The Power of Accounting: Capitalization of Cloud Computing for Utilities

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Abstract

This study examines the real effects of changes in accounting standards on utilities' investment decisions and operating performance. Following changes in U.S. GAAP related to capitalization of cloud computing costs, utilities are more likely to request and receive approval from their state public service commission (PSC) to include these costs in their rate base, allowing them to earn a regulated return. Prior to these accounting changes, cloud computing costs were rarely approved for rate-base inclusion, giving utilities little incentive to invest in cloud computing despite its operational advantages. Using a difference-in-differences design, we find utilities receiving rate-base approval increase cloud computing investment, experience shorter duration of power outages, and incur lower regulatory fines. These effects are greater in states where the PSC chair is Republican or more experienced. We corroborate our findings by surveying practitioners in the utilities industry, who confirm that capitalization of cloud computing costs influences investment decisions and operational outcomes.

Artificial Intelligence: The authors used artificial intelligence tools for spelling and grammar. No artificial intelligence tools were used for data analysis, idea generation, or any other substantive contribution to the manuscript.

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1. Introduction

Cloud computing and on-premise software provide similar technological solutions and involve comparable implementation activities, but their accounting treatment has historically differed. On-premise software development and implementation costs were generally capitalized, while all cloud computing costs were expensed. In response to concerns that this difference in accounting treatment does not reflect economically different arrangements, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) 2015-05. ASU 2015-05 allows capitalization of cloud computing costs when the arrangement includes a software license, although such arrangements are rare in practice. Because ASU 2015-05 does not address cloud computing implementation costs, which can be substantial, the FASB issued ASU 2018-15, allowing capitalization of cloud computing implementation costs even when the arrangement itself is expensed. We examine whether capitalization of cloud computing costs has real effects on utilities' investments in cloud computing and operational outcomes.

Cloud computing offers several advantages over traditional on-premise software. First, cloud computing is typically more cost-effective by eliminating both the need for upfront hardware investments and the costs associated with maintaining physical infrastructure (Surbiryala and Rong 2019; Gajbhiye and Shrivastva 2014; Marston et al. 2011). Second, cloud computing allows for easy scalability, enabling firms to quickly scale up or down their computing resources based on demand (Marston et al. 2011; Surbiryala and Rong 2019; AEE/EEI 2021). Third, cloud service providers typically offer high levels of reliability and security through redundant infrastructure and data backup mechanisms that reduce the risk of downtime and ensure continuous access to critical business applications and data (Gajbhiye and

Shrivastva 2014; NARUC 2016). Finally, cloud computing facilitates real-time data integration and analytics, in contrast to the batch processing commonly associated with on-premise software systems (Marinescu 2022).

While cloud computing offers technological advantages, the National Association of Regulatory Utility Commissioners (NARUC) notes that utilities have lagged behind other industries in adoption, primarily because of the traditional accounting treatment for cloud computing and the associated effects on rates (NARUC 2020). A utility's rates are set by its respective state public service commission (PSC). When the PSC allows costs to be capitalized in the rate base, the utility is permitted to recover those costs through rates and to earn a regulated return on the invested capital. When costs are expensed, only the amount of the cost may be recovered from customers, with no return earned on that amount. Therefore, capitalized costs allow a utility to generate higher allowable revenues and profits.

The PSC's decision on which costs to allow to be capitalized in the rate base is heavily influenced by the Federal Energy Regulatory Commission's (FERC's) Uniform System of Accounts (USoA). The USoA generally follows GAAP with regulatory modifications (American Public Power Association 2012; USAID 2019). Traditionally, USoA treated on-premise software as an intangible asset *included* the rate base and cloud computing costs as operating expenses *excluded* from the rate base. This difference in accounting treatment led to utilities favoring on-premise software, even though cloud computing is expected to provide greater technological advantages (NARUC 2016).

The distorted incentive structure of regulated firms to generate higher allowable revenue by overinvesting in capital assets (e.g., on-premise software) and underinvesting in efficiency-enhancing technologies that are expensed (e.g., cloud computing) is known as the AJW effect

(Averch and Johnson 1962; Wellisz 1963; Kahn 1988). We examine whether recent changes in GAAP that permit capitalization of cloud computing costs help mitigate the AJW effect in the utilities industry.

Following ASU 2015-05 and ASU 2018-15, the FERC issued an Accounting Order on December 20, 2019, stating that cloud computing implementation costs capitalizable under GAAP should also be capitalized for regulatory accounting purposes. We expect that the standard-setting activities by the FASB and the FERC increased awareness of the accounting treatment for cloud computing costs and provided support for utilities seeking regulatory approval to capitalize such costs in their rate base. Consistent with this expectation, we find a significant increase in the number of utilities seeking approval for rate-based capitalization of cloud computing costs beginning in 2018. This result is consistent with a change in accounting treatment leading to increased investment in cloud computing, helping to mitigate the AJW effect.

To examine the real operational outcomes of rate base capitalization of cloud computing, we identify a sample of 41 utilities that we estimate received approval to include cloud computing costs in their rate base ("treatment utilities") and 15 utilities that we estimate did not request such approval ("control utilities"). Using a difference-in-differences design, we compare operational outcomes cited as benefits of cloud computing investments: *reliability*, *efficiency*, and *security* (AEE/EEI 2021; NARUC 2016; Oracle 2024). We measure operating *reliability* with indices on the duration and frequency of power outages, operating *efficiency* with a utility's operating and maintenance expense scaled by total revenue, and operating *security* with fines assessed by the North American Electric Reliability Corporation ("NERC") for violations of its security standards. Consistent with our expectations, we find that following regulatory approval to capitalize cloud computing costs, treatment utilities experience shorter outage duration and incur lower security violation fines.

To provide additional insights and help validate our primary conclusions, we perform cross-sectional tests examining whether the real effects of cloud computing capitalization vary with the PSC chair's political affiliation and years of experience. We find that utilities regulated by PSC chairs who are Republican or more experienced invest more in cloud computing following capitalization and exhibit lower regulatory fines, along with some improvement in reliability. These cross-sectional results suggest that regulatory characteristics shape both investment responses and operational outcomes.

To connect our empirical results with practitioners' views, we conduct a survey of 18 practitioners in the utilities industry regarding their perceptions of the benefits of cloud computing and the potential incentives and disincentives for this investment.[1] Respondents generally agree with the potential benefits of cloud computing and further indicate that the most common reasons why utilities would be hesitant to invest in cloud computing are an emphasis on capital improvements over technological improvements, concerns about the rate approval process, implementation costs, and security issues. Although only 43 percent of respondents report having approval to include any cloud computing costs in their rate base, 86 percent agree that obtaining approval to include cloud computing in their utility's rate base would increase the likelihood of investment in cloud computing. Overall, these practitioner responses support our empirical findings that regulatory approval to capitalize costs in the rate base is a crucial factor in a utility's decision in whether to invest in cloud computing.

[1] The Institutional Review Board at the authors' institutions approved the survey.

Our study makes at least four contributions. First, the findings add to an interesting literature on the real effects of accounting treatments on managerial decisions. Research shows that managerial decisions are affected by accounting treatments, including the accounting for leases (Ma and Thomas 2023; Li and Venkatachalam 2024), stock options (Choudhary et al. 2009; Carter and Lynch 2003), post-retirement benefits (Mittelstaedt et al. 1995), and depreciation (Jackson et al. 2009). Our study demonstrates that changes in accounting treatment for cloud computing have real effects on utilities' investment decisions and operational outcomes, thereby responding to calls for research that bridges accounting sub-disciplines (Labro 2025b)

Second, this study addresses a void in existing research by focusing on utilities. At the opening plenary session of the American Accounting Association's 2025 Annual Meeting, and in a subsequent published article, Dr. Eva Labro emphasized that one way to improve the practical relevance of research is to examine specific industries, such as utilities (Labro 2025a, 2025b). Utilities and financial institutions are often excluded from accounting research studies because of the unique accounting considerations and the effects of regulation on these two industries. However, unlike financial institutions, utilities are seldom the subject of academic research. In the last 20 years, only three articles in the leading accounting academic journals examine utilities specifically (Preston and Vesey 2008; Mueller and Carter 2007; Bhojraj et al. 2004), with none published in the past 15 years.[2] Research on utilities is particularly important given the recent dramatic increase in electricity demand driven by the rapid expansion of artificial intelligence data centers. Utility experts compare this growth to transformative periods like rural

[2] Consistent with Oler et al. (2016), we define the leading accounting academic journals as (ordered alphabetically): *Accounting, Organizations, and Society; Contemporary Accounting Review*; *Journal of Accounting and Economics*; *Journal of Accounting Research; The Accounting Review;* and *Review of Accounting Studies*.

electrification or the advent of air conditioning (Wall Street Journal 2024). While this demand poses risks to grid reliability, emerging cloud-based technologies such as artificial intelligence-enabled forecasting and smart grid solutions offer opportunities to improve efficiency and reduce blackout risks (MIT Technology Review 2024). Given the industry's rapid expansion and the role of accounting in rate-setting, further accounting research in this sector is both timely and essential.

Third, this study provides insights to regulators about the consequences of the capitalization of software costs. Our results suggest that capitalization of technological costs can incentivize investment and result in associated operational benefits. As standard setters consider changes to the accounting for software, utility regulators should consider how related decisions to approve or deny inclusion of such costs in the rate base can create incentives or disincentives for utilities to invest in and receive the benefits of technological innovations.

Fourth, our study demonstrates how researchers can confirm empirical evidence using practitioners' views, thereby answering the call for accounting research to be more useful to practitioners and policy makers (Rajgopal, 2021). While researchers can infer practitioners' views from empirical evidence, direct evidence using surveys and interviews allows for additional confidence in a study's conclusions (Rajgopal 2021). We conducted numerous phone/video interviews and solicited feedback from practitioners using a survey. The views expressed by practitioners closely match our empirical evidence, validating the real-world applicability of our findings.

2. Background, Hypotheses, and Empirical Design

The Ratemaking Process

State regulators set utility rates. These regulators aim to establish rates that are fair to consumers and, at the same time, provide a reasonable rate of return to utilities. For example, on its website, the State of Georgia Public Service Commission states the following regarding its role and responsibility (https://psc.ga.gov/about-the-psc/#roles_and_responsibilities):

> *The Georgia Public Service Commission has exclusive power to decide what are fair and reasonable rates for services under its jurisdiction. It must balance Georgia citizens' need for reliable services and reasonable rates with the need for utilities to earn a reasonable return on investment.*

Typically, the rate-making process begins when a utility files a rate case with its respective state PSC. In its rate case, a utility proposes rates to charge its customers and justifies its proposed rates. The PSC holds public hearings and solicits input from consumers, advocacy groups, and other stakeholders. The PSC then issues a decision approving, modifying, or denying the proposed rate changes.

Finalized rates are based on a utility's total revenue requirement, which is spread over the various classes of consumers (e.g., residential, commercial, etc.). An important distinction in calculating the revenue requirement is costs included in the rate base versus operating expenses. If a cost is allowed to be capitalized as part of a utility's rate base, the utility can earn a rate of return on the investment. In contrast, if a cost is is treated as an operating expense and thus excluded from the rate base, the utility can recover the cost as part of its revenue requirement but cannot mark it up to earn a return on the underlying cost. This calculation is demonstrated in Equation (1):

$$\textit{Revenue Requirement} = (\textit{Rate Base} \times \textit{Rate of Return}) + \textit{Operating Expenses} \qquad (1)$$

Rate Base represents a utility's assets on which a utility is allowed to earn a return, and the *Rate of Return* represents a return on invested capital to ensure that the utility can provide a fair return to its investors. *Operating Expenses* represent an estimate of a utility's recurring operating expenses. In the rate-making process, the PSC approves the rate base, the rate of return, and the estimate of operating expenses. See Chakravarthy et al. (2021) for a more thorough discussion of the rate-making process.

In general, to be included in a utility's rate base, the PSC must conclude that the investment is prudent and satisfies the "used and useful" criterion (Lyon and Mayo 2005). That is, the investment is either used in operations or is necessary for meeting customer demand and maintaining the quality and reliability of the service. State PSCs review costs included in the rate base to ensure that customers are only charged for prudent and necessary investments related to the provision of utility services. Therefore, the rate-making process helps maintain fair and reasonable rates while encouraging efficient and effective utility management.

In addition to influencing the rates that utilities charge their customers, the rate-making process also impacts capitalization in GAAP financial statements. Specifically, according to ASC 980-340-25, utilities are allowed to recognize a regulatory asset for cost capitalizations approved in the rate-making process because it is probable they will recover these costs through future revenues. Therefore, when costs are allowed to be included in the rate base, the incurred costs are capitalized as a regulatory asset in GAAP financial statements even if GAAP does not allow for non-regulated entities to capitalize these same costs. For example, if a utility incurs significant costs associated with a storm and its PSC allows the utility to include these costs in its rate base to pass along these costs to its customers, the utility can capitalize these storm costs in its GAAP financial statements as a regulatory asset because it is probable the utility will recover these costs through future revenues. In contrast, GAAP does not allow non-regulated entities to capitalize storm costs.

Accounting for Cloud Computing

Cloud computing and on-premise software solutions are two different forms of technology solutions. Cloud computing refers to the delivery of computing services, including storage, servers, databases, networking, software, and analytics, over the internet ("the cloud"). These services are typically offered by cloud service providers on a pay-as-you-go basis, eliminating the need for organizations to invest in and maintain physical infrastructure. In contrast to cloud computing, on-premise software refers to software applications that are installed and operated on the premises of an organization, typically within its own data centers or server infrastructure.

When cloud computing emerged as a technology solution, GAAP did not address how to account for the fees associated with these arrangements, leading to diversity in practice (FASB 2014). In response, the FASB issued ASU 2015-05, which specifies that if a cloud computing arrangement includes an internal-use software license, then it should be accounted for similar to on-premise software (i.e., generally capitalized as an intangible asset).[3] If the arrangement does not include a transfer of the software license, cloud computing costs should be expensed as a service contract (i.e., expensed as incurred).

ASU 2015-05 did not address the accounting treatment for implementation costs, which can be substantial. Implementation costs include the initial costs of configuring and integrating a

[3] Specifically, the cloud computing arrangement is treated as the purchase of a software license (intangible asset) when (1) the customer has the contractual right to take possession of the software without significant penalty, and (2) the customer could run the software on its own or with another vendor.

technological solution for use. Under GAAP, implementation costs of on-premise software are generally capitalized. However, after the issuance of ASU 2015-05, it remained unclear how to treat implementation costs for cloud computing arrangements, particularly those without an internal-use software license.

In response, the FASB issued ASU 2018-15, essentially aligning the accounting for implementation costs of cloud computing arrangements with those of on-premise software, regardless of whether the arrangement includes an internal-use software license. Based on this standard, cloud computing implementation costs in the development stage are capitalized as a prepaid asset and expensed over the term of the arrangement as an operating expense.[4]

The changes in GAAP related to cloud computing are important for our study for the following reason. Most state PSCs require financial information prepared in accordance with the FERC's USoA (American Public Power Association 2012; USAID 2019), and the USoA generally follows GAAP with modifications for specific regulatory requirements and adjustments. Following the issuance of ASU 2018-15, the FERC updated its USoA to similarly address cloud computing implementation costs. On December 20, 2019, the FERC issued an Accounting Order stating that cloud computing implementation costs capitalizable under GAAP should also be capitalized for regulatory accounting purposes and included in the utility's rate base. In essence, the regulatory accounting treatment for cloud computing implementation costs became consistent with that of on-premise software, providing support for utilities seeking regulatory approval to capitalize cloud computing costs in their rate base (USAID 2019).

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[4] Following our sample period, FASB issued ASU 2025-06, which removes "stages" for determining capitalized versus expensed internal-use software development and implementation costs. Under ASU 2025-06, companies will capitalize implementation costs when management commits to funding the arrangement and it is probable the software will be used for its intended function.

The 2018 rate case for Ameren Illinois provides an example of the influence of GAAP. The Director of Regulatory Accounting at Ameren Illinois was asked if the proposed rate base additions "include any cloud computing projects that do not qualify for capitalization under generally accepted accounting principles?" (Illinois Commerce Commission 2018, 26). The Director was not asked about technology solutions that *do* qualify for capitalization under GAAP. In essence, GAAP's capitalization of cloud computing costs provided the foundation for this question.

In Appendix A, we provide excerpts from two rate cases showing how the FERC USoA and GAAP provide support for rate base capitalization. In the first example, the Wisconsin PSC references the FERC Accounting Order in its justification for approving capitalization (Public Service Commission of Wisconsin 2020). In the second example, the Mississippi PSC references GAAP in its justification for approving capitalization (Mississippi Public Service Commission 2022). GAAP and the FERC Accounting Order collectively provide support for utilities that seek regulatory approval to capitalize cloud computing costs in their rate base.

Hypotheses

Averch and Johnson (1962) and Wellisz (1963) describe a regulatory distortion commonly referred to as the AJW effect (Kahn 1988). Under a rate-of-return regulation, the AJW effect predicts that regulated firms will *overinvest* in capital assets because allowed revenues and profits are tied to the size of the capital base. Kahn (1988) further argues that this incentive structure discourages investments in efficiency-enhancing technologies that reduce capital expenditures, particularly when such investments are not eligible for inclusion in the rate base. Applied to the utilities industry, the AJW effect implies that when on-premise software costs are capitalized and included in the rate base, while cloud computing costs are treated as operating expenses and therefore excluded, utility managers will prefer investment in on-premise software. Thus, the AJW effect provides a theoretical foundation for resistance to cloud computing investment in regulated environments.

Prior to the FERC Accounting Order, NARUC recognized this disincentive in a 2016 resolution in which it stated the following (NARUC 2016, 1; emphasis added):

> *The* ***disparity in accounting treatments*** *between these two software approaches creates a regulatory incentive for utilities to invest in on-premise software solutions and creates unintended financial hurdles that hinder utilities from realizing the benefits that so many other industries are experiencing with cloud-based software.*

Consistent with this concern, a recent survey of 152 U.S. utilities by Cloud for Utilities, a non-profit organization, shows that 58 percent of respondents indicated that their utility invested in on-premises software over cloud computing because of the inability to earn a rate of return for cloud computing (NARUC 2020).

While the AJW effect suggests that utilities may resist technologies that reduce capital investment, regulatory approval to capitalize cloud computing costs attenuates this incentive by allowing utilities to earn a regulated rate of return on those expenditures. Therefore, we predict that utilities increase their requests to include cloud computing costs in the rate base following accounting and regulatory standard-setting activities that permit capitalization, leading to our first hypothesis.

H1: Utilities are more likely to request approval to capitalize cloud computing costs in their rate base following standard-setting activities that support such capitalization.

Cloud computing solutions can improve utilities' reliability, efficiency, and security (AEE/EEI 2021; NARUC 2016; Oracle 2024). If, as predicted in H1, regulatory approval to include cloud computing costs in a utility's rate base encourages investment in cloud computing, such approval should also be associated with the realization of operational benefits of cloud computing. This leads to our second hypothesis:

H2: The realization of operational benefits from cloud computing is positively associated with regulatory approval to capitalize cloud computing costs in a utility's rate base.

Empirical Design

We first examine whether utilities increased their requests for capitalization of cloud computing costs in their rate base in connection with the standard-setting activities supporting the capitalization. We test H1 by examining utility rate cases with the following model:

$$REQUEST = \alpha_0 + \alpha_1 \, POST + \alpha_2 \, Controls + \varepsilon \quad (2)$$

REQUEST equals one if the rate case contains the key phrase "cloud computing" or "software as a service," and equals zero otherwise. With the idiosyncratic nature of each state's rate-making process and the large volume of documents included in each rate case, we are unable to isolate specific requests and approvals for capitalization of cloud computing costs. The PSC reviews items included in the rate base for prudence and for satisfaction of the "used and useful" criterion. Therefore, capitalization of costs in the rate base typically accompanies some mention either by the utility or the PSC in the rate-making process. We treat the presence of these key phrases in a rate case as an indication that the utility is requesting approval for capitalization of cloud computing costs.

POST is an indicator variable that equals one for years ending in or after 2018, and zero otherwise. We select 2018 as the benchmark year for our analyses since the EITF reached a consensus on the accounting for cloud computing implementation costs on January 18, 2018, and the related FASB Exposure Draft was issued on March 1, 2018.

For H2, we test whether firms that requested capitalization of cloud computing costs experienced greater operational benefits associated with cloud computing arrangements. We use a difference-in-differences design in which we compare utilities that have received regulatory approval to capitalize cloud computing costs in their rate base (treatment firms) and those that have not (control firms).

$$OUTCOME = \beta_0 + \beta_1\, TRT \times POST + \beta_2\, Controls + \text{Firm FE} + \text{Year FE} + \varepsilon \quad (3)$$

OUTCOME is one of four proxies to capture the operational outcomes associated with cloud computing investment. *TRT* is an indicator variable that equals one for the treatment firms (i.e., firms that have received regulatory approval to capitalize cloud computing costs in the rate base) and zero otherwise.[5]

Our first two operational outcome proxies capture the service reliability based on the duration and frequency of power outages. We obtain the utility's average duration of each power outage per customer per year in minutes (*AVG_DUR_OUT*) and the average frequency of power outages per customer per year (*AVG_FREQ_OUT*). As a potentially important control variable, we calculate a state average duration and frequency metric, *excluding* the respective test utility (*STATE_AVG*). *STATE_AVG* helps to control for variation in power outages due to factors beyond the control of the test utility (e.g., severe weather patterns).[6]

Our other two operational outcome proxies are operating efficiency and fines for violation of reliability and security standards. We measure operating efficiency as a utility's operating and maintenance expense scaled by total revenue (*O&M*). We measure the reliability and security of a utility's system with NERC fines. NERC establishes reliability and security standards for North American utilities, and issues fines for violations of those standards. *LN_FINES* equals the natural log of one plus the NERC assessed fine.

[5] Details of this identification are provided in Section 3.
[6] The results without controlling for state averages stay qualitatively the same.

Linking an investment in cloud computing to changes in NERC fines or power outages is consistent with industry publications denoting the benefits of cloud computing (AEE/EEI 2022) and claims made by providers of cloud computing systems (e.g., Oracle 2024; AMCS 2024; ESource 2024). As an anecdotal example of the link between cloud computing and service reliability, in a recent article in Power Magazine, representatives from Alabama Power, one of our treatment firms, explain how a cloud-based data analytics solution helped them identify locations to make targeted improvements, which resulted in improved operating efficiencies and reduced customer outages (PowerMag 2024).

For each of the outcome variables, lower values are more desirable. Our variable of interest, *TRT* × *POST*, captures the treatment effect, that is, the effect of regulatory approval to capitalize cloud computing costs in the rate base on the dependent variables. We expect that cloud computing results in lower duration and frequency of power outages, lower O&M, and lower NERC fines (H2: $\beta_1 < 0$). Consistent with Chakravarthy et al. (2021), we control for firm size (*SIZE*), leverage (*LEVERAGE*), and net losses (*LOSS*). See Appendix B for variable definitions.

3. H1 Sample Selection and Results

We obtain utilities' financial information from 2010 to 2022 using HData, a comprehensive repository of annual and quarterly reports filed with the FERC, and rate case information from Insight Engine, a comprehensive repository of filings with regulatory commission of each state. We obtain information on fines from NERC, and reliability and revenue per kilowatt data from the U.S. Energy Information Administration.

Panel A of Table 1 presents our sample selection process. From a list of all utilities from HData, we identify firm location from page 101 of the FERC Form 1 and eliminate utilities operating in more than one state, and therefore, subject to more than one state regulatory commission. Next, we eliminate utilities for which we cannot identify a finalized rate case from 2013 to 2022.[7] We require that all utilities in our sample have at least one rate case in or after 2018 to ensure the opportunity for the PSC to consider capitalization of cloud computing costs in at least one rate case after ASU 2018-15 and the FERC Accounting Order. The process results in a sample of 71 utilities.

H1 predicts an increase in the likelihood of utilities seeking approval for rate base capitalization of cloud computing costs beginning in 2018. To test this prediction, we utilize Insight Engine to search the rate cases of our sample utilities. We search for key phrases "cloud computing" and "software as a service," and we search for an accounting order regarding cloud computing costs. Figure 1 presents the number of utility rate cases each year that mention "cloud computing" (CC) or "software as a service" (SaaS) from 2013 through 2022. We see a sharp increase in rate cases mentioning either key phrase in 2018 with a sustained level of rate case mentions thereafter. These findings are consistent with more utilities requesting inclusion of cloud computing costs in their rate base beginning in 2018.

Table 2 presents our regression estimation of Equation (2) in which we analyze the 174 rate cases for our 71 sample firms. The dependent variable in these regressions is *REQUEST*, an indicator equal to one if the rate case mentions either "cloud computing" or "software as a service," and zero otherwise. The coefficient for our variable of interest, *POST*, is positive and

[7] We begin our search for rate cases in 2013 to examine the five years prior to the issuance of ASU 2018-15. We end in 2022 as all the other data (FERC Form 1 financial information, NERC fines, revenue per kilowatt hour) is examined through 2022.

significant across Table 2 using OLS or logistic regressions, and with or without control variables. These regression results align with those shown in Figure 1 and support H1. Beginning in 2018, the likelihood of utilities seeking PSC approval to include cloud computing costs in the rate base increased significantly.

4. H2 Sample Selection and Results

Next, we focus on the outcomes of capitalization of cloud computing costs by utilities. First, we consider a utility to have approval to capitalize cloud computing in its rate base, and therefore identify the utility as a treatment firm, if it satisfies one of two conditions between March 1, 2018 and December 31, 2020: (1) any rate case finalized during this time period includes the key phrases "cloud computing" or "software as a service"; or (2) the state PSC issues an accounting order for that utility specifically allowing the capitalization of cloud computing costs in the rate base. We select March 1, 2018, as the beginning date of the search period because this is the issuance date of the FASB Exposure Draft on cloud computing costs, which provided visibility to this issue. We select December 31, 2020, as the final date by which a utility firm must have received regulatory approval to capitalize cloud computing costs in its rate base. This cut-off ensures that treatment firms had adequate time to gain approval following the 2018 Exposure Draft and allows us to observe a sufficient post-approval period within our final sample year of 2022. This process results in 41 utilities as treatment firms (520 firm-year observations).

We classify utilities as control firms if the key phrases "cloud computing" or "software as a service" do not appear in any of the rate cases between 2013 and 2022, and if there is no accounting order for cloud computing costs prior to June 30, 2022. There are 15 firms identified as control firms (195 firm-year observations). We exclude the remaining 15 utilities that contain the key phrases "cloud computing" or "software as a service" in rate cases finalized in 2021 and 2022. These rate cases occur years after ASU 2018-15 and the FERC Accounting Order and it leaves limited or no post-approval observations in our sample period.

It is possible that our treatment sample includes firms that request approval to capitalize cloud computing in the rate base but are not granted approval. Likewise, it is possible that our control sample includes firms that have automatic approval by the FERC order and, therefore, do not specifically mention any related terms in the rate case. However, both of these scenarios create a bias against finding our predicted results.

Table 3 presents descriptive statistics for our samples of treatment, control, and unassigned firms separately. We winsorize our variables at the 1st and 99th percentiles. We note that due to our small sample size, our analysis is susceptible to the influence of outliers since each observation is weighted more heavily for a small sample compared to a large sample. Therefore, we also remove observations with dependent variables greater than 300 percent of the state average, where available. Finally, to limit the effect of outliers in the regression for *O&M* and *LN_FINES*, we eliminate outliers with dfbeta values greater than $2/\sqrt{n}$ (Belsley et al. 1980; Blankespoor et al. 2014). The number of observations varies across empirical analyses due to differences in data availability from multiple sources and is detailed in Panel B of Table 1.

Pivotal to our tests of H2 is the assumption that utilities identified as treatment firms receive regulatory approval to include cloud computing costs in their rate base and subsequently increase their investment in cloud computing. To validate this assumption, we measure investment in cloud computing using the capital expenditures in regulatory assets containing keywords associated with cloud computing ('cloud,' 'cyber,' 'data,' 'software,' or 'system') each year. While cloud computing costs could be included in regulatory assets, miscellaneous intangible plant, or PP&E, regulatory assets are the only reported location on the FERC Form 1 that allows for specific identification of cloud computing spending due to the level of disaggregated detail for regulatory assets.[8] With this identification of cloud computing spending, we validate our treatment classification by examining spending on cloud computing by treatment firms over the period between 2013 and 2022.

Figure 2 shows that the aggregate annual spending on cloud computing by treatment firms increases from $0 in 2013 to just over $3 million in 2017 to more than $81.7 million in 2022. Similarly, the average cloud computing spending per utility reporting cloud computing regulatory assets increases from less than $75 thousand in 2017 to nearly $2 million per utility in 2022. Of significant note is that this measure of spending on cloud computing is equal to zero for control firms in all years.[9]

Table 4 presents regression analyses to validate our treatment identification. The significant positive coefficients on *POST* in the specifications in columns (1) through (3) indicate an average increase in cloud computing spending of between $793 thousand and $909 thousand by treatment firms beginning in 2018. Columns (4) through (6) present results with the dependent variable defined as the utility's amount of cloud computing spending as a percentage of the utility's reported regulatory assets. The positive coefficients indicate that the spending on cloud computing as a proportion of regulatory assets by treatment firms also increased in the

[8] Utilities report on page 232 of the FERC Form 1 a list of all their regulatory assets and the changes in the balance of those assets during the year. We identify regulatory assets associated with cloud computing based on whether the description in column (a) of page 232 contains any of the listed keywords. Unlike regulatory assets, which are enumerated individually on page 232 of the FERC Form 1, Miscellaneous Intangible Plant is reported as a single aggregated line item on page 204 of the FERC Form 1.

[9] This does not necessarily imply that control firms spend nothing on cloud computing services, but it does indicate that control firms report no regulatory assets related to cloud computing. This is consistent with not having regulatory approval to include cloud computing costs in the rate base.

post-periods. Together with Figure 2, these results help validate our assumption that treatment firms receive regulatory approval to include cloud computing costs in their rate base and increase their spending on cloud computing.

Table 5 presents our test of H2 using Equation (3) for power outage metrics. The dependent variable is the average duration of power outage per customer (*AVG_DUR_OUT*) and the average frequency of power outages per customer (*AVG_FREQ_OUT*). When the dependent variable is *AVG_DUR_OUT,* the coefficient for our variable of interest, *TRT* × *POST*, is negative and significant across all three specifications. When the dependent variable is *AVG_FREQ_OUT,* the coefficient on *TRT* × *POST* is negative but insignificant. These results suggest that the average duration in power outages decreases by 46 to 55 minutes following capitalization of cloud computing costs. These results also suggest no difference between treatment and control firms in the change in the frequencies of power outages.

Finally, Table 6 presents our regression estimation of Equation (3) with dependent variables of operating and maintenance expense (*O&M*) and the natural log of one plus the dollar value of NERC fines (*LN_FINES*). The coefficient for our variable of interest, *TRT* × *POST*, is negative and significant for one of the three specifications when the dependent variable is *O&M*. We make no inference from these results since the results vary with the fixed effect specification. When the dependent variable is *LN_FINES*, the variable of interest is negative and significant across all three specifications, suggesting that investment in cloud computing results in lower regulatory fines.

5. Cross-Sectional Test

To further examine the real effects of capitalizing cloud computing costs, we conduct cross-sectional tests based on the PSC chair's political affiliation and years of experience. Prior research suggests that political ideology shapes regulatory climate. Navarro (1982) finds that commissions more responsive to consumer groups, typically under Democratic control, tend to adopt rate-suppressive policies, implying fewer costs capitalized in the rate base. Likewise, Lim and Yurukoglu (2018) document that Republican commissioners are associated with higher allowed returns, providing stronger investment incentives, which could make them more likely to approve capitalization. Taken together, these studies suggest that Republican commission may favor capitalization, yet a commission that supports utility profits might prioritize traditional physical assets over cloud-based solutions (i.e., a stronger AJW effect). This tension creates ambiguous predictions about whether political affiliation of the PSC chair encourages or discourages cloud computing investment.

Regarding the chair's experience, Carpenter (2004) studies the pharmaceutical regulatory environment and explains that regulators learn and adapt over time. Chakravarthy et al. (2021) apply this theory to utilities and show that experienced regulators are better at detecting accounting manipulation in rate cases and distinguishing permanent from transitory costs. Experienced regulators learn by observing patterns in operating expenses and are better able to identify cost-effective investments that yield operational benefits. Applying this theory to rate base capitalization, we expect more experienced PSC chairs will encourage cloud computing investment.

We identify the PSC chair using data from the Institute of Public Utilities at Michigan State University for the years 2018-2020. We then identify his/her political party and number of years of tenure as of 2020. We test the differences between samples with PSC chairs that are

Republican throughout the 2018-2020 time period versus PSC chairs that are Democrat or a mix of Democrat and Republican due to changes in PSC chair.[10] We also test the differences between PSC commission chairs with more than three years of experience versus those with three or fewer years of experience.[11] We re-estimate the results in Tables 4, 5, and 6 for subsamples based on the regulator's political party (Table 7) and experience (Table 8). Before presenting results, we caution that our cross-sectional tests have a limited number of observations and therefore have lower power and limited generalizability.

Table 7 examines the role of the PSC chair's political affiliation. Panel A indicates that treatment utilities with Republican chairs invest more in cloud computing following capitalization (coefficients of 5,440.631 and 0.037). Panel B suggests that these utilities experience fewer power outages and lower regulatory fines. The cross-sectional difference in outage duration (−80.89) has a one-tailed p-value of 0.109.

Table 8 focuses on chair experience. Panel A shows that treatment utilities with more experienced PSC chairs increase cloud computing investment in the post-period (coefficients of 1,438.226 and 0.012). Panel B further provides modest evidence of improved operational outcomes, with the only significant cross-sectional difference for fines. Treatment utilities with more experienced PSC chairs exhibit a decrease in fines (−1.4883), while utilities with less experienced PSC chairs exhibit an increase (1.9085). Overall, the cross-sectional results are generally consistent with greater investment in cloud computing when PSC chair is Republican or is more experienced, and utilities realizing greater benefits from these investments.

[10] We find similar results in untabulated tests when comparing Republican PSC chairs to all other political affiliations (Democrat, Independent, and unknown).
[11] We repeat our tests using different benchmarks such as two years instead of three and median tenure. The results do not vary.

6. Survey of Practitioners in the Utilities Industry

Prior to and during our empirical investigation, we conducted numerous phone and video conversations with key professionals in the utilities industry to better understand the nuances of cloud computing investments and better understand specific incentives and disincentives that practitioners consider most relevant. These individuals included financial officers and regulatory specialists, and their views were tremendously helpful in guiding our empirical design. In addition, the views they expressed were consistent with our findings, giving us greater confidence in the reliability of our conclusions.

This essential preparatory work further motivated the creation of a formal survey to gain an even broader perspective. We conducted a survey of professionals in the utility industry to formally document their views on the benefits of cloud computing investments and the incentives and disincentives in this investment. Our aim is to connect our empirical evidence with perspectives from practice. The survey was distributed by email through utility member organizations to 108 individuals. We received 18 responses (16.67 percent response rate), consisting of three partial responses and 15 complete responses.[12] Table 9 presents the results of our survey. As detailed in Panel A, 13 of the 18 respondents are employed by investor-owned utilities, while the remainder are employed by co-operatives, municipalities, a utility authority, and a nonprofit organization.

We first asked participants if their organization had invested in cloud computing, and all participants responded affirmatively. We then asked about reasons why utilities might choose not to invest in cloud computing solutions and about the specific areas in which their organizations

[12] The three partial responses answered questions regarding the costs and benefits of cloud computing but did not complete questions related to including cloud computing in the utility's rate base. We present all responses to each question, which results in a different number of responses across questions.

had invested in cloud computing solutions. Panels B and C report these responses. The most common reason for lack of investment is the emphasis on capital investment over technology, indicated by more than half of respondents (10 out of 18). This emphasis is consistent with the inherent capital-intensive nature of the utility industry as well as the AJW effect, discussed earlier, which suggests that regulated firms are incentivized to prioritize capital investment over technological advancement. Other common reasons for lack of investment in cloud computing include the rate approval process, implementation costs, and security concerns. The two least common reasons for lack of investment (two out of 18) are the lack of benefits and the lack of technological understanding, suggesting that most respondents believe that utilities understand the technologies available and are aware of the benefits that cloud computing provides.

The most common type of investment in cloud computing solutions by utilities is in the customer interface (11 out of 18), followed by accounting and administrative tools (9 out of 18). We note a wide range in the level of investment in cloud computing. For example, four respondents indicate only one area of cloud computing investment, while six respondents indicate three or more areas of cloud computing investment.

Next, we asked participants about the benefits their organization has experienced because of investment in cloud computing technologies. Panel D reports the results.[13] The benefit with the highest average agreement (4.59/5.00) is scalability. Eighty-eight percent of respondents either strongly agree or somewhat agree that cloud computing provides scalability. Other benefits with high levels of agreement are remote access by the workforce (4.53/5.00) and operating efficiencies (4.29/5.00). At least half of the respondents either strongly agree or somewhat agree

[13] The number of responses presented includes only those for which the respondent marked one of the five option to indicate a level of agreement or disagreement. Responses indicating the benefit was not applicable are excluded for that specific benefit. One respondent indicated that all of the listed potential benefits were not applicable, thus the maximum number of responses for any listed benefit is 17 despite having 18 responses.

with each of the benefits listed, including service reliability and compliance with regulatory standards.

Of specific interest for our research setting were our questions related to including cloud computing in the utility's rate base, presented in Panel E. Most respondents (86 percent, with 57 percent strongly agreeing) indicated that obtaining approval to include cloud computing costs in the utility's rate base would increase the likelihood of investment in cloud computing solutions. These responses align with our empirical findings that rate base approval of cloud computing costs is associated with greater investment in cloud computing and its benefits. On the other hand, only 43 percent reported that their utility has approval to include cloud computing costs in its rate base.

Overall, these survey results suggest that while utilities generally agree with the potential benefits of cloud computing, regulatory approval to capitalize these costs in the rate base remains a key factor shaping the extent to which utilities are willing to invest in these technologies.

7. Conclusion

Historically, the differences in the accounting treatment between cloud computing and on-premise software created a disincentive for utilities to invest in cloud computing arrangements, despite their operational advantages. In this paper, we examine the real effects of aligning regulatory accounting treatment for these technologies. Our findings show that when regulators approve the rate base capitalization of cloud computing costs, utilities increase investment in cloud computing technology, experience shorter power outages, and receive lower regulatory fines. This study demonstrates how accounting treatment can create incentives that influence management decisions, leading to significant impacts beyond the financial statements.

Utilities are unique in that capitalization in the rate base affects their top line revenue, which makes capitalization particularly impactful to management decisions in the utilities industry. Therefore, it is possible that our findings are not generalizable to other industries. However, it is important to note that GAAP accounting for on-premise software and cloud computing has differing effects on earnings before interest, taxes, and depreciation ("EBITDA"), which can affect management decisions to invest (Ma and Thomas 2023). Therefore, it is possible that the difference in accounting for cloud computing and on-premise software affects management decisions in industries that are specifically mindful of EBITDA. At the same time, given the unique regulatory environment of utilities, we acknowledge that our results may not be generalizable to other industries.

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Appendix A. Support for Rate Base Capitalization

This appendix presents two examples of state PSCs supporting the capitalization of cloud computing costs by referencing the FERC Accounting Order (Example 1) and GAAP (Example 2).

Example 1: Madison Gas and Electric

In its final decision issued December 29,2020, the Wisconsin PSC approved Madison Gas and Electric (MGE), a treatment firm, to continue capitalizing cloud computing costs in its rate base, referencing the FERC Accounting Order in its decision (Public Service Commission of Wisconsin 2020, 42-43; emphasis added):

> Cloud-based computing systems are arrangements in which a pool of computing resources, such a servers, storage, applications, and services can be rapidly deployed in response to demand. Cloud computing offers utilities the ability to expand their capacity and sophistication with respect to meter data management, emergency notification, advanced meter data analytics, and predictive maintenance, among other functions. Under previous accounting principles, MGE would treat its prior computing system as a capital expense and include it in its rate base, which allowed MGE to gain a return on it. A cloud-based solution, however, is typically a service contract that can be included as an operating expense, which would not earn a rate of return. As such, a utility is not incentivized to adopt cloud-based solutions, which has been found to cause the utility industry to lag behind corporate peers.
>
> In its Settlement Agreement, MGE included four cloud computing service contracts in its electric and gas rate base. The total of the four contracts included in the rate base for the cloud assets is $1.7 million, which is a significant upfront software expenditure that is made to improve reliability of service for MGE's customers. ***It is also consistent with Federal Energy Regulatory Commission's (FERC) ruling*** in December 2019, as can be seen in FERC Docket No. AI20-1-000. The ruling allows a utility to represent cloud implementation costs as Plant, Property, and Equipment instead of an Other Asset on its financial statements. MGE has adopted this accounting treatment effective December 2019 for its cloud implementation costs. The implementation costs are amortized to FERC 404, Amortization of Limited Term Plant (60 percent to electric and 40 percent to gas).
>
> The Commission finds it reasonable to authorize MGE to continue to capitalize costs related to cloud computing. This accounting treatment further allows MGE to not only receive a return on its investment, but also incentivize the company to take advantage of opportunities that will save costs and enhance operations. ***In addition, it allows MGE to stay consistent with the FERC ruling***, and to earn a return on a large investment.

Example 2: Mississippi Power Company

Mississippi Power Company (MPC)[14] filed a petition for an accounting order from the Mississippi PSC to allow capitalization of cloud computing costs in its rate base. The Mississippi PSC approved the request, referencing GAAP in its final decision, issued December 6, 2022: (Mississippi Public Service Commission 2022, 2-3; emphasis added):

> Based upon the information and evidence contained in the record of this matter; this Commission finds that MPC's request for an accounting order is just and reasonable and in the public interest. The Commission also finds that the treatment prescribed herein is consistent with applicable accounting guidance.
>
> After the effective date of this order, MPC is hereby authorized to defer in a regulatory asset account, ***to the extent allowed by GAAP***, one-time O&M expenditures associated with major technology projects, including, but not limited to, general and administrative and overhead costs, detailed planning, training, data conversion, closeout, hosting fees prior to implementation, license support maintenance and service fees prior to implementation for on premises software, and business re-engineering costs.' This authority shall be available for both new software systems (including cloud-based solutions) and for existing system upgrades that provide improved functionality and/or the opportunity for sustained system life. Because the software and cloud computing solutions provide service to customers over their entire useful life, the deferral of these costs will allow the related costs to be recovered over a period more consistent with when customers receive the benefits of these services. The accounting authority herein will also allow MPC to focus on the best available outcome and benefit for customers when evaluating software solutions.

[14] MPC is a control firm in our study because of the timing of this order. This order was issued in December 2022, the last year of our sample. Therefore, they did not have approval to capitalize cloud computing costs in their rate base during the years of our sample.

Appendix B. Variable Definitions

Dependent Variables	
Approval Request (H1)	
REQUEST	An indicator variable that equals one for rate cases including the key phrase "cloud computing" or "software as a service," and zero otherwise.
Operational Outcomes (H2)	
AVG_DUR_OUT	Customer average interruption duration index, which measures the average duration of customer interruption.
AVG_FREQ_OUT	System average interruption frequency index, which assesses how often a customer experiences interruption on average.
O&M	Operating and maintenance (O&M) expense scaled by revenue.
LN_FINES	Natural log of one plus the total amount of the NERC assessed fines.
Independent Variables	
TRT	An indicator variable that equals one for utilities that between March 1, 2018 and June 30, 2020: (1) have any rate case finalized during this time period that mentions "cloud computing" or "software as a service"; or (2) the state PSC issues an accounting order for that utility specifically allowing the capitalization of cloud computing costs in the rate base. It equals zero for utilities that had no mention of "cloud computing" or "software as a service" in any rate case between 2013-2022 and never received an accounting order from their state PSC allowing capitalization of cloud computing costs in the rate base.
POST	An indicator variable that equals one for firm-year observations after January 1, 2018, and zero otherwise.
Cross-Sectional Variables	
REPUBLICAN	An indicator variable that equals one if the state PSC chair between 2018 and 2020 is a Republican; and zero if the chair is a Democrat. Missing for all PSC chairs whose political party affiliation is unknown.
HIGH TENURE	An indicator variable that equals one if the tenure of the PSC chair is greater than three years; and zero otherwise.
Other Variables	
SIZE	Natural log of one plus total assets.
LEVERAGE	Long-term liabilities scaled by total assets.
LOSS	An indicator variable for loss, which equals one if income before extraordinary items is negative, and zero otherwise.
CC_SPD	The amount of regulatory assets reported on page 232 of the FERC Form 1 containing keywords associated with cloud computing ("cloud", "cyber", "data", "software", or "system").
CC_SPD_RA%	The amount of regulatory assets reported on page 232 of the FERC Form 1 containing keywords associated with cloud computing ("cloud", "cyber", "data", "software", or "system"), scaled by total regulatory assets.

Figure 1. Mentions in Rate Cases

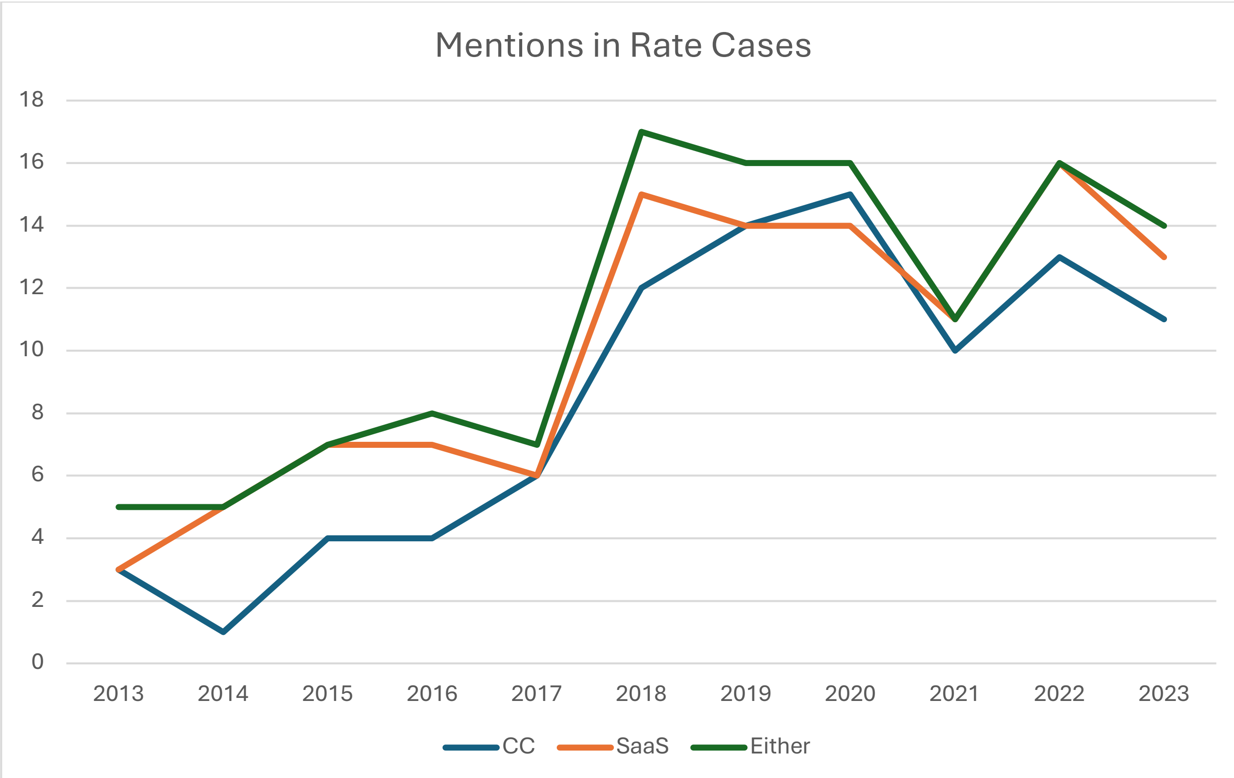
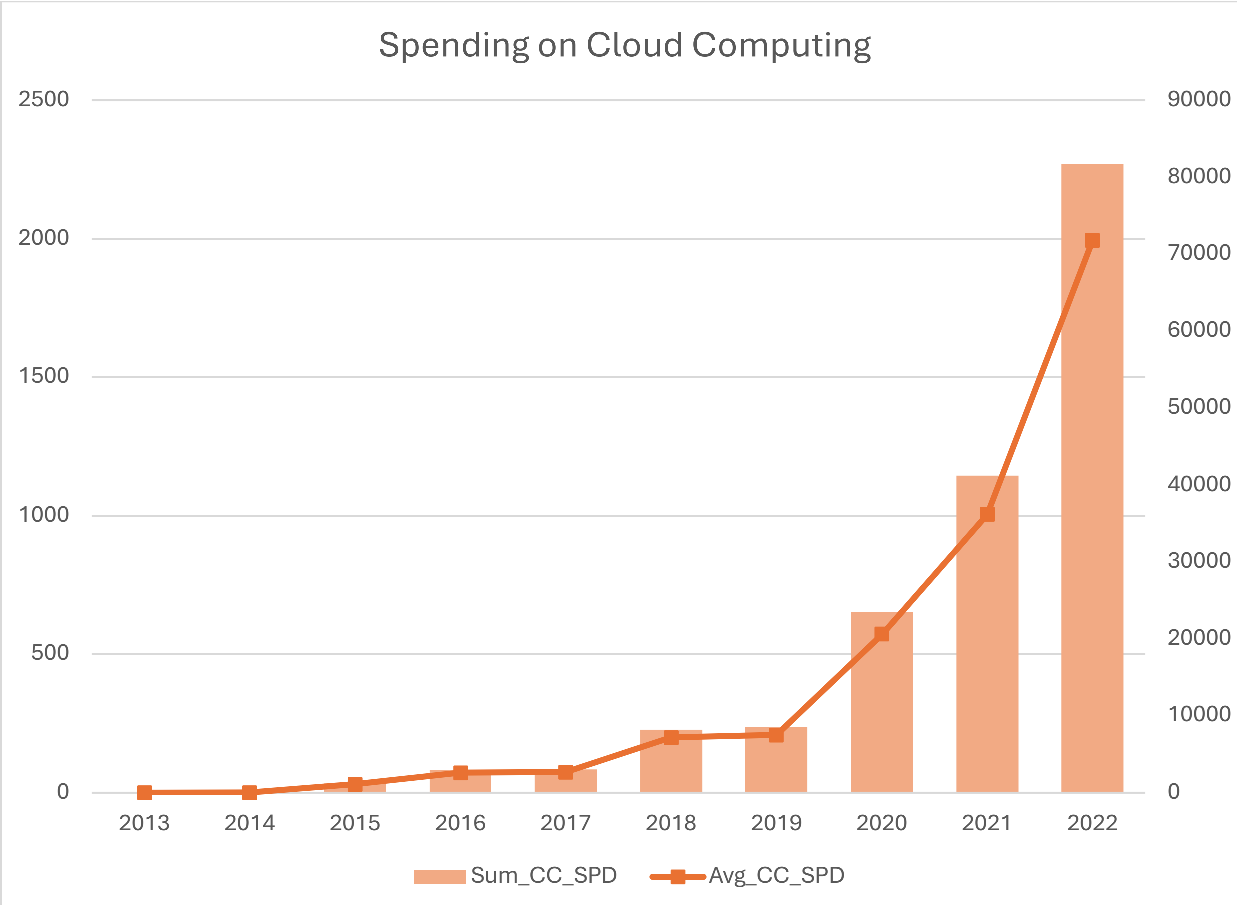


Figure 2. Spending on Cloud Computing by Treatment Firms



This figure shows the amount of cloud computing investment by treatment firms over time. These amounts are reported under regulatory assets in FERC Form 1 with one of the following words: "cloud", "cyber", "data", "software", or "system". The line shows average amount spent (left axis) and the bar graph shows the aggregate amount spent (right axis). The amounts are shown in thousands. In contrast, control firms report zero dollars of spending on cloud computing.

Table 1

Panel A: Sample Selection

	No. of Utilities
Utilities with FERC Form 1 financial data from HData.	246
Less: Utilities that operate in more than one state.	(67)
Less: Utilities without a finalized rate case in Insight Engine from 2013-2022.	(91)
Less: Utilities with no rate case in or after 2018.	(17)
Sample of utilities eligible for selection as Treatment or Control	71
Treatment Firms (mention of "cloud computing" or "software as a service" in rate cases finalized between March 1, 2018 and December 31, 2020)	41
Control Firms (no mention of "cloud computing" or "software as a service" in any rate cases between 2013-2022)	15
Uncategorized Firms (mention of "cloud computing" or "software as a service" is in rate cases finalized in 2021 or 2022)	15

This panel presents (1) the process of identifying utilities eligible for selection as treatment or control firms, and (2) the allocation of these utilities between treatment firms, control firms, and uncategorized firms.

Panel B: Number of Observations for Regressions

	Treatment	Control	Total
Table 4: Observations with *CC_SPD*	520	-	520
Table 5 (Test of H2): Observations with *AVG_DUR_OUT*	330	130	460
Table 5 (Test of H2): Observations with *AVG_FREQ_OUT*	338	128	466
Table 6 (Test of H2): Observations with *O&M*	499*	193*	692*
Table 6 (Test of H2): Observations with *LN_FINES*	520*	195*	715*

*These represent the number of observations before influential outliers are excluded based on their dfbeta values. This exclusion is made for each individual regression in Table 7, resulting in a different number of observations for each column.

Table 2
Test of H1: Cloud Computing Mentions in Rate Cases

	REQUEST			
	OLS		*Logit*	
	(1)	(2)	(3)	(4)
POST	0.231***	0.224***	0.960***	0.973***
	(3.85)	(3.73)	(3.83)	(3.75)
SIZE		0.065**		0.299**
		(2.29)		(2.08)
LEVERAGE		−0.737		−3.219
		(−0.83)		(−0.78)
CONSTANT	0.455***	−0.356	−0.182	−3.941*
	(6.85)	(−0.78)	(−0.68)	(−1.67)
Fixed effects	No	No	No	No
N	174	174	174	174
Adjusted R^2	0.047	0.075	0.039	0.070

The dependent variable is an indicator variable for mentions of either 'cloud computing' or 'software as a service' in their rate cases. Variable definitions are presented in Appendix B.
***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 3
Descriptive Statistics

Variable	N	Mean	Median	Std Dev	Q1	Q3
Panel A. Treatment						
CC_SPD	520	327.54	0.00	3047.97	0.00	0.00
CC_SPD_RA%	509	0.00	0.00	0.02	0.00	0.00
AVG_DUR_OUT	353	220.09	161.34	175.14	122.92	237.72
AVG_FREQ_OUT	353	1.28	1.19	0.57	0.94	1.53
O&M	499	0.64	0.64	0.09	0.58	0.70
LN_FINES	520	1.22	0.00	3.42	0.00	0.00
SIZE	520	15.29	15.66	2.57	14.98	16.46
LEVERAGE	520	0.28	0.28	0.06	0.25	0.31
LOSS	520	0.01	0.00	0.12	0.00	0.00
REPUBLICAN	130	0.50	0.50	0.50	0.00	1.00
HIGH TENURE	520	0.50	0.50	0.50	0.00	1.00
Panel B. Control						
CC_SPD	195	0.00	0.00	0.00	0.00	0.00
CC_SPD_RA%	193	0.00	0.00	0.00	0.00	0.00
AVG_DUR_OUT	134	175.93	129.67	144.32	93.30	187.55
AVG_FREQ_OUT	134	1.40	1.31	0.68	1.03	1.68
O&M	193	0.67	0.66	0.10	0.60	0.75
LN_FINES	195	1.60	0.00	3.90	0.00	0.00
SIZE	195	14.89	15.47	2.21	14.14	16.07
LEVERAGE	195	0.27	0.28	0.06	0.25	0.31
LOSS	195	0.05	0.00	0.21	0.00	0.00
REPUBLICAN	104	0.25	0.00	0.44	0.00	0.50
HIGH TENURE	195	0.53	1.00	0.50	0.00	1.00
Panel C. Unassigned						
CC_SPD	195	102.51	0.00	838.22	0.00	0.00
CC_SPD_RA%	194	0.00	0.00	0.02	0.00	0.00
AVG_DUR_OUT	138	195.98	149.27	166.31	111.76	205.02
AVG_FREQ_OUT	138	1.28	1.10	0.55	0.86	1.51
O&M	195	0.64	0.63	0.09	0.59	0.69
LN_FINES	195	2.08	0.00	4.41	0.00	0.00
SIZE	195	15.71	15.67	1.38	14.92	16.59
LEVERAGE	195	0.29	0.30	0.05	0.27	0.32
LOSS	195	0.02	0.00	0.12	0.00	0.00
REPUBLICAN	52	0.50	0.50	0.50	0.00	1.00
HIGH TENURE	195	0.60	1.00	0.49	0.00	1.00

This table presents descriptive statistics for treatment (Panel A), control (Panel B) and unassigned (Panel C) firms. Variables are winsorized at 1st and 99th percentiles. Variable definitions are presented in Appendix B.

Table 4
Regulatory Approval Validation

	CC_SPD			*CC_SPD_RA%*		
	(1)	(2)	(3)	(4)	(5)	(6)
POST	792.72*	817.57*	908.89*	0.0066**	0.0061**	0.0041
	(1.48)	(1.50)	(1.45)	(1.82)	(1.70)	(1.03)
SIZE		153.23*	175.74		0.0026**	0.0112
		(1.48)	(1.24)		(1.75)	(1.23)
LEVERAGE		−5,704.29*	−9,585.13		−0.0263	−0.0727*
		(−1.44)	(−1.30)		(−1.19)	(−1.32)
LOSS		799.00**	1,050.38***		0.0530*	0.0442*
		(1.75)	(3.05)		(1.62)	(1.63)
Fixed effects	No	No	Firm	No	No	Firm
N	520	520	520	509	509	509
Adjusted R^2	0.0141	0.0231	0.131	0.0197	0.120	0.278

This table presents regulatory approval validation tests. The dependent variables are the dollar spent on cloud computing (*CC_SPD*), and the amount as a percentage of total regulatory assets (*CC_SPD_RA%)* by treatment firms. Control firms have zero for *CC_SPD* and *CC_SPD_RA%* and are excluded in this analysis.
***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 5
Test of H2: Regulatory Approval and Reliability

	AVG_DUR_OUT			*AVG_FREQ_OUT*		
	(1)	(2)	(3)	(4)	(5)	(6)
TRT* × *POST	−46.2621**	−46.0092**	−55.2709**	−0.0002	−0.0027	−0.0345
	(−2.34)	(−2.30)	(−2.33)	(−0.00)	(−0.02)	(−0.29)
TRT	59.5590***	60.2773***		−0.0552	−0.0507	
	(2.94)	(2.98)		(−0.45)	(−0.41)	
POST	60.8953***	64.6723***		0.1515*	0.1710	
	(3.14)	(2.60)		(1.34)	(1.08)	
SIZE	4.7281*	4.9221*	−1.7535	−0.0556**	−0.0557**	−0.0475
	(1.35)	(1.39)	(−0.43)	(−1.70)	(−1.71)	(−1.18)
LEVERAGE	−122.1919	−139.2084	−16.4577	−0.4247	−0.4991	0.5887
	(−0.96)	(−1.09)	(−0.09)	(−0.51)	(−0.59)	(0.73)
LOSS	−8.9805	−2.8093	6.9649	0.0478	0.0527	0.1316*
	(−0.52)	(−0.17)	(0.26)	(0.28)	(0.31)	(1.46)
STATE_AVG	0.4155***	0.4068***	0.3953***	0.5357***	0.5337***	0.3161***
	(3.22)	(3.12)	(3.04)	(5.72)	(5.57)	(4.29)
Fixed effects	No	Year	Year & Firm	No	Year	Year & Firm
N	460	460	460	466	466	466
Adjusted R^2	0.253	0.256	0.405	0.289	0.282	0.724

This table presents the impact of regulatory approval on reliability. The dependent variables are the average duration of outages per customer, *AVG_DUR_OUT*, and the average frequency of outages per customer, *AVG_FREQ_OUT*. Variable definitions are presented in Appendix B.

***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 6
Test of H2: Regulatory Approval and Benefits of Efficiency and Security

	O&M			*LN_FINES*		
	(1)	(2)	(3)	(4)	(5)	(6)
TRT* × *POST	0.0102	0.0144	−0.0167**	−1.2337***	−1.0623***	−0.9939***
	(0.82)	(1.12)	(−2.19)	(−4.40)	(−3.63)	(−3.44)
TRT	−0.0269**	−0.0298**		1.4061***	1.2104***	
	(−1.77)	(−1.88)		(4.82)	(4.02)	
POST	−0.0314***	−0.0351**		−0.0841	−1.1899**	
	(−2.84)	(−2.34)		(−0.82)	(−2.38)	
SIZE	−0.0320***	−0.0303***	−0.0114	−0.1637**	−0.1428*	−0.1874*
	(−6.83)	(−6.54)	(−0.57)	(−1.84)	(−1.63)	(−1.37)
LEVERAGE	−0.5586***	−0.5434***	−0.0142	−1.8981	−1.7898	1.5047
	(−4.08)	(−3.98)	(−0.18)	(−0.77)	(−0.69)	(0.39)
LOSS	0.0151	0.0164	0.0546**	0.3559	0.5749	0.1905
	(0.47)	(0.54)	(2.14)	(0.55)	(0.84)	(0.60)
Fixed effects	No	Year	Year & Firm	No	Year	Year & Firm
N	641	645	645	674	676	665
Adjusted R^2	0.390	0.437	0.878	0.102	0.136	0.231

This table presents the impact of regulatory approval on reliability. The dependent variables are operating and maintenance expense scaled by revenue (*O&M*), and the natural log of fines (*LN_FINES)*. Variable definitions are presented in Appendix B.

***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 7
Cross-sectional Test using Political Party Affiliation of Public Service Commission Chair

Panel A. Cloud Computing Investment

	CC_SPD	*CC_SPD_RA%*
REPUBLICAN	2,625.147*	0.023**
	(1.61)	(2.67)
POST	437.423	0.001
	(1.04)	(0.07)
REPUBLICAN × POST	5,440.631*	0.037*
	(1.41)	(1.47)
N	130	125
Adjusted R^2	0.186	0.305

Panel B. Reliability, Efficiency, and Security Benefits

	AVG_DUR_OUT		*AVG_FREQ_OUT*		*O&M*		*LN_FINES*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	REP	*DEM*	*REP*	*DEM*	*REP*	*DEM*	*REP*	*DEM*
TRT × POST	-134.33***	-53.44	-0.59**	0.10	-0.00	0.04	-5.94***	-1.49
	(−3.77)	(−0.99)	(-2.37)	(0.42)	(-0.19)	(1.17)	(-8.03)	(-0.91)
Diff (High-Low)	-80.89		-0.69**		-0.05		-4.45**	
	(−1.28)		(2.08)		(-1.12)		(−2.51)	
N	63	102	66	103	91	136	91	143
Adjusted R^2	0.657	0.612	0.564	0.779	0.931	0.748	0.221	0.142

This table presents cross-sectional tests using the political party of the PSC chair. Panel A presents results on cloud computing regulatory assets within treatment firm. Panel B presents cross-sectional results on reliability, efficiency, and security benefits. *REP* is for firms whose PSC chair is a Republican, and *DEM* is for Democrat. All models include control variables and firm- and year-fixed effects. Variable definitions are presented in Appendix B.
***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 8
Cross-sectional Test using Commissioners' Experience

Panel A. Cloud Computing Investment

	CC_SPD	*CC_SPD_RA%*
HIGH TENURE	-2,026.211*	-0.073
	(-1.31)	(-1.30)
POST	171.979	-0.002
	(1.13)	(-0.65)
HIGH TENURE × POST	1,438.226*	0.012**
	(1.48)	(1.74)
N	520	509
Adjusted R^2	0.144	0.295

Panel B. Reliability, Efficiency, and Security Benefits

	AVG_DUR_OUT		*AVG_FREQ_OUT*		*O&M*		*LN_FINES*	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	HIGH TENURE	*LOW TENURE*	*HIGH TENURE*	*LOW TENURE*	*HIGH TENURE*	*LOW TENURE*	*HIGH TENURE*	*LOW TENURE*
TRT × POST	−39.194	−35.602*	0.004	−0.035	−0.008	−0.011	−1.488*	1.909**
	(−1.04)	(−1.38)	(0.02)	(−0.28)	(−0.49)	(−0.45)	(−1.64)	(1.81)
Diff (High-Low)	−3.592		0.039		0.003		−3.397***	
	(−0.08)		(0.16)		(0.10)		(−2.47)	
N	216	244	220	246	357	335	364	351
Adjusted R^2	0.605	0.280	0.694	0.777	0.849	0.819	0.162	0.186

This table presents cross-sectional tests using PSC commissioners' experience. Panel A presents results on cloud computing regulatory assets within treatment firm. Panel B presents cross-sectional results on reliability, efficiency, and security benefits. *HIGH TENURE* is for firms whose PSC commissioner's tenure is more than three years, and *LOW TENURE* is for those with tenure equal to or less than three years. All models include control variables and firm- and year-fixed effects. Variable definitions are presented in Appendix B.

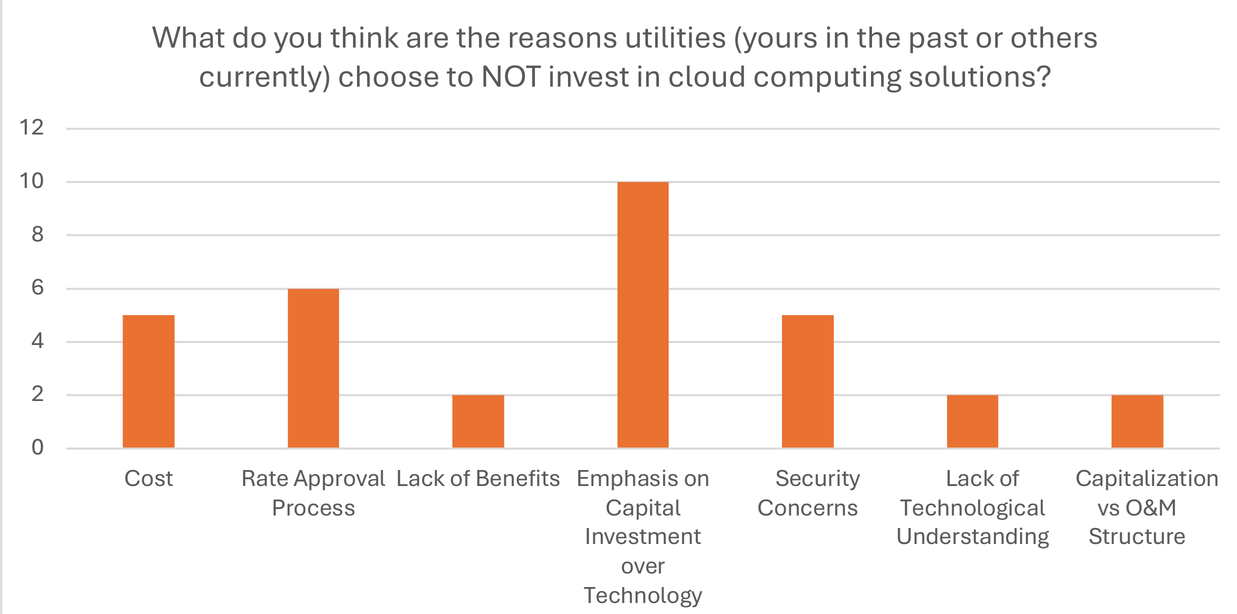
***, **, * represent statistical significance at the 1%, 5%, and 10% levels, respectively, using a one-tailed test.

Table 9 Survey Responses

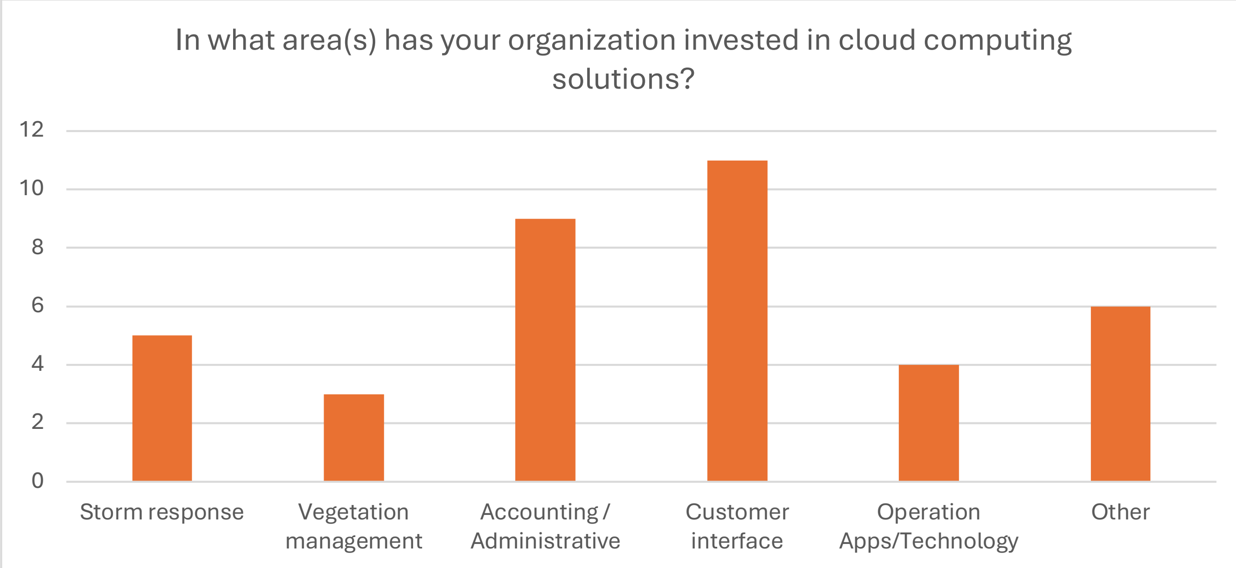
Panel A: Ownership Structure

What is the ownership structure of the utility for which you work?	
Investor owned	13
Co-operative	2
Municipality	1
Other (Self-funded Nonprofit; Authority)	2
Total	18

Panel B: Noninvestment in Cloud Computing



Panel C: Cloud Computing Investments



Panel D: Benefits of Cloud Computing

My organization has experienced benefits in the following areas as a result of an investment in cloud computing technologies:

	N	Average	Strongly Agree	Somewhat Agree	Neither	Somewhat Disagree	Strongly Disagree	Agree (4 or 5)	Disagree (1 or 2)
Operating efficiencies (cost savings)	17	4.29	53%	35%	0%	12%	0%	88%	12%
Compliance with regulatory standards	15	3.87	33%	33%	27%	0%	7%	67%	7%
Reliability in providing services to customers	17	4.06	35%	35%	29%	0%	0%	71%	0%
Improved data management and demand forecasts	17	4.18	53%	12%	35%	0%	0%	65%	0%
Scalability (adjusting demand up and down)	17	4.59	76%	12%	6%	6%	0%	88%	6%
Reduced response time to weather-related outages	14	3.71	29%	21%	43%	7%	0%	50%	7%
Remote access by workforce	17	4.53	65%	24%	12%	0%	0%	88%	0%
Customer satisfaction	17	4.00	29%	41%	29%	0%	0%	71%	0%

Panel E: Rate Base Inclusion of Cloud Computing							
	N	**Average**	**Strongly Agree**	**Somewhat Agree**	**Neither**	**Somewhat Disagree**	**Strongly Disagree**
Obtaining approval to include cloud computing costs in your utility's rate base increases the likelihood that your organization will invest in cloud computing technology solutions.	14	4.43	57%	29%	14%	0%	0%

	N	**Yes**	**No**	**Don't Know**
Has your organization obtained approval to include certain cloud computing costs in its rate base?	14	43%	50%	7%

In a typical rate case for your organization, what percent of the proposed rate increases do you typically expected to be approved by your respective public service commission?	73.7%