)

A: Electric	CAPM central	CAPM high	CAPM low	Corp	RoD	UK	UST	UST Auto
1982		−4.93	−1.34		3.19		−1.83	0.78
1986		1.04	4.15	1.85	2.15		3.13	3.08
1990		−1.47	1.59	−0.07	0.80		0.51	0.90
1994		−1.10	1.91	0.64	−0.03		0.78	0.43
1998	2.02	0.55	3.50	2.34	0.29	2.33	2.31	1.05
2002	3.54	0.82	3.90	2.23	0.33	4.05	2.84	1.25
2006	−0.19	0.56	3.51	2.45	0.56	1.47	2.32	0.83
2010	3.47	1.63	4.52	3.24	0.90	−0.58	3.26	0.97
2014	3.32	1.91	4.67	3.92	1.12	1.36	3.26	0.64
2018	4.16	1.04	3.89	2.89	1.51	0.14	2.58	0.14
2022	2.31	1.24	3.98	2.74	1.98	3.54	2.55	0.03
B: Natural Gas								
1982		−4.20	−1.02		2.86		−1.55	1.04
1986		1.47	4.31	2.00	1.75		3.42	3.37
1990		−0.90	1.85	−0.03	0.88		0.86	1.25
1994		−0.93	1.81	0.55	−0.01		0.79	0.45
1998	1.97	0.68	3.35	2.32	−0.02		2.27	1.01
2002	3.29	0.83	3.64	2.23	0.00		2.71	1.13
2006	−0.30	0.43	3.16	2.18	0.30		2.16	0.66
2010	3.38	1.63	4.41	3.32	0.74		3.43	1.14
2014	3.35	1.99	4.68	4.14	1.00	1.04	3.61	0.99
2018	4.23	1.21	3.97	3.02	1.47	−0.13	2.97	0.54
2022	2.20	1.15	3.86	2.63	1.96	4.41	2.82	0.31

Note: Gap percentage figures are a weighted average across utilities, weighted by rate base. "Corp" compares to same-rated corporate bonds. "UST" compares to 10-year US Treasuries. "UST auto" compares to 10-year Treasuries with 50% passthrough. 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 3 for consolidated calculations.

Table 9: Relationship Between Approved Rate of Return and Utility Capital by Rate of Return Benchmark (Absolute Totals)

	CAPM Central	CAPM Low	CAPM High	Corp	RoD	UK	UST	UST Auto
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
RoE gap (%)	0.0276**	0.0403***	0.0371***	0.0226**	0.0049	0.0135	0.0370***	0.0241**
	(0.0103)	(0.0116)	(0.0102)	(0.0086)	(0.0052)	(0.0100)	(0.0115)	(0.0095)
Fit statistics								
Observations	1,222	1,322	1,322	1,062	1,322	1,091	1,326	1,326
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Within R^2	0.81	0.76	0.76	0.79	0.75	0.78	0.76	0.76
Dep. var. mean	8,432.4	8,126.4	8,126.4	8,125.6	8,126.4	9,374.2	8,106.1	8,106.1

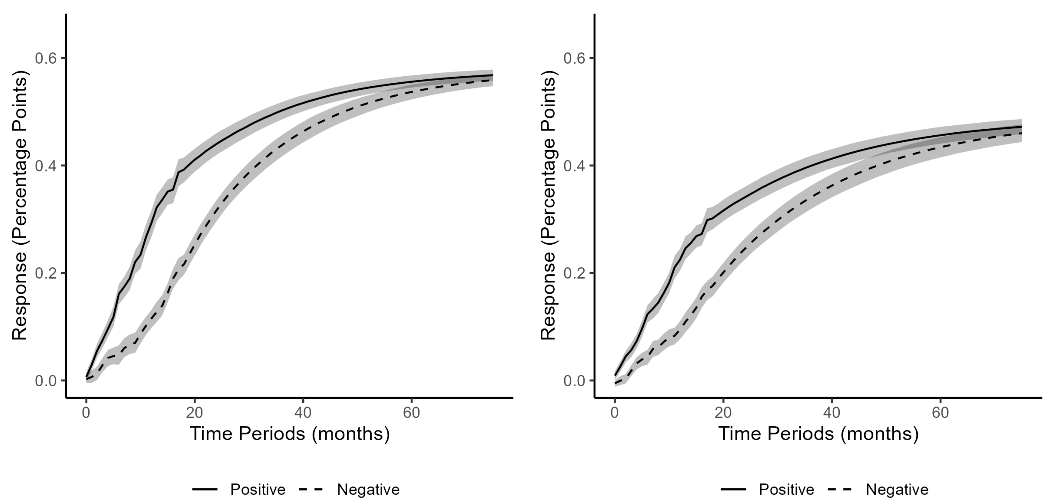
Clustered (Year & Company) standard-errors in parentheses
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Notes: The table uses approved RoE. The dependent variable is log of the utility's total plant, as reported to FERC, in millions of $ at the end of the rate case. Columns 1–7 show varying cost of capital benchmarks. The fixed effects correspond to the specification used for column 3 in table 4.

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. 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 13: 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 inde
an increase in the index and dashed line is for a decrease. 95% confidence intervals are estimated via block bootstrappi
1000 replications. The plotted results use a benchmark index of 10-year US Treasuries. Analysis across the two panel colu
with either proposed or approved rates of return. See calculation details in section 4.2.

Figure 13 presents the same results as figure 2 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 10 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 10: 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.

D 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 11: Relationship Between Approved Rate of Return and Utility Capital (per KWh)

	Fixed effects specs.			
Model:	(1)	(2)	(3)	(4)
Variables				
RoE gap (%)	0.0238**	0.0250***	0.0286***	0.0232**
	(0.0094)	(0.0089)	(0.0097)	(0.0100)
Fixed-effects				
Year-Month	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	1,326	1,326	1,326	1,326
R^2	0.99	0.99	0.99	0.99
Within R^2	0.97	0.96	0.82	0.75
Dep. var. mean	0.8885	0.8885	0.8885	0.8885

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. Columns 1–4 show varying levels of fixed effects. Our preferred specification is column 2 of table 11.

Table 12: 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 (%)	0.0286***	-0.0068	-0.0053
	(0.0097)	(0.0136)	(0.0244)
Fit statistics			
Observations	1,326	1,329	1,313
R^2	0.99	0.98	0.94
Within R^2	0.82	0.72	0.25
Dep. var. mean	0.8885	0.1157	0.1353

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 5.

Table 13: Relationship Between Approved Rate of Return and Electric Utility Capital and Opex by Expenditure Type (per KWh)

Model:	Total (1)	Dist (2)	Trans (3)	Gen (4)	Other (5)
Variables					
RoE gap (%)	0.0173	0.0202**	0.0270	-0.0218	0.0254
	(0.0109)	(0.0097)	(0.0184)	(0.0197)	(0.0152)
Fit statistics					
Observations	996	1,001	910	834	985
R^2	0.99	0.99	0.98	0.99	0.98
Within R^2	0.76	0.86	0.65	0.34	0.67
Dep. var. mean	1.083	0.3589	0.2250	0.5442	0.0658

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 (%)	-0.0062	0.0241	-0.0308	-0.0083	0.0089
	(0.0110)	(0.0148)	(0.0272)	(0.0157)	(0.0103)
Fit statistics					
Observations	922	922	912	917	922
R^2	0.98	0.97	0.95	0.97	0.97
Within R^2	0.68	0.61	0.33	0.58	0.67
Dep. var. mean	0.1587	0.0109	0.0120	0.1105	0.0260

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 6.

Table 14: Relationship Between Approved Rate of Return and Utility Capital by Rate of Return Benchmark (per KWh)

Model:	CAPM Central (1)	CAPM Low (2)	CAPM High (3)	Corp (4)	RoD (5)	UK (6)	UST (7)	UST Auto (8)
Variables								
RoE gap (%)	0.0240**	0.0321***	0.0301***	0.0194**	0.0043	0.0077	0.0286***	0.0145*
	(0.0102)	(0.0102)	(0.0094)	(0.0077)	(0.0052)	(0.0092)	(0.0097)	(0.0072)
Fit statistics								
Observations	1,222	1,322	1,322	1,062	1,322	1,091	1,326	1,326
R^2	0.99	0.99	0.99	1.0	0.99	0.99	0.99	0.99
Within R^2	0.85	0.81	0.81	0.85	0.81	0.85	0.82	0.82
Dep. var. mean	0.9387	0.8904	0.8904	0.8090	0.8904	1.054	0.8885	0.8885

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 9.

E 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 the weak first stages or concerns about the exclusions restriction.

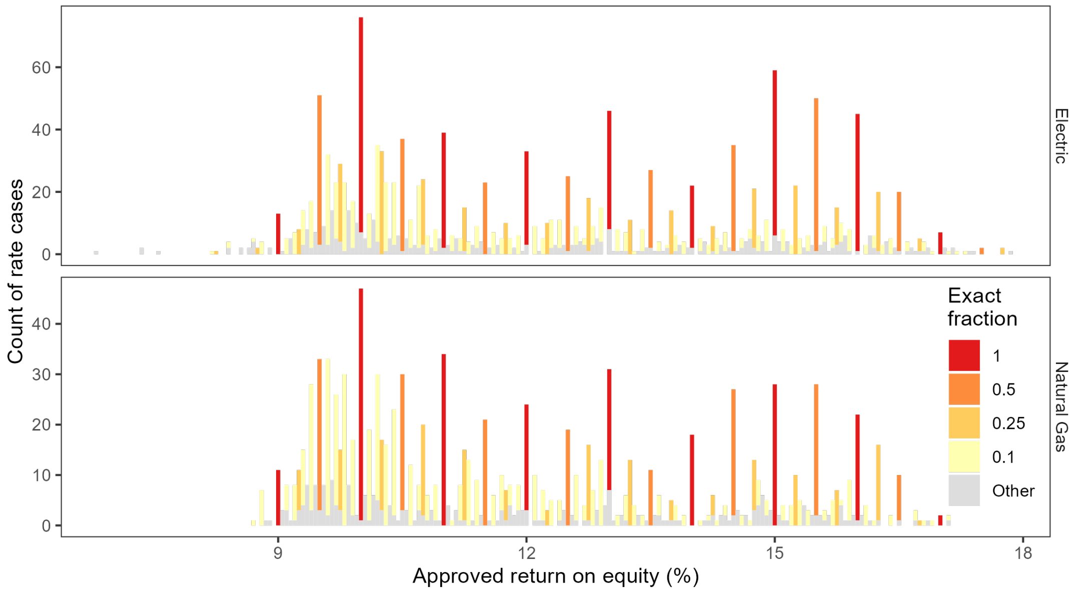
The first IV we explore focuses on the timing and duration of rate cases. The average utility has ten rate cases over the course of our sample period and the average rate case is in effect for about three years. We therefore examine an IV that relies on the idea that market measures of the cost of capital move around in ways that aren't always easy for the regulator or utility to anticipate. For instance, if the allowed return on equity is fixed in year 0 and financial conditions change in year 2 such that the RoE gap increases, then we would expect the utility to be incentivized to increase their capital investments in ways that are unrelated to other aspects of the capital investment decision. For this instrument to work, it needs to be the case that these movements in capital markets are conditionally independent of decisions that the utility is making, except via this return on equity channel. We control for common year fixed effects, so the variation that drives our estimate is that different utilities will come up for their rate case at different points in time.

This rate case timing IV does have a strong first stage, as shown below in table 15. However, there are potential concerns with the exclusion restriction. Specifically, while many rate case processes in principle involve regulators and utilities committing to a given return on equity for a set number of years, in practice we find there is a lot of discretion to deviate from this if conditions change. As such, in situations where market moves in the cost of capital significantly disadvantage a utility, many can and do move to file a new rate case or limited issue rider to secure an adjustment.

A second 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. 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 14. 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 third and final 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 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

Figure 14: 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).

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 three of these instruments are summarized in table 15.

Table 15: First Stage Regressions for Various Instruments

Model:	(1)	(2)	(3)
Variables			
IV Timing	0.9334***		
	(0.0469)		
IV Rounding × Sign = -1		-0.2989	
		(0.3098)	
IV Rounding × Sign = 1		-0.3668	
		(0.3106)	
IV Test Year			0.0318
			(0.0202)
Fixed-effects			
Year-Month	Yes	Yes	Yes
Company	Yes	Yes	Yes
State	Yes	Yes	Yes
Service Type	Yes	Yes	Yes
Fit statistics			
Observations	3,568	3,568	3,460
R^2	0.90	0.85	0.85
Within R^2	0.34	0.0008	0.0010
Dependent variable mean	6.0	6.0	6.0
F-test, stat.	7.2	4.4	4.7
F-test (projected), stat.	1,405.8	1.1	2.6
Wald (joint nullity), stat.	395.7	0.87	2.5

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 rate case timing. Column 2 shows the instrument using rounding. Column 3 shows the instrument using test year method.

F Detail on Excess Consumer Cost

Table 16 shows our excess consumer cost results broken out by gas and electric utilities.

Table 16: Excess costs, by different benchmarks and by service type (2019$ billion per year)

A: Electric	CAPM central	CAPM high	CAPM low	Corp	RoD	UK	UST	UST Auto
Fixed	5.11	2.22	7.53	4.47	1.45	3.09	5.11	1.51
Adjusted	5.87	2.40	8.75	5.03	1.52	3.47	5.71	1.57
B: Natural Gas								
Fixed	1.08	0.53	1.54	0.89	0.28	0.27	1.14	0.37
Adjusted	1.24	0.57	1.79	1.01	0.29	0.30	1.29	0.39

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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