Dynamic Natural Monopoly Regulation: Time Inconsistency, Moral Hazard, and Political Environments

Supplementary Material

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Abstract

This supplementary material provides additional details of our paper "Dynamic Natural Monopoly Regulation: Time Inconsistency, Moral Hazard, and Political Environments". It consists of five sections.

1. In Section 1, we present three sensitivity analyses.
    (1) In Section 1.1, we present a sensitivity analysis of the relationship between the rate of return and political environments with respect to market structure (deregulation).
    (2) In Section 1.2, we present a sensitivity analysis regarding the valuation of reliability.
    (3) In Section 1.3, we present a sensitivity analysis of our key regression results to inclusion of parent company fixed effects.
2. In Section 2, we present four analyses to complement the preliminary analyses (Section 4 in the main text).
    (1) In Section 2.1, we analyze electricity pricing across customer classes.
    (2) In Section 2.2, we examine how measures of disallowances of capital investment by regulators vary with the political environment.
    (3) In Section 2.3, we investigate the relationship between return on equity and regulatory ideology in Southern states and by time period.
    (4) In Section 2.4, we document the reduced-form relationship between reliability and political ideology of regulators.
3. In Section 3, we provide additional discussion regarding the model.
    (1) In Section 3.1, we present details on the simulations underlying the model predictions in Section 3.5.3 of the main text.
    (2) In Section 3.2, we present a further discussion on the contractibility of the rate of return and the utility's effort in energy loss.
    (3) In Section 3.3, we present a further discussion on the empirical identification of our model.
4. In Section 4, we present an additional counterfactual experiment regarding commission design and minority representation.
5. In Section 5, we consider alternative model specifications for energy loss, and present robustness of the welfare implications from our counterfactual experiments.

Contents

List of Tables

1 Sensitivity Analyses

1.1 Rate of Return Regression – Market Structure (Deregulation)

In this subsection, we present a sensitivity analysis of the relationship between the rate of return and political environments documented in Section 4.1 – Table 3 in the main text. Specifically, we include the market structure, or deregulation status, of each state's electricity market as a control variable. All the distribution utilities in our study are local monopolists, regulated by state-level regulators, regardless of the deregulation status of their state. Deregulation occurs in the wholesale market for the generation of electricity and in the retail market with retailers that sell electricity to final users by paying access fees to monopoly distribution utilities.

We use a panel data set with the dummy variable of deregulation. The data set covers 50 states with yearly observations from 1990 to 2012. The period of deregulation for a given state is defined as the period between legislation for restructuring and the legislation for repeal (if there was repeal) or the present (if there was no repeal).[1]Among 1150 state-year observations in our data, 289 observations belong to the period of deregulation.

Theoretically, there are two possible channels through which market structure may influence the rate of return. The first channel is vertical relationships. In states with deregulated markets, utilities tend to be divested. That is, distribution utilities tend not to engage in electricity generation. Since generation is the part of the industry that requires the most risky, large-scale investment, separation of generation and distribution utilities decreases the fair rate of return for distribution utilities. The second channel is the influence of retail competition and the volatility of the wholesale electricity market, which may make cash flow and input costs for electric distribution utilities unstable. This may increase the fair rate of return required to attract capital.

Table S.1 shows the relationship between return on equity and political environments, analogous to Table 3 in the main text, with the dummy variable of deregulation as a control variable. It shows that the key results on return on equity and political environments are robust to controlling for the market structure. Curiously, the deregulation variable shows different signs and statistical significance of coefficients depending on the specification and the data period. Since the coefficient estimates are not robust across specifications and do not seem to significantly affect the key results, we abstract from the market structure in the main analysis in our study.

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[1] The source of information is each state's profile on the U.S. Energy Information Administration website. For details, see `http://www.eia.gov/electricity/policies/restructuring/restructure_elect.html`.

1.2 Valuation of Reliability

In this subsection, we analyze how low valuations of reliability would need to be, or how expensive reliability improvements would need to be, for us to conclude that there is not under-investment.

In our main text, we argue that the inability of the regulator to commit to future policies leads to socially suboptimal capital levels. Our estimated costs of improving reliability paired with the surveyed valuations of improving reliability indicate that there is under-investment in the data. The ingredients in this empirical calculation are certainly subject to caveats such as whether survey can achieve truthful elicitation, and how to aggregate of surveys with differently phrased questions. However, the surveys employed in this study mostly followed the industry standard "Interruption Cost Estimation Guidebook," which recommends, for industrial and commercial respondents, a two to four hour on-site survey with at least one mid- to senior-level analyst. Although the residential surveys are done by mail and are therefore less reliable, the contribution of residential valuations to the calculation is negligible. Moreover, as the surveyors are the utilities that serve the survey respondents for the purpose of planning, the survey respondents would consider their responses as consequential, suggesting that survey responses are more likely to match true valuations (Landry and List, 2007).

In Table S.2, we alter the value of reliability estimates within the surveyed range. Our baseline estimates are based on the midpoint for each customer class (\$6765 to avoid a 30 minute outage for industrial customers, \$379.5 for commercial customers, and \$1.75 for residential customers). We calculate aggregate willingness to pay for reliability improvements by weighting these valuations by the fraction of such customers for the average utility. Column (1) corresponds to our baseline estimates, and concords with our commitment counterfactual in Section 7.1 of the main text, where the implied increase in investment would lead to approximately 50% more distribution capital in the steady state, leading to roughly 20% fewer outages.[2]

At the high end of the surveyed values (Columns (2) and (5)), under-investment becomes more severe. Even at the low end of the surveyed values, there is too little distribution capital (Column (3)). The break-even points could be reached by either reducing the fraction of commercial consumers by more than one half (Column (8)), or by increasing the cost of reliability improvements by capital investment (Column (4)) such that the elasticity of SAIDI to distribution capital is two-thirds our preferred estimate. Some utility territories may very well be in this range, but the results suggest that the mean utility has too little distribution capital.

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[2] A computationally costlier but more accurate way to assess robustness would be to re-estimate the model for each of these values, and re-simulate commitment.

1.3 Inclusion of Parent Company Fixed Effects

In this subsection, we document robustness of our key results in the preliminary analyses (Section 4 in the main text) to inclusion of parent company fixed effects. In Table S.3, Columns (1) and (2) show the results of controlling for parent company fixed effects in the regressions of investment on return on equity in Columns (1) and (2) of Table 4 in the main text, Section 4.2. Column (3) shows the result of controlling for parent company fixed effects in the regressions (Column (4) of Table 6 of the main text) of log energy loss on *Republican Influence*. Column (4) shows the result of controlling for parent company fixed effects in the regressions of $\log(SAIDI)$ on the log net value of the distribution plant (Column (4) of Table 5 in the main text). The coefficient estimates are overall robust to the inclusion of parent company fixed effects.

2 Additional Preliminary Analyses

2.1 Pricing across Customer Classes

In this subsection, we explore an additional dimension in which political environments may influence the conduct of electric utilities – pricing across customer classes (residential, industrial, and commercial). In principle, pricing across customer classes should be based on the variation in the costs of delivery. However, regulators that are pro-industry may be biased towards reducing prices for commercial and industrial customers at the expense of an increase in the price for residential customers. To explore this possibility, we use two variables: the ratio of residential price to industrial price, and the ratio of residential price to commercial price.

As in Table 3 of the main text, we regress these price ratios on political ideology and other characteristics of political environments. Table S.4 shows the result on the ratio of residential to industrial prices. Table S.5 shows the result on the ratio of residential to commercial prices. The two tables show *no* robust relationships between price ratios and political environments. In Panel A of both tables, the specifications with both utility-state and year fixed effects (Columns (1)-(5)) do not show any statistically significant estimates. In Columns (6)-(10), without year fixed effects, some coefficient estimates are statistically significant, but the magnitude is not robust and the sign is negative, which is contrary to the conventional view that conservative regulators would favor industrial or commercial customers relative to residential customers. In Panel B of both tables, the specifications with only the Nominate scores and year fixed effects (Columns (1) and (6)) yield negative coefficient estimates, which is again the opposite of what is plausible. In specifications with more control variables, the coefficient estimates tend to get smaller in absolute magnitude and lose statistical significance. Overall, we do not find any systematic evidence that political environments influence electricity pricing across customer classes. Thus, we abstract from this issue in the main text.

2.2 Capital Disallowance Analysis

In this subsection, we explore a dimension of regulatory discretion that we do not consider in our main text: capital disallowance. Our main model puts all the regulatory discretion into the rate of return decision. In practice, another way to exert regulatory discretion is through a capital disallowance. Regulators can differ in what types of investments they deem prudent enough to be included in the regulatory capital base and thus into the revenue requirement. In a suitably augmented version of our model, one would conjecture conservative regulators, who we estimate to be more utility friendly, to be more lax about allowing investments into the capital base. Supposing one had such evidence at hand, one could provide a good rationale for enriching the model to allow for asymmetric information regarding the capital base.[3] Regulators could audit investments at a cost to discern which should be considered prudent. The degree to which regulators engage in such auditing would depend on their weight on utility profits.

Here we attempt to measure capital disallowances as they vary with the political environment. We find suggestive, but ultimately limited, evidence that conservative environments are more lax about allowing investments into the capital base. We constructed two variables for each rate case. First, we construct Net Base Ratio, which is the the ratio of approved rate base to the net distribution plant (total distribution capital accounting for depreciation). When this ratio is equal to one, all investments are incorporated into the rate base. When it is less than one, the approved rate base is less than the total amount of investment. Therefore, some investments are not incorporated into the rate base. We also construct Req Ratio: the ratio of the approved rate base to the requested rate base as recorded by the RRA data set. If this is equal to one, the utility is granted their full request for the rate base, and when it is less than one, some of their request is not met. The means of these new variables are 0.74 and 0.93, respectively. We then employed these ratios as dependent variables in regressions on political ideology.

Table S.6 presents the regression results. In addition to the full sample, we also limited the sample to utilities that do not own generation assets and utilities that do not cross state boundaries. Without these restrictions, there can be large differences in the ratio of approved rate base to net distribution plant because the approved rate base includes generation assets or the net distribution plant includes distribution assets from other states. Panel A presents the results for Net Base Ratio. Panel B presents the results for Req Ratio.

We see some scattered evidence that more conservative environments are more lax about allowing capital investments into the rate base. Specifically, we see a positive and significant coefficient

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[3] In our current formulation, asymmetric information is divorced from investment decisions that affect the capital base.

on Republican Influence in column (3) for Net Base Ratio and column (2) for Req Ratio. This would be the expected prediction from enriching our model: just like conservative commissions audit the line loss effort less, they would audit the capital investments less, leading to higher allowances of capital into the rate base. In addition to these marginally significant results, there is no evidence in the opposite direction. However, the overall statistical evidence is not strong across specifications. While it would be interesting to investigate in the future with more data, we conclude that these empirical results do not form a strong enough reduced form core to estimate a model of dynamic asymmetric information. While it is comforting that the results more closely resemble what moving our model in such a direction would predict, the evidence is not strong enough to justify such a significant addition to the dynamic model.

2.3 Return on Equity and Political Environments in Southern States

In this subsection, we document further details of Table 3 Panel A in the main text on the relationship between return on equity and *Republican Influence*. Specifically, we investigate to what extent Southern states influence coefficient estimates. The reason we investigate this relationship is because, without parent company fixed effects, we find noisy results of the effect of *Republican Influence* on return on equity over the full time period, while we find a strong positive relationship when we look at more recent years. One contributor to these results is that the early 1990's was the tail end of the conversion of Southern Democrats to the Republican party. That is, some of those affiliated with the Democratic party in the Southern states were effectively Republicans, but had not changed their party affiliation yet. This pattern would bias our results towards finding a negative relationship between *Republican Influence* and return on equity.

Columns (1)-(2) and (3)-(4) of Table S.7 show the coefficient estimates for *Republican Influence* for Southern and non-Southern states, respectively. The comparison of coefficient estimates across columns confirms that Southern Democrats, who are effectively Republicans, weakened the coefficient estimate of *Republican Influence* in the regressions with the full sample.[4]

2.4 Reliability and Political Environment

In this subsection, we provide an additional analysis of the relationship between the political environment and reliability. In Section 4 in the main text, we provide evidence on three relationships: (1) political environment and return on equity; (2) return on equity and investment; and (3) investment and reliability. These three relationships lead us to the following question: do political environments with conservative regulators tend to have better reliability?

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[4] Altering the cut off year between 1996 and 2000 does not change the pattern of results appreciably.

Table S.8 shows results of regressing $\log(SAIDI)$ on *Republican Influence* (fraction of Republican commissioners) using the following specification:[5]

$$\log(SAIDI_{it}) = \alpha + \gamma_t + \beta_1 Republican\ Influence_{it} + \beta_2 x_{it} + \varepsilon_{it}$$

The results suggest that having more regulators of conservative ideology is associated with better reliability.[6] Moreover, the strength of the relationship is quantitatively meaningful. On average, a long term all-Republican regulatory commission is associated with about 20 percent fewer outage minutes of electricity relative to no Republican commissioners.

3 Additional Discussions

3.1 Details on Simulations of the Model Predictions

In this subsection, we provide details on the simulations underlying the model predictions in Section 3.5.3 in the main text. To generate the set of parameter values underlying the simulations, we created twenty deviations from the estimated parameter values, and solved the model for all pairwise combinations. As mentioned in the main text, sixteen of these correspond to doubling, halving, tripling, and dividing by three the parameters γ_e, γ_κ, γ_r, and η. Two cases correspond to spreading out and shifting the α process. Specifically, in one case, we shift the set of possible α's down by 0.025 and multiply the shifted values by 1.0125. In the other case, we shift the set by 0.05 and multiply the shifted values by 1.025. Lastly, in the other two cases, we alter the transition matrix for the α process. In one case, we make the diagonal elements equal to 0.8, and the adjacent elements to the diagonal equal to 0.1 (for the boundaries, we set the diagonal elements equal to 0.9). In the other case, we set the diagonal elements to 0.2, and the adjacent elements to 0.4 (for the boundaries, we set the diagonal elements to 0.6).

Figure 1 graphs the results of this exercise. Each panel corresponds to a histogram of a model statistic across sets of parameter values. The first three panels plot the distributions of the mean value of a policy in the most conservative state minus the mean value of that policy in the least conservative state. The last two plot the distributions of regression coefficients across sets of parameter values. The model consistently predicts that investment decreases in α, the weight on

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[5] In this regression, we do not include utility-state fixed effects. The identification of a model with utility-state fixed effects would hinge on a spontaneous response in reliability to changes in political ideology, which is at odds with the mechanism of the effect we laid out above. It may take a few years for high return on equity adjudicated by conservative regulators to cause a substantial increase in distribution capital and subsequent improvement in reliability. Therefore, regressions with utility-state fixed effects would not properly capture the influence of political ideology on reliability.

[6] We also ran regressions with Nominate scores as a measure of political ideology, and did not obtain any statistically significant results. Thus, we regard this only as weak evidence on the relationship.

consumer surplus. The rate of return decreases in α. Effort increases in α. Investment is positively correlated with the return on capital. Finally, reliability[7] is negatively correlated with α. In all cases we assume that α is serially positively correlated, as we estimate α to follow local political ideology. With the implied relationship that conservative ideology corresponds to lower α, the model predicts that rate of return, investment, and reliability are higher with more conservative regulators, while effort is lower with more conservative regulators.

3.2 Contractibility of the Rate of Return and the Utility's Effort Level

In this subsection, we provide a further discussion on the contractibility of the rate of return and the utility's effort, an issue laid out in Section 3.5.5 in the main text.

Regulator's Decision on the Rate of Return In the main text, we identified three reasons for incompleteness or lack of contracts: (1) unforeseen contingencies, (2) cost of writing a contract, and (3) cost of enforcing a contract. The three reasons apply to the regulator's decision on the rate of return. Various unforeseen contingencies may discourage the regulator from entering into a contract with the utility. For example, the U.S. electricity industry has gone through significant changes for our data period such as deregulation of electricity generation, retail competition, and renewable portfolio standards. All these changes were anticipated to affect the profitability of electric utilities and hence their fair rate of return. However, the specific direction and the magnitude of the effects were difficult to predict. Complexities of such changes in the industry may easily discourage the regulator and the utility from entering into a contract.

The cost of writing a contract may also be a reason for the lack of a contract. PUC's with different ideological makeup would desire to adjudicate different rates of return. This, in conjunction with high turnover of PUC members, implies that the PUC may want to frequently write a new contract, the cost of which may in turn discourage the PUC's and the utility from entering into a contract.

In addition, there are two distinctive features of the rate of return adjudication that make enforcement of a contract difficult or ineffective. First, due to the dynamic nature of the time inconsistency problem in the rate of return adjudication, the issue of whether a regulator can bind its successors to a decision and the issue of renegotiation become central. This in turn implies obstacles in enforcing the contract. There exists a legal doctrine in the U.S. called "rule against legislative entrenchment", which means that a legislative body cannot bind its successors to previously-agreed-upon terms. The PUC essentially functions as a legislative body when it comes to rate-setting. In light of this, Paul L. Joskow wrote, "Is it credible for the regulator to commit not to renegotiate the contract,

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[7] The observed SAIDI measure used in the empirical analysis is inversely related with reliability: high SAIDI means low reliability.

especially in light of U.S. regulatory legal doctrines that have been interpreted as foreclosing the ability of a regulatory commission to bind future commissions?" (p. 1310, Joskow (2007)). In general, a contract that involves an action unique to the government, such as regulation, may differ significantly from contracts between private parties in that it may only have limited power to influence future actions. This explains the lack of a contract on the rate of return in the conventional rate regulation.[8]

Second, regulators have other policy instruments in addition to rate of return, such as the disallowance of capital investments. This in turn undermines regulators' ability to make a credible commitment to revenue streams for the utility even with a contract. Suppose that regulators sign a contract for future rate of returns and then find themselves in a state of the world where they would like to change the rate of return. They could use other instruments to reduce the revenue to the utility such as being more strict on allowing capital or increasing regulatory lag. If the utility anticipates such possibilities, then regulators' contract on the rate of return, if any, may end up being essentially meaningless.

Utility's Effort on Energy Loss The cost of deviating from full pass-through creates a regulatory trade-off similar to the insurance versus incentives trade-off in traditional moral hazard problems despite the utility being risk-neutral. One might wonder why the regulator would desire to pass through input costs fully in the first place. In other words, why do most states have automatic adjustment clauses? The main reason is to avoid repetitive rate cases due to short-term fluctuations in power costs driven by fuel price volatility. Absent an automatic adjustment, the utility and regulator would either have to engage in frequent rate cases, or the utility would be a riskier investment causing an increase in the utility's cost of capital.[9] The implementation of automatic adjustment clauses, however, is such that they apply to the total expenditure on purchased power, thereby blunting the incentives to reduce line loss.

An alternative to making adjustments based on the total expenditure would be for the regulator to specify the appropriate actions to reduce line losses, and reward the utility for carrying out those actions. However, the cost of doing this is potentially very high for the regulator. There are many different factors that affect energy losses, which makes it difficult to determine what set of specific actions would be appropriate for any given time period. Both the existence of unforeseen contingencies and the cost of writing such a contract suggest a rationale for simpler automatic adjustment paired with the option to conduct prudence reviews. Furthermore, adding complications to the contract renders enforcement more difficult, especially when judges who deal with enforcement have incentives that do not align with the regulator. Judges' decisions may be

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[8] McGinnis and Rappaport (2003) discuss the historical origin of the rule against legislative entrenchment and legal arguments for the unconstitutionality of legislative entrenchment.

[9] See Graves et al. (2006) for more detail on the justifications for automatic adjustment mechanisms.

influenced a great deal by their ideology, reelection incentives, or campaign contributions from the industry.[10] A possible misalignment between the interests of the PUC and those of the state court may hinder enforcement of the contract, which may in turn discourage the regulator and the utility from using a complex contract in the first place.

3.3 Empirical Identification

In this subsection, we provide details of the relationship between model parameters and moments in the data discussed in Section 6 of the main text. We use the notions of (scaled) sensitivity and sufficiency in Gentzkow and Shapiro (2013). Their notion of sensitivity is the expected coefficient in a regression of model parameters on moments in the data across repeated draws from their joint asymptotic distribution. Scaled sensitivity measures how much a one-standard deviation change in a moment in the data affects the expected value of a model parameter in units of its asymptotic standard deviation, fixing other moments in the data. Sufficiency of a moment for a model parameter is the probability limit of the R^2 of a regression of the model parameter on the moment across repeated draws from their joint asymptotic distribution.

The moments in the data we use are the means, variances of, and correlations between the primary variables: capital levels, fraction of Republican commissioners, Nominate score, investment, energy loss, and regulated rates of return. In Table S.9, we report the scaled sensitivity measure for each parameter with respect to each of the chosen moments. We computed scaled sensitivity by re-estimating the model for different bootstrapped samples of the data. We bootstrapped blocks of all yearly observations for a utility-state pair, estimated the model parameters using the primary estimates as starting values, and regressed the estimates on the summary statistics. Scaled sensitivity corresponds to the regression coefficient times the ratio of the standard deviation of the moment across bootstrap samples to the standard error of the coefficient estimate. The estimated model parameters are each sensitive to those moments that would be most intuitive, as described in Section 6 of the main text. The sufficiency statistics are generally low, in the range of 5% to 35%. Much of the variation in parameters across different data sets is due to higher order features of the data.

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[10] U.S. state court judges are particularly susceptible to the influence of politics because a majority of states have direct elections of judges by voters. For more concrete discussions on the influence of political environments on state court judges, see Lim (2013), Lim et al. (2015)), and Lim and Snyder (2015)).

4 Additional Counterfactual: Commission Design and Minority Representation

In this section, we present an additional set of counterfactuals regarding commission design and minority representation. We consider imposing a restriction on the influence of politics in regulation, specifically a rule that requires that no more than a certain fraction of regulatory commissioners can be from the same party. This rule is already in place in some states. The bound is typically three commissioners out of five. For example, in Connecticut, no more than three among five can be from the same political party; in Colorado, no more than two among three can be from the same political party. We simulate such a rule ("Minority Representation") with a *mean-preserving shrinkage* of the Markov process governing the evolution of the regulator's weight on consumer surplus. We reduce the standard deviation of the Markov process to 40% of the baseline, which corresponds to the implied reduction in the standard deviation of α if the fraction of Republican commissioners were bounded between 0.4 and 0.6 in the data. Table S.10 shows the results. By construction, this policy has little effect on *mean* outcomes. What determines the mean level of investment is the expected stream of future returns, which is not affected by this policy. However, this policy has a significant effect on the *second moment* of rate of return, and a slight decrease in the same for investment. Our result would be useful in designing and assessing policy tools to reduce variation in the quality and efficiency of energy distribution over time and across states.[11] We also consider a regulatory commission at the mean α with zero variance as a theoretical benchmark ("Centrist Commission" in Table S.10). The results are similar to the minority representation counterfactual, but with even greater decreases in the variance of observable outcomes.

5 Alternative Model Specification: Energy Loss

In this section, we conduct robustness exercises using two alternative model specifications of energy loss: (1) we completely drop the effort to reduce energy loss choice and the auditing choice from the model; and (2) we allow capital to affect energy loss. In our baseline specification in the main text, we assumed that capital has no effect on energy loss. For each of these two alternative specifications, we re-estimate all model parameters and re-compute counterfactual results.

The takeaways are as follows. First, the magnitude of under-investment due to the time incon-

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[11] A more complicated version of our model can also predict a larger influence of the minority representation requirement. We have aggregated many different utilities when estimating the parameters of the utility-regulator model. In particular, the Markov process governing the weight on consumer surplus is assumed to be the same across utilities for computational tractability. In reality, more extreme states would have different means and less variance than we currently estimate. In such a case, minority representation rule could have more pronounced effects on observable outcomes.

sistency problem is large under all specifications. Second, the magnitude of under-investment due to the time inconsistency problem is larger when capital decreases energy loss. Third, allowing capital to affect loss softens the tradeoff between investment and productivity in assessing welfare implications of regulator ideology. In the baseline specification, a liberal regulator audits more than a conservative regulator, leading to less energy loss. A conservative regulator grants higher rates of return, leading to more investment. When investment reduces energy loss, the higher level of capital investment under a conservative regulator creates a countervailing force that balances out its laxer auditing. This softens the tradeoff. However, at the elasticity of energy loss to capital investment that we use,[12] the tradeoff still exists. That is, capital investment does not reduce energy loss enough to offset the better performance on energy loss under a liberal regulator.

Before going into detail on the results, we discuss choices that enter the second alternative specification where capital reduces line loss. The first alternative specification, where we eliminate line loss from the model altogether, is conceptually straight-forward and simpler from a computational point of view. The main issue to deal with in allowing capital to reduce line loss is to obtain the relevant elasticity: by how much does capital investment reduce line losses? From the engineering literature on line losses, we identified several types of capital projects that can affect line losses:

1. Adding appropriate substation transformers
2. Increasing line size and/or adding secondary lines (as loss increases faster than linearly on congested lines)
3. Using newer transformers
4. Adding capacitors
5. Adding metering equipment to track down high loss segments or equipment

The engineering literature on line losses focuses on *voltage optimization* and *phase balancing*, two engineering tasks that do *not* require expensive new capital. Regarding capital, the literature suggests that the greatest reduction in losses comes from tracking down poorly performing equipment and replacing them with newer equipment. However, the capital cost of such efforts could be significantly smaller than the labor cost of identifying the poorly performing equipment. Furthermore, capital additions can worsen losses if mis-applied. For example, adding a secondary line whose route is longer than the original line could increase losses.

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[12] We employ the values from Table E-1 from "Assessment of Transmission and Distribution Losses in New York PID071178 (NYSERDA 15464)", available on the New York State Energy Research and Development Authority (NYSERDA) website. The report estimates the average benefit-to-cost ratio in terms of reducing energy loss to be 1.13 for a variety of small scale capital projects across different utilities. We are not able to estimate this relationship between capital and energy loss in our data, nor is it certain that increasing our measure of capital necessarily reduces energy loss. Our exercise here is aimed at checking robustness for the case in which raising our aggregate capital measure does reduce energy loss on average.

This literature is mostly theoretical and does not deal with monetary costs. The best quantitative evidence available is from engineering reports for small-scale utility projects in New York from the report "Assessment of Transmission and Distribution Losses in New York PID071178 (NYSERDA 15464)," which we mentioned above in footnote 12. This series of projects produced a mean benefit-to-cost ratio of 1.13. We calibrate a new parameter in our model to generate this benefit-to-cost ratio from reducing losses by increasing capital for the average utility. This is likely to yield an overestimate of the true effect because the projects in the New York report aimed to reduce line losses. However, in our model where all capital is assumed homogeneous, even capital investment aimed at improving reliability, such as replacing an wooden pole with a steel pole, now generates an additional benefit by reducing line loss at the value calibrated from the New York study.

Table S.11 presents the results from the commitment counterfactual under the alternative specifications of energy loss, which yield the first two takeaways mentioned above. Each column corresponds to the predicted change moving from the baseline to the commitment counterfactual. The first column corresponds to the main model. The second and third columns present results from the alternative specifications. In both alternative specifications, commitment remains an issue of nearly the same quantitative importance as in the main model. When capital can improve energy loss, the commitment counterfactual leads to even higher commitment rates of return and steady state capital. This is because capital has an extra benefit of reducing energy loss in addition to reducing power outages.

Table S.12 presents the results from conservative rate and maximal audit counterfactuals under the alternative specification where capital affects energy loss. These analyses yield the third takeaway mentioned above. It is a quantitatively small effect, but moving from the baseline to the conservative rate of return policy leads to higher consumer surplus when capital reduces energy loss. The extra capital induced by the higher rate of return relative to the baseline has the additional effect of lowering energy loss. This leads to lower electricity prices for consumers, and increases their value. Likewise, moving from the baseline to the most liberal policy reduces energy loss by a smaller amount in the alternative specification than in the main model.

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Table S.1: Regression of Return on Equity on Political Ideology and Deregulation

Dependent Variable: Return on Equity

	Panel A: Republican Influence as a Measure of Ideology									
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Republican Influence	0.0536	0.266**	0.227*	0.468***	0.715***	0.217	0.472**	0.826***	1.144***	1.307***
	(0.143)	(0.103)	(0.125)	(0.140)	(0.201)	(0.280)	(0.209)	(0.231)	(0.220)	(0.270)
Deregulation	-0.0310	0.0290	-0.0551	0.0596	-0.225**	-0.991***	-0.485**	-0.0971	0.759***	0.261***
	(0.125)	(0.137)	(0.129)	(0.171)	(0.0851)	(0.168)	(0.206)	(0.229)	(0.135)	(0.000)
Observations	3,342	3,342	2,481	1,771	1,047	3,342	3,342	2,481	1,771	1,047
R-squared	0.703	0.752	0.727	0.738	0.771	0.502	0.629	0.590	0.634	0.724
Time Period	All	All	Year>1995	Year>2000	Year>2005	All	All	Year>1995	Year>2000	Year>2005
Utility-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No

	Panel B: Nominate Score as a Measure of Ideology									
	House of Representatives					Senate				
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominate Score	1.033***	0.647*	0.656*	0.728*	0.695*	0.799***	0.396	0.540*	0.537**	0.485*
	(0.371)	(0.351)	(0.366)	(0.393)	(0.375)	(0.281)	(·)	(0.286)	(0.266)	(0.268)
Deregulation	0.256	0.0630	-0.00743	-0.0658	-0.0274	0.170	0.0276	-0.0340	-0.107	-0.0769
	(0.225)	(0.138)	(0.283)	(0.239)	(0.250)	(0.198)	(·)	(0.260)	(0.217)	(0.229)
Campaign Unlimited				0.295	0.305				0.279	0.287
				(0.259)	(0.245)				(0.234)	(0.222)
Ballot				-0.256	-0.246				-0.262	-0.253
				(0.192)	(0.191)				(0.184)	(0.185)
Elected					0.353*					0.301
					(0.192)					(0.184)
Observations	3,329	3,329	721	528	528	3,329	3,329	721	528	528
R-squared	0.281	0.752	0.398	0.391	0.399	0.285	0.751	0.403	0.394	0.400
Sample	All	All	Rate Case	Rate Case	Rate Case	All	All	Rate Case	Rate Case	Rate Case
Utility-State FE	No	Yes	No	No	No	No	Yes	No	No	No
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	Yes	Yes	No	No	No	Yes	Yes
Financial Controls	No	No	No	Yes	Yes	No	No	No	Yes	Yes

Note: Unit of observation is rate case in Panel B, Columns (3)-(5) and (8)-(10). It is utility-state-year in others. Robust standard errors, clustered by state, are in parentheses. In Panel B Column (7), variance matrix is highly singular. *** p<0.01; ** p<0.05; * p<0.1

Table S.2: Robustness to Alternative Valuations and Costs of Reliability Improvements

	Specifications							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Valuation of Customers								
Industrial	6765	9200	4388	6765	9200	4388	6765	6765
Commercial	379.5	435	324	379.5	435	324	379.5	379.5
Residential	1.75	3	0.5	1.75	3	0.5	1.75	1.75
Fraction of Customers								
Industrial	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0	0.0038
Commercial	0.125	0.125	0.125	0.125	0.125	0.125	0.125	**0.0107**[a]
Residential	0.8712	0.8712	0.8712	0.8712	0.8712	0.8712	0.875	0.9855
Technology Parameter [b]	0.525	0.525	0.525	**0.2213**[a]	0.2213	0.2213	0.525	0.525
Cost of One Minute[c] Improvement	26.234	26.234	26.234	62.266	62.266	62.266	26.234	26.234
PV of One Minute[c] Improvement	62.224	76.624	48.008	62.224	76.624	48.008	40.807	26.228
Break-even Capital[d] Improvement	2.372	2.921	1.8300	1.000	1.231	0.771	1.556	1.000
Under-Investment	Yes	Yes	Yes	No	Yes	No	Yes	No

Note: This table presents robustness of our assessment of under-investment to alternative valuations of reliability improvements and alternative costs of improving reliability by capital expenditure. “Valuation” refers to the estimated willingness to pay to avoid a 30 minute power outage by customer class. “Fraction” refers to the fraction of electricity consumers from that customer class.

[a] Bold numbers (0.0107 and 0.2213) indicate that these values were chosen to match the break-even point to observed mean capital.

[b] “Technology Parameter” refers to the relationship between the value of distribution capital and reliability, estimated in Column (4) of Table 5 in the main text. For example, 0.525 means that a 10% increase in the value of distribution capital is associated with a 5.25% decrease in SAIDI.

[c] The cost and present value (PV) of one-minute improvement are evaluated at the mean level.

[d] “Break-even capital investment” indicates the multiple of the mean observed capital level beyond which further investments to improve reliability are not cost effective.

Table S.3: Robustness of Key Regression Results to Including Parent Company Fixed Effects

Variable	Dependent Variable			
	Gross Investment	Net Investment	log(Energy Loss)	log(SAIDI)
Return on Equity	0.0039*** (0.0011)	0.0034*** (0.0013)		
Republican Influence			0.090* (0.050)	
log(Net Distribution Plant)			0.328** (0.125)	-0.434** (0.196)
Observations	510	510	3,276	1,192
R-squared	0.617	0.542	0.944	0.796
Utility FE	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes
Other Controls	None	None	None	O&M expenses Weather
Sample Restriction	No	No	Yes[a]	No
Parent Company FE	Yes	Yes	Yes	Yes

Note: This table assesses the robustness of our preferred regression estimates to the inclusion of parent company fixed effects. Robust standard errors, clustered by state, in parentheses. *** p<0.01; ** p<0.05; * p<0.1

[a] As in Table 6 in the main text, we use the sample restriction $0.5 < \text{efficiency} < 1$, where $\text{efficiency} = \frac{\text{total sales}}{\text{total sales+loss}}$.

Table S.4: Regression of Cross-class Pricing on Political Ideology 1

Dependent Variable: Residential price/Industrial price

	Panel A: Republican Influence as a Measure of Ideology									
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Republican Influence	-0.227	-0.258	-0.411	-0.633	0.0162	-0.386	-0.401	-0.740*	-1.062*	-0.526
	(0.259)	(0.171)	(0.357)	(0.464)	(0.682)	(0.251)	(·)	(0.426)	(0.593)	(0.571)
Observations	3,629	3,629	2,776	1,913	1,050	3,629	3,629	2,776	1,913	1,050
R-squared	0.318	0.519	0.377	0.503	0.757	0.267	0.499	0.342	0.482	0.749
Time Period	All	All	Year>1995	Year>2000	Year>2005	All	All	Year>1995	Year>2000	Year>2005
Utility-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No

	Panel B: Nominate Score as a Measure of Ideology									
	House of Representatives					Senate				
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominate Score	-0.399	-0.389	-0.397	-0.0393	-0.0275	-0.433**	-0.492	-0.492**	-0.291	-0.309
	(0.264)	(·)	(0.337)	(0.288)	(0.292)	(0.209)	(0.296)	(0.232)	(0.200)	(0.209)
Campaign Unlimited				0.0200	0.0201				0.0582	0.0603
				(0.174)	(0.175)				(0.223)	(0.223)
Ballot				-0.121	-0.123				-0.282	-0.279
				(0.116)	(0.116)				(0.169)	(0.169)
Elected					-0.0631					0.0834
					(0.0753)					(0.123)
Observations	3,618	3,618	584	583	583	3,618	3,618	584	470	470
R-squared	0.051	0.501	0.079	0.138	0.138	0.056	0.502	0.095	0.220	0.220
Sample	All	All	Rate Case	Rate Case	Rate Case	All	All	Rate Case	Rate Case	Rate Case
Utility-State FE	No	Yes	No	No	No	No	Yes	No	No	No
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	Yes	Yes	No	No	No	Yes	Yes

Note: Unit of observation is rate case in Panel B, Columns (3)-(5) and (8)-(10). It is utility-state-year in others. Robust standard errors, clustered by state, are in parentheses. In Panel A Column (7) and Panel B Column (2), variance matrix is highly singular. *** $p<0.01$; ** $p<0.05$; * $p<0.1$

Table S.5: Regression of Cross-class Pricing on Political Ideology 2

Dependent Variable: Residential price/Commercial price

	Panel A: Republican Influence as a Measure of Ideology									
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Republican Influence	-0.0130	-0.0250	-0.0374	-0.0433	-0.0346	-0.0458**	-0.0570**	-0.106**	-0.137**	-0.144
	(0.0295)	(0.0231)	(0.0371)	(0.0497)	(0.114)	(0.0206)	(0.0251)	(0.0399)	(0.0642)	(0.118)
Observations	3,742	3,742	2,868	1,978	1,081	3,742	3,742	2,868	1,978	1,081
R-squared	0.571	0.695	0.591	0.655	0.833	0.488	0.655	0.532	0.612	0.814
Time Period	All	All	Year>1995	Year>2000	Year>2005	All	All	Year>1995	Year>2000	Year>2005
Utility-State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No

	Panel B: Nominate Score as a Measure of Ideology									
	House of Representatives					Senate				
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Nominate Score	-0.148**	-0.120**	-0.137	-0.00645	0.00183	-0.102**	-0.0564*	-0.151**	-0.0566	-0.0558
	(0.0621)	(0.0475)	(0.110)	(0.0861)	(0.0869)	(0.0461)	(0.0283)	(0.0712)	(0.0563)	(0.0573)
Campaign Unlimited				0.0375	0.0375				0.0143	0.0142
				(0.0400)	(0.0386)				(0.0438)	(0.0439)
Ballot				-0.0567	-0.0580				-0.0780*	-0.0781*
				(0.0390)	(0.0385)				(0.0451)	(0.0452)
Elected					-0.0442					-0.00399
					(0.0314)					(0.0341)
Observations	3,731	3,731	584	583	583	3,731	3,731	584	470	470
R-squared	0.108	0.697	0.134	0.290	0.293	0.103	0.695	0.157	0.351	0.351
Sample	All	All	Rate Case	Rate Case	Rate Case	All	All	Rate Case	Rate Case	Rate Case
Utility-State FE	No	Yes	No	No	No	No	Yes	No	No	No
Parent Company FE	No	Yes	No	No	No	No	Yes	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	No	No	No	Yes	Yes	No	No	No	Yes	Yes

Note: Unit of observation is rate case in Panel B, Columns (3)-(5) and (8)-(10). It is utility-state-year in others. Robust standard errors, clustered by state, are in parentheses. *** p<0.01; ** p<0.05; * p<0.1

Table S.6: Capital Disallowances

	Panel A: Net Base Ratio				
	(1)	(2)	(3)	(4)	(5)
Republican Influence	-0.015	0.137	0.320*		
	(0.0455)	(0.082)	(0.155)		
Nominate House				0.045	
				(0.126)	
Nominate Senate					-0.037
					(0.121)
Observations	414	74	54	54	54
R-squared	0.8876	0.9525	0.9287	0.6164	0.6164
Utility-state FE	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes
Demographics and Terrain	No	No	No	Yes	Yes
No Generation Assets	No	Yes	Yes	Yes	Yes
Single State Utilities	No	No	Yes	Yes	Yes

	Panel B: Req Ratio				
	(1)	(2)	(3)	(4)	(5)
Republican Influence	-0.0002	0.029**	0.036		
	(0.0135)	(0.010)	(0.027)		
Nominate House				-0.0008	
				(0.025)	
Nominate Senate					0.026
					(0.018)
Observations	462	82	60	60	60
R-squared	0.4054	0.8340	0.8730	0.6134	0.5450
Utility-state FE	Yes	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes
Demographics and Terrain	No	No	No	Yes	Yes
No Generation Assets	No	Yes	Yes	Yes	Yes
Single State Utilities	No	No	Yes	Yes	Yes

Note: This table presents regressions of ratios of approved capital to invested capital as they depend on the political environment. Standard errors are clustered by state. Column 1 includes all rate cases. Column 2 includes rate cases from utilities that operate only in distribution. Columns 3 through 4 include rate cases from distribution only utilities that operate in a single state. These restrictions make the Form 1 Net Distribution Plant variable most comparable to the approved capital base measure from RRA.

Table S.7: Regression of Return on Equity on Republican Influence in Southern States and by Time Period

Dependent Variable: Return on Equity

Variable	(1)	(2)	(3)	(4)
Republican Influence	-0.667	0.193	0.0356	0.254
	(0.475)	(0.260)	(0.331)	(0.153)
Observations	360	677	785	1,520
R-squared	0.800	0.737	0.757	0.713
Time Period	Year<1998	Year>=1998	Year<1998	Year>=1998
States	Southern	Southern	Non-Southern	Non-Southern
Utility FE	Yes	Yes	Yes	Yes

Note: The Southern states are comprised of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Texas, and Virginia. Robust standard errors, clustered by state, in parentheses. *** $p<0.01$; ** $p<0.05$; * $p<0.1$

Table S.8: Regression of log(SAIDI) on Republican Influence

	Dependent Variable: log(SAIDI)			
Variable	(1)	(2)	(3)	(4)
Republican Influence	-0.267**	-0.260**	-0.217*	-0.215*
	(0.106)	(0.110)	(0.117)	(0.118)
Observations	1,844	1,836	1,256	1,248
R-squared	0.083	0.202	0.157	0.276
Year FE	Yes	Yes	Yes	Yes
Demographic Controls	No	Yes	No	Yes
Weather Controls	No	No	Yes	Yes

Note: Robust standard errors, clustered by state, in parentheses. *** p<0.01; ** p<0.05; * p<0.1

Table S.9: Scaled Sensitivity Measure

	γ_e	γ_κ	a_0	a_1	a_2	η	γ_r	σ_i
Mean Investment	**-0.1059**	**0.0992**	**0.1313**	-0.0546	0.0546	**-0.1519**	-0.0381	0.0858
Mean Return	0.0020	-0.0098	0.0527	-0.1042	-0.0494	**0.1677**	**0.4860**	0.0381
Mean Energy Loss	**-0.1162**	0.0329	-0.1132	0.0247	-0.0588	0.0229	**0.1311**	0.0479
Mean Republican Fraction	**0.0967**	**-0.0907**	-0.0230	**0.1247**	0.0418	0.0424	0.0766	-0.0178
Mean Nominate	0.0094	0.0054	0.1028	0.0185	0.0438	-0.0161	-0.0191	0.0627
SD Investment	0.0185	-0.0277	0.0012	0.0156	0.0111	-0.0040	-0.0544	**0.1627**
SD Return	-0.0669	0.0485	-0.0683	**-0.1317**	-0.0295	0.0310	-0.0839	-0.0147
SD Effort	-0.0761	0.0720	-0.0192	-0.0425	**-0.0728**	-0.0148	0.0078	0.0857
SD Republican	0.0944	-0.0565	**-0.1816**	**0.1337**	-0.0412	**0.1198**	-0.0705	0.0251
SD Nominate	-0.0506	0.0555	0.0460	0.0725	-0.0299	-0.0669	**0.1184**	0.0484
Corr(Effort,Republican)	-0.0113	0.0245	-0.0139	0.0232	**-0.1075**	-0.0061	-0.0756	**-0.0869**
Corr(Return,Nominate)	0.0099	0.0127	**-0.1357**	**0.1469**	-0.0178	0.0033	**-0.3508**	0.0037
Corr(Return,Investment)	-0.0494	0.0222	-0.0284	-0.0681	-0.0154	-0.0159	0.0917	-0.0286
Corr(Capital,Investment)	**-0.1889**	**0.1827**	0.0294	-0.0054	0.0765	-0.1594	0.0226	0.0403
Corr(Capital,Return)	0.0326	-0.0464	**-0.2418**	0.0052	-0.0385	**0.5447**	**0.2136**	**0.1925**
Corr(Capital,Effort)	-0.0749	0.0723	-0.0841	0.0814	-0.0612	0.0069	0.0778	**-0.1062**
Corr(Effort,Investment)	-0.0727	**0.0791**	-0.0249	-0.0156	**-0.1350**	-0.0051	-0.0024	0.0113
Corr(Republican,Investment)	0.0288	-0.0228	0.0358	0.0124	0.0476	0.0271	0.0661	0.0925
Corr(Nominate,Investment)	0.0223	-0.0422	0.0502	**-0.1620**	**-0.0673**	-0.0784	-0.0258	-0.0330
AutoCorr(Republican)	-0.0728	0.0366	**0.1243**	-0.0276	**0.0772**	**-0.1081**	-0.0305	-0.0530
AutoCorr(Nominate)	-0.0540	0.0540	0.0101	-0.0923	0.0120	-0.0075	-0.0818	-0.0221
Mean Capital	-0.0002	0.0086	-0.1181	-0.0999	-0.0098	-0.0591	0.0059	**-0.0861**
SD Capital	**-0.0963**	**0.0912**	0.0625	0.0232	0.0605	0.0000	0.0225	0.0088
Sufficiency	0.0719	0.0658	0.1326	0.0861	0.0449	0.3545	0.3323	0.1208

Note: This table presents scaled sensitivity measures obtained by re-estimating model parameters on block-bootstrapped data sets, regressing the bootstrap estimates on moments of the bootstrapped data sets, and scaling the regression coefficients by the standard deviation of the moment divided by the standard deviation of the bootstrap estimated parameter. The bolded values are the five highest absolute value moments for each parameter. Sufficiency is the R^2 from the regression of estimates on moments.

Table S.10: Results of Commission Design Counterfactual Experiments

	Baseline	Minority Representation		Centrist Commission	
			Δ %		Δ %
Mean Return on Capital	0.100	0.100	0.09%	0.100	0.05%
SD Return on Capital	0.003	0.002	-50.15%	0.001	-82.08%
Mean Audit	0.974	0.974	0.00%	0.974	0.00%
SD Audit	0.000	0.000	-56.80%	0.000	-93.95%
Mean Investment Rate	0.052	0.053	0.41%	0.053	0.45%
SD Investment Rate	0.028	0.028	-2.46%	0.028	-2.53%
Mean Energy Loss	0.069	0.069	0.05%	0.069	0.01%
SD Energy Loss	0.002	0.001	-56.80%	0.000	-93.95%
Utility Value Per Capita	1616.012	1615.853	-0.01%	1615.988	0.00%
Consumer Value Per Capita	539558.700	539571.893	0.00%	539573.974	0.00%
Total Welfare	541174.712	541187.746	0.00%	541189.962	0.00%

Note: Different rates of change (Δ%) in summary statistics can be associated with seemingly identical numbers due to round-up errors.

Table S.11: Commitment Counterfactual under Alternative Model Specifications of Energy Loss

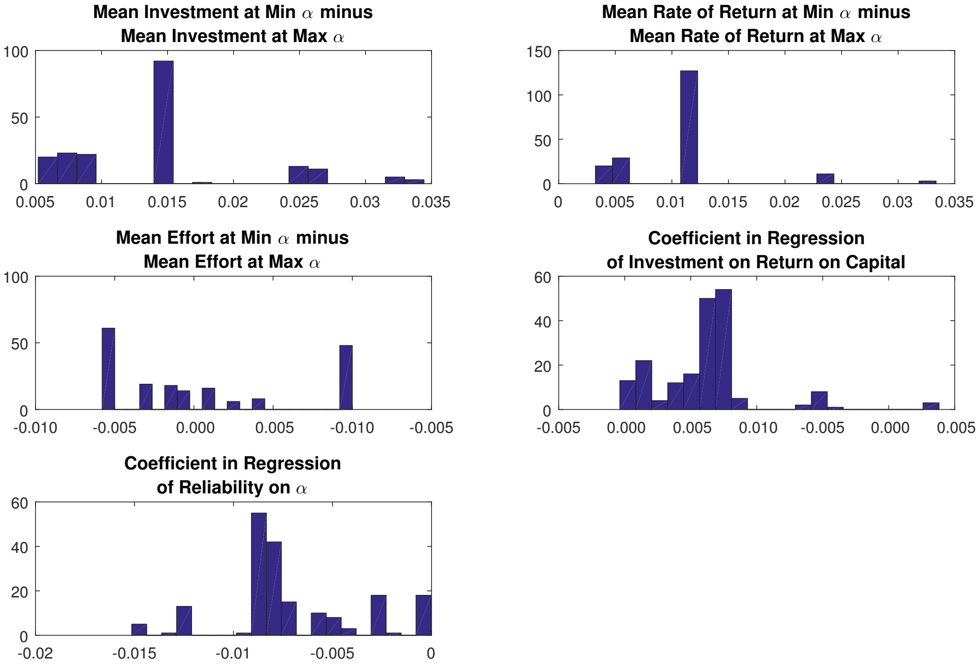
Estimated Percentage Change from the Baseline	Main Model	Alternative Specifications: Model Without Energy Loss	Alternative Specifications: Capital Affecting Energy Loss
Mean Return on Capital	8.36%	9.56%	11.61%
Return Policy wrt Baseline	14.00%	15.00%	19.00%
SD Return on Capital	15.79%	20.66%	19.33%
Mean Audit	-0.01%	–	-0.01%
SD Audit	-14.01%	–	-14.72%
Mean Investment Rate	-2.93%	-4.23%	-1.19%
SD Investment Rate	-8.46%	-21.21%	-13.88%
Investment Policy wrt Baseline	45.90%	53.22%	64.30%
Mean Energy Loss	-1.09%	–	1.14%
SD Energy Loss	-14.01%	–	14.72%
Utility Value Per Capita	84.52%	81.86%	99.99%
Consumer Value Per Capita	-0.05%	-0.06%	-0.06%
Total Welfare	0.20%	0.21%	0.23%
Steady State Capital Per Capita	59.44%	61.12%	63.69%
SAIDI (average outages)	-17.59%	-18.00%	-18.45%

Note: This table presents the percentage difference in commitment counterfactual outcomes relative to the baseline under alternative specifications of how energy loss enters the model. The second column eliminates the effort and auditing decisions from the model altogether. The third column allows capital to reduce energy loss. Each column is generated by re-estimating the model parameters under the alternative specification and re-running the baseline and commitment counterfactual.

Table S.12: Conservative Rate and Most Liberal Counterfactual under Alternative Model Specifications of Energy Loss

	Conservative Rate		Most Liberal	
	Main Model	Capital Affecting Energy Loss	Main Model	Capital Affecting Energy Loss
Mean Return on Capital	3.24%	4.37%	-0.09%	-0.07%
SD Return on Capital	-55.57%	-64.46%	1.83%	-1.56%
Mean Audit	-0.01%	-0.01%	-0.01%	-0.04%
SD Audit	-3.20%	-1.69%	-96.92%	-96.49%
Mean Investment Rate	7.62%	13.75%	-0.16%	-0.18%
SD Investment Rate	5.96%	-14.43%	1.20%	0.65%
Mean Energy Loss	-0.92%	-0.72%	-5.22%	-4.90%
SD Energy Loss	-3.20%	-1.70%	-96.92%	-96.49%
Utility Value Per Capita	31.90%	29.48%	-0.40%	-0.30%
Consumer Value Per Capita	0.01%	0.02%	0.03%	0.03%
Total Welfare	0.11%	0.10%	0.03%	0.03%

Note: This table presents the percentage difference in the conservative rate and most liberal counterfactual outcomes relative to baseline under different specifications of how energy loss enters the model. The second and fourth columns were generated by re-estimating the model parameters under the alternative specification, and rerunning the baseline, conservative rate, and most liberal counterfactuals.


Mean Investment at Min α minus Mean Investment at Max α

Mean Rate of Return at Min α minus Mean Rate of Return at Max α

Mean Effort at Min α minus Mean Effort at Max α

Coefficient in Regression of Investment on Return on Capital

Coefficient in Regression of Reliability on α

Figure 1: Distribution of Simulation Results Across Parameter Values