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# Effect on the Cost of Capital of Ratemaking that Relaxes the Linkage between Revenue and kWh Sales

An Updated Empirical Investigation of the  
Electric Industry

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A Brattle Group Report

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This report was prepared as a working paper of The Brattle Group. All results and any errors are the responsibility of the authors and do not represent the opinion of The Brattle Group, Inc. or its clients.

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## I. Executive Summary

The purpose of this report by *The Brattle Group* (“*Brattle*”) is to describe the research the authors have done on the effect, if any, on the cost of capital (“COC”) of ratemaking mechanisms that significantly relax the linkage between the collection of base revenue and the amount of kWh sales.<sup>1</sup> The two ratemaking mechanisms we analyze are revenue decoupling and fixed-variable rates, which are alternatives to the standard ratemaking in general rate cases. The linkage comes particularly from the common use of volumetric rates (\$ per kWh) for residential and small commercial customer classes that collect significant amounts of fixed costs in the volumetric charge. Revenue decoupling is separate from the somewhat similar trackers (using balancing accounts and riders) that true-up forecast to actual variable costs, like fuel and purchased power, EE program expenditures, and certain kinds of capital expenditures. We have reviewed the relevant finance theory and conclude that the issue cannot be answered definitively on a theoretical basis. While there are theoretical arguments why adoption of linkage-relaxing ratemaking could decrease the COC, there are also valid theoretical reasons why it would not and could even be associated with an increase in the COC. An empirical test is required to answer the question of whether the COC is affected upon adoption of decoupling. To conduct the test, we develop a sample of fifteen electric holding companies with thirty-seven regulated

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<sup>1</sup> “Linkage-relaxing ratemaking” is new terminology for policies that have been broadly referred to as “decoupling” in the past. The new term was introduced by the Edison Electric Institute (“EEI”) in the most recent publication of their periodic survey of alternative ratemaking policies of U.S. and Canadian regulated electric and gas companies, *Alternative Regulation for Emerging Utility Challenges: 2015 Update*, Pacific Economics Group Research LLC, Chapter III, “Relaxing the Link Between Revenue and System Use,” November 11, 2015. This new terminology clarifies that “revenue decoupling” is one of three specific alternatives of this linkage-relaxing rate policy.

subsidiaries that were central to the rapid growth in revenue decoupling in the U.S. during the period 2005 through 2015.

The main linkage-relaxing mechanism we consider is revenue decoupling,<sup>2</sup> which adjusts a utility's rates annually or more frequently to help its actual revenue track its allowed revenue more closely. In this family of related state policies, there are variations in several different dimensions,<sup>3</sup> but revenue decoupling policies have strong similarities, and in the way they function, they are distinct from traditional general rate case ratemaking. All of the holding companies in our sample have one or more subsidiaries with revenue decoupling. In general ratemaking, allowed cost of service is used to set rates that are expected to collect the revenue requirement (i.e., the full cost of service) based upon an approved kWh sales forecast. The actual revenue collected involves inherent uncertainty because actual retail kWh sales (or therms of natural gas) may substantially differ from the forecast used to set rates due to the random effects of weather and economic cycles on sales as well as from designed reductions in sales due to policies favoring energy efficiency ("EE") and distributed generation ("DG"), particularly rooftop solar programs. Under revenue decoupling, the difference in revenues collected resulting from differences in kWh sales is subsequently refunded to or collected from customers so that target

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<sup>2</sup> Revenue decoupling is a somewhat heterogeneous, but well-defined set of ratemaking policies in place around the U.S., and we adopt EEI's definition in its survey mentioned in footnotes 1. The EEI definition starts with the use of a Revenue Balancing Account ("RBA") to achieve an annual revenue target. A Revenue Adjustment Mechanism ("RAMs") to adjust the target over time without a general rate case is also included in the definition. Some states have revenue decoupling policies with no periodic revenue target adjustments but frequently include other balancing accounts that adjust the collectible revenue levels, e.g. rate riders for certain environmental expenses or capital additions.

<sup>3</sup> This is discussed in Section II below.

revenue uncertainty is dampened.

Revenue decoupling is frequently part of a state energy efficiency or distributed generation policy with the goal of slowing the growth in the consumption of electricity. Decoupling facilitates a more active role for the utility by eliminating its “through-put incentive” to increase earnings from increasing sales. However, in regulatory hearings on revenue decoupling, the resulting reduction in the variability of base revenues has led to a corresponding request by intervenors for regulators to reduce the allowed return on equity (“ROE”) in conjunction with approval of revenue decoupling.

Fixed-Variable Rates (“FVR”) is the second linkage-relaxing mechanism. A FVR structure has a very similar effect in reducing the volatility of revenue, but it accomplishes this by recovering a much higher percentage of fixed costs in monthly charges that do not vary with usage and less in the volumetric per kWh rate. FVR (and the alternative of including demand charges where residential and small commercial customers are served with smart meters) are being much more actively discussed at present and have supporters and detractors.<sup>4</sup>

We develop our sample from nationwide surveys of which the state-regulated utilities have gotten approval for revenue decoupling between 2005 and 2015. In each instance, we determine the subsidiary’s holding company, whether that holding company has any other subsidiaries with revenue decoupling or FVR. We analyze both rate mechanisms for two related reasons. First,

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<sup>4</sup> We take no position on the relative merits of revenue decoupling and FVR (or on demand charges). Our empirical test is focused on whether revenue decoupling, with or without a contribution from FVR, lowers the cost of capital for a regulated utility.

revenue decoupling and FVR theoretically and in practice have a similar stabilizing effect on actual revenues. This of course is a prime reason some argue a COC reduction is likely. However, revenue decoupling is also introduced in situations when the normal revenue growth of the utility is being undermined, and the primary goal of the policy is not to reduce volatility, but rather to address the throughput incentive. As a result, the net effect on risk is cannot be determined by theory alone. Second, we find that our sample of 15 electric holding companies with subsidiaries with revenue decoupling includes four that have FVR in place. We include FVR in our analyses to ensure that we capture the effect of these types of policies on the COC, and because the FVR is a policy of interest by itself.

For each quarter of the 2005 to 2015 study period (44 quarters), we determine the revenue decoupling or FVR status of every subsidiary of each holding company. We use this information to develop two independent, asset-weighted decoupling indexes for each holding company, one for revenue decoupling and one for FVR.<sup>5</sup> Each holding company's index can range in value from 0.00 (*i.e.*, no subsidiaries with revenue decoupling, or independently FVR) to 1.00 (all subsidiaries have revenue decoupling, or FVR). If revenue decoupling or FVR affects the COC, the effect will be reflected in the returns demanded by investors in capital markets.

For each holding company in each quarter, we also estimate the COC as the dependent variable based upon *Brattle's* standard methodology used in providing expert testimony on the cost of capital. The final database consists of over 465 observations. We then use regression analysis to

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<sup>5</sup> For each company, we calculate the decoupling index for revenue decoupling and for FVR as the share of the total assets of the company that belong to subsidiaries that operate under the policies.

determine if revenue decoupling, or that and FVR together, have had a statistically significant impact on the COC. Our results show that although the estimated coefficient for the decoupling index is negative, the direction expected if there is a reduction in risk, it is statistically insignificant by normal statistical standards.

There are at least two theoretical explanations for our empirical results of no significant effect. First, based on fundamental financial theory, we know that a linkage-relaxing mechanism would reduce the COC only if it reduces systematic risk (i.e., non-diversifiable risk), which is the type of risk that affects the COC. Non-diversifiable risks are those directly correlated with the stock market and the business cycle. Therefore, if the reduction in the variability in revenues from the linkage-relaxing mechanism is primarily related to diversifiable risk, such as weather, it would not affect the COC. However, reducing diversifiable risk would still provide a benefit to debt holders (which could eventually reduce the cost of debt, esp. if the company had a low debt rating) and thus to the customers, but not through reducing the cost of equity capital.

The second theoretical possibility is that any risk-reducing effects from a linkage-relaxing mechanism are being offset by a contemporaneous increase in systematic risk stemming from other causes – possibly the very causes motivating the decoupling in the first instance. Revenue decoupling is never instituted in a vacuum, but frequently along with the adoption of regulatory policies pursuing aggressive energy efficiency (“EE”) or widespread distributed generation (“DG”) that increases the possibility of the under recovery of fixed costs. These two theoretical possibilities are not mutually exclusive, so the lack of statistical significance in our results could be the result of a combination of both explanations. Again, we believe that the effect on the

COC of ratemaking that relaxes the linkage between revenues and kWh sales cannot be determined theoretically alone but requires empirical testing.

Our study of revenue decoupling does not provide statistical evidence of a reduction in a utility's COC, but reducing the cost of capital was not the original or an appropriate intention for decoupling. Revenue decoupling remains an extremely valuable regulatory policy with benefits for customers, regulators, and the utility. For example, low or stagnant sales growth can lead utilities to file serial rate cases in an effort to recover the full cost of providing service, which diverts regulatory and utility resources from other important forward-looking issues.<sup>6</sup> The authors expect some form of linkage-relaxing ratemaking to be a natural part of the slow-sales-growth utility of the future.

## II. Developments in the Policy of Revenue Decoupling

Electricity, and particularly its distribution, is a capital intensive industry with a correspondingly high percentage of total costs represented by fixed costs that is significantly above the average for other industries in the U.S.<sup>7,8</sup> Going back to the 1950's, the rate design for the residential and

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<sup>6</sup> The Washington Utility and Transportation Commission approved revenue decoupling for Puget Sound Energy's electric and gas businesses in Order 7, Dockets UE-121697 and UG-121705 (consolidated), June 25, 2013. On page 1, the Synopsis says: "The Commission in this Order implements several innovative ratemaking mechanisms that, together, fulfill the Commission's policy goal of breaking the recent pattern of almost continuous rate cases for Puget Sound Energy, Inc. (PSE). As the Commission observed in PSE's 2011/2012 general rate case (GRC): This pattern of one general rate case filing following quickly after the resolution of another is overtaxing the resources of all participants and is wearying to the ratepayers who are confronted with increase after increase. This situation does not well serve the public interest and we encourage the development of thoughtful solutions."

<sup>7</sup> One standard measure of capital intensiveness is "asset turnover ratio," which is the annual revenue

Continued on next page

small commercial classes, the customer segments where the fixed distribution costs are the highest, evolved to collect a minor share of fixed costs in fixed charges and relied on volumetric charges (\$ per kWh) for the rest. Included in the volumetric rate are much of the fixed capital investment and operations and maintenance (O&M) costs of the utility. One reason for this design is that it satisfies equity considerations, forcing larger (and possibly higher income) users to pay more of the fixed costs than the cost allocation principles might produce. A second reason the volumetric rate design has worked for so long was that in the whole 20th century, annual economic growth was 3% to 4%, and growth in electric sales was commensurate, as shown in Figure 1 below. This kind of growth in electric demand required rapid investment between general rate cases, and the growth in kWh sales along with volumetric rates to a degree automatically met the revenue need.

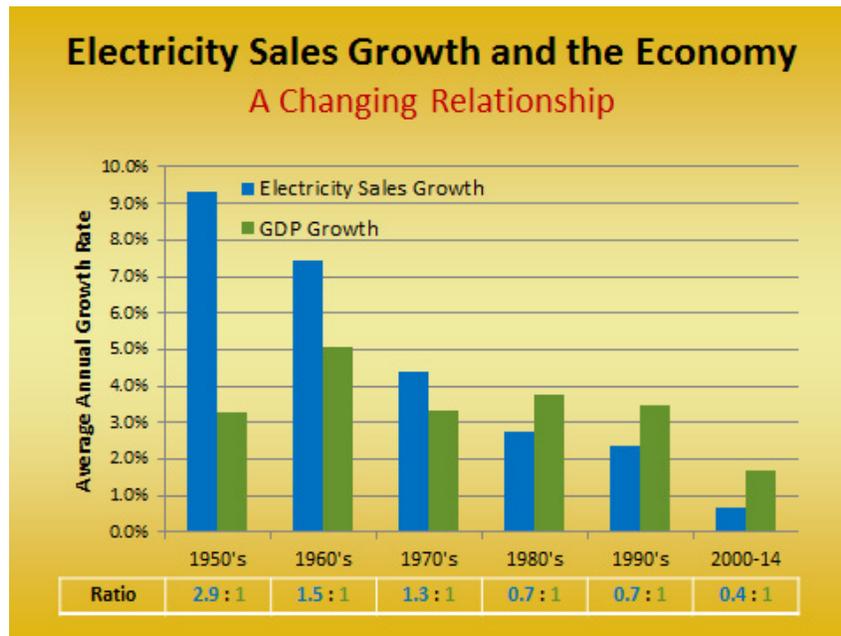
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divided by the dollar value of the total assets of the company. A lower value indicates higher capital intensity. Electric, natural gas and water are among the lowest, around 0.35; capital goods industry is approximately 1.0 and retail goods 2.0 or above. Thus, fixed cost recovery is a major issue for utilities.

<sup>8</sup> Although fuel and purchased power costs can be sizeable, they are variable costs and not part of the lost revenue problem discussed here. These costs are nearly always collected in clauses that automatically set revenues equal to costs, because costs are from markets that change rapidly and are generally outside the control of the utility.

**Figure 1**  
**History of the Relationship of GDP to Electric Consumption**



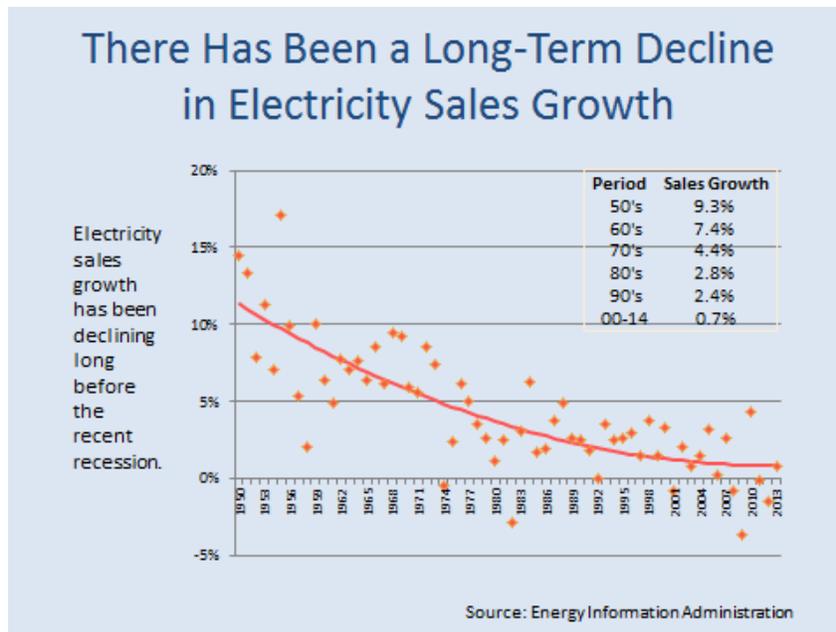
Source: John Caldwell, Chief Economist, EEI, 2016

An intrinsic consequence of volumetric rates is that revenue from the residential and small commercial classes is subject to considerable more variability from the normal changes in weather, short-run economic fluctuations, changes in customer growth, and changes in consumer tastes. The variation makes it difficult for the utility to forecast its sales reliably so that it can have high confidence in recovering its authorized fixed-costs. Utilities have a “through-put” incentive to encourage increased sales once rates are set in a general rate case.<sup>9</sup> However, the rate of growth that supported this volumetric-based structure is a thing of the past. Figure 2 below clearly shows that behind the year-to-year volatility there has been a long-run decline in the growth rate of electric retail sales in the U.S. Currently, the average growth rate is only

<sup>9</sup> The competition between electric and gas companies for new water heating business in the last century was one result.

slightly positive, and many utilities have negative growth. In the last decade, which largely corresponds to our study period, one major contributing factor to this decline was the increase in EE expenditures by electric utilities, which is expected to continue.

**Figure 2**  
**Long Run Trend in U.S. Electric Sales Growth**



A conflict in incentives surfaces as soon as utilities are asked to facilitate aggressive energy efficiency (“EE”) and/or distributed generation (“DG”) programs. The revenue decoupling mechanism was developed to eliminate this conflict by severing the link between recovery of base, or fixed, revenues and volumetric sales of kWh.

Under revenue decoupling, the final, actual revenue recovered is not or only partially based upon actual kWh sales. Instead, cost recovery is based on an allowed target for total revenue or per

customer revenue.<sup>10</sup>

There are variations in several dimensions for revenue decoupling policies set by individual states. These dimensions include first, whether the allowed revenue is adjusted from year to year as discussed in footnote 2; second, whether the allowed revenue is total revenue or revenue per customer and thus trues up to the actual number of customers; third, whether and what kind of cap there is on the size of the annual rate adjustment; fourth, whether the policy is limited to the residential and small customer classes; fifth, whether the pooling of rate classes for purposes of the true-up; and sixth whether all or just some kWh demand fluctuations are decoupled from actual revenues, e.g., in some cases weather fluctuations are not removed in when revenues are trued up. While these dimensions affect how closely actual revenue comes to allowed revenue each year and over time, the effects on risk are not obvious. In our empirical analyses, we do not attempt to differentiate the decoupling policies on these dimensions.

Over a subsequent period, rates are adjusted to achieve a true-up of actual revenues to the target that is equal or much closer to the allowed revenues. The majority of revenue decoupling mechanisms also includes a second feature to adjust the revenue target annually for a set period of years, called by EEI the Revenue Adjustment Mechanism or RAM.<sup>11</sup>

Revenue decoupling has a long history, with the earliest version instituted in California in the

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<sup>10</sup> Not all costs are recovered through the kWh charge. Some are recovered through riders such as for fuel costs.

<sup>11</sup> See *EEI 2015 Survey, Op. Cit.*, Table 4, Revenue Decoupling Precedents. This table shows that there are 32 regulated electric companies that have revenue decoupling and about 75% have a RAM.

1980s, first for natural gas utilities and in 1982-83 for electric utilities.<sup>12</sup> California policy makers determined that decoupling would be “in the public interest” because utilities were being asked to pursue aggressive energy efficiency goals.

With revenue decoupling, the short run sales forecast is important to set the initial level of volumetric rates accurately and to minimize the size of revenue balancing account. The policy is symmetric. Customers are protected if sales are greater than forecast, and utilities recover their fixed costs if EE programs and other programs are more effective than expected.<sup>13</sup> Contrary to the assertion that revenue decoupling only shifts the risk of recovering revenue from the utility to the customers, both benefit when the policy results in a symmetric sharing of the risk of recovering allowed revenues.<sup>14</sup> From year to year, revenue decoupling with a RAM will also move the allowed revenue and protect against the declining trend of unit sales, and thus revenues over time. This depends on how the desired targets are set, and the utilities’ ability to recover increasing costs and infrastructure investments through trackers, for example, between rate cases. In both cases, properly designed decoupling promotes the utility’s ability to facilitate the EE and DG policies without undermining its financial stability. Note that the decoupling true-up amounts are recovered from or returned to customers in subsequent periods. Hence, if

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<sup>12</sup> Dr. John L. Jurewitz, *Decoupling and Energy Efficiency Incentives: The California Experience*, EEI 2007 Spring Legal Conference, Charleston, SC, April 16, 2007.

<sup>13</sup> An additional benefit is that disputes over sales forecasts may be reduced because the earnings of the regulated company are not affected by differences in forecasts with full revenue decoupling.

<sup>14</sup> If the rate setting process was in fact biased against recovery of the full cost of service, then decoupling might be said to shift risk away from utility by correcting this asymmetric risk. The decline of sales through time from EE and DG might contribute to such a bias, which is why revenue decoupling is often linked to these policies.

some customers are reducing their average loads due to EE or DG, and that drives the level of the decoupling balances, there is some reallocation of costs to customers not participating in those programs and technologies.

So far, we have focused our discussion on revenue decoupling. Linkage-relaxing rate policies also include FVR and lost revenue adjustment mechanisms (“LRAM”).<sup>15</sup> Revenue decoupling and FVR are broad policies in terms of eliminating base revenue variability from all or most sources. Those two mechanisms are the focus of our empirical work. LRAMs are inherently narrower, in the sense that their focus is only on the specific kWh savings that stem directly from a utility’s EE or DG programs. LRAM is an important policy, but this policy has not been the focus of claims that it lowers the cost of capital. We have not included LRAMs in the empirical work underlying this report.

As discussed above, revenue decoupling solves the incentive problem for a utility to pursue EE program success. FVR does this also but in a different way. To the extent that fixed charges recover a larger portion of the utility’s fixed costs, the utility is less affected by changes in kWh sales because recovery of its fixed costs are not as much at risk. The throughput incentive is mitigated but not eliminated by FVR.

Many intervenors have argued that the utility’s risk has been reduced by revenue decoupling

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<sup>15</sup> See EEI 2015 Survey, *Op. Cit.*, Table 3, Current LRAM Precedents, and Table 5 Fixed Variable Residential Pricing Precedents. EEI’s definition of fixed variable rates is that the rates of power and gas distributors have a fixed monthly customer charge equal to or in excess of \$15 (or \$20 for vertically integrated utilities).

policies, and, therefore, the allowed ROE should be reduced. By design, both types of linkage-relaxing policies reduce the variability of revenues, which according to intervenors translates directly into reducing the kind of risk that determines the COC financial markets require. The argument proceeds to first, estimate the COC in the standard way, and second, reduce the estimate by a recommended amount (*i.e.*, a number of basis points (“bps”)) as a consequence of the assumed reduction in risk. The recommended reduction in allowed ROE is therefore quantitatively associated with the risk reduction from revenue decoupling alone, and is treated independently from the all other risk factors considered in the first step of COC estimation. Some proposed discrete reductions have been as high as 300 bps. To our knowledge, no recommendation for a reduction in the allowed ROE was accompanied by any empirical evidence showing a reduction in the COC from implementation of decoupling.

Regulators have been persuaded by these theoretical arguments in just under one-fifth of past decisions adopting revenue decoupling for either electric utilities or gas LDCs.<sup>16</sup> The time profile of these decisions for electric utilities is shown in Figure 3. Since 2010 there has been no explicit, *ex post* reduction in the allowed ROE in 12 decisions in conjunction with initial approval of revenue decoupling. All of the decisions reducing the allowed ROE in electric companies by the amount of 50 bps have come from decisions in three regulatory jurisdictions: Maryland, the District of Columbia, and Hawaii.<sup>17</sup> Other states have made smaller bps

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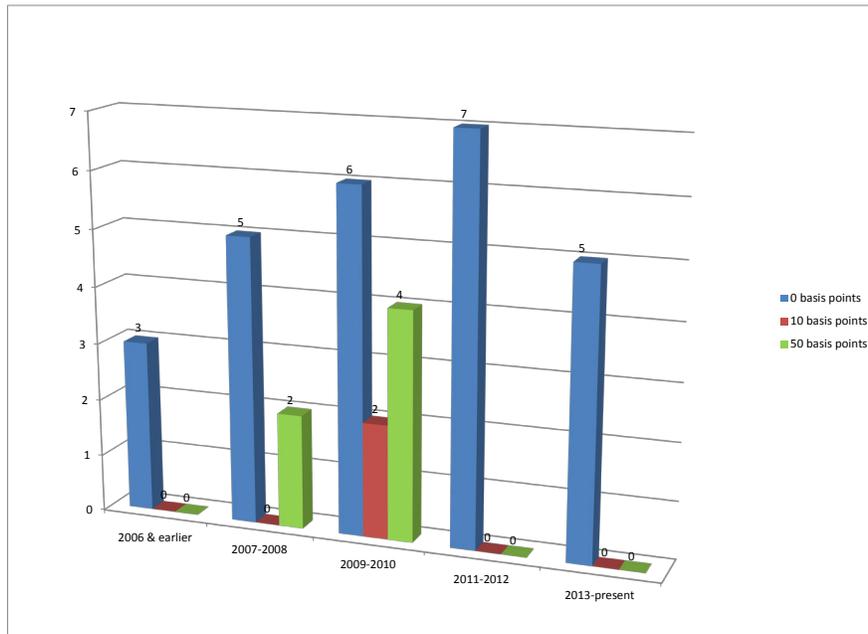
<sup>16</sup> We have extended the work of Pamela Morgan, *A Decade of Decoupling for US Energy Utilities: Rate Impacts, Designs, and Observations*, Graceful Systems LLC, December 2012.

<sup>17</sup> We display the distribution of ROE reductions and non-reductions for the initial revenue decoupling decisions. We do not catalogue and include all of the sequential decisions in rate cases. Note that the

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reductions. In general rate cases, Maryland no longer makes a deduction, in part because the coverage of revenue decoupling was removed during the outages from declared major storms and thus weakened.

**Figure 3**  
**Time Profile of ROE Reductions upon**  
**Approval of Electric Revenue Decoupling Policies:**  
**Before 2006 to Present**



The purpose of our empirical analysis is to provide a foundation upon which to answer the question of the effect of revenue decoupling on the COC that is not based solely on supposition.

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effect of decoupling on the COC will be reflected in the market estimates of the COC based upon the initial decision on revenue decoupling. If expected by investors, subsequent decisions reaffirming decoupling would not change any effect on the COC. Regulatory decisions can change of course. For example, the Maryland Public Service Commission (“MPSD”) first approved revenue decoupling for Baltimore Gas & Electric (BG&E) in November 2007 and lowered BG&E’s allowed ROE by -50 bps. This policy was continued in the subsequent electric rate case number 9230, Dec. 6, 2010, but the MPSD later eliminated any bps reduction in allowed ROE in electric rate case number 9299, Order No. 85374, February 22, 2013.

In these regulated, high fixed cost industries, the determinants of the cost of capital are complicated. For at least two reasons, there should be no presumption that revenue decoupling automatically lowers the COC by a specific amount that should be deducted from the previously estimated cost of capital. First, a sample must be used for estimating the cost of capital, and today that sample is likely to have some utilities that already have decoupling. Second, adoption of decoupling policies is always in response to a changing situation and therefore could be coincident with other influences that may be increasing non-diversifiable risk. Any reduction in the allowed return on equity should be based upon empirical evidence that decoupling reduces the cost of capital.

The *Brattle* authors have considerable experience analyzing the issues of decoupling rate policy and the frequently asked question as to whether it has a measurable impact, as assessed in financial markets, on the cost of capital of regulated companies. In 2011-12, the authors published a report on the first empirical test of the hypothesis in the natural gas delivery industry and found that there was no statistically significant effect on the COC with decoupling.<sup>18</sup> In 2014, we published our first study of electric power industry and again found no statistically significant effect of decoupling on the COC.<sup>19</sup> Updated studies of the gas delivery

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<sup>18</sup> Joseph B. Wharton, Michael J. Vilbert, Richard E. Goldberg, Toby Brown, *The Impact of Decoupling on the Cost of Capital: An Empirical Investigation*, Brattle Report, Original Version March 2011, Revised July 2012.

<sup>19</sup> Michael J. Vilbert, Joseph B. Wharton, Charles Gibbons, Melanie Rosenberg, Yang Wei Neo, *The Impact of Revenue Decoupling on the Cost of Capital for Electric Utilities: An Empirical Investigation*, Prepared for The Energy Foundation, March 20, 2014.

and the electric industries were published in November 2014.<sup>20</sup>

### III. Cost of Capital Theory and the Effect of Revenue Decoupling

Our empirical analyses reported here address the question of whether the adoption of a revenue decoupling mechanism affects the market-determined COC for the regulated electric companies.

We begin by a review of the financial theory regarding how decoupling could affect the COC and why it may not.

A company's cost of capital is determined in the capital markets based upon expected cash flows and their risk. Volatility of market returns is positively related to the total risk of the investment.<sup>21</sup> Cost-of-capital experts therefore rely upon market data to estimate a company's COC, not accounting data.

Decoupling focuses narrowly on reducing the volatility of a utility's base revenues, not its market cash flows, though the former influences the latter indirectly.<sup>22</sup> A regulated utility's operating earnings (*i.e.*, earnings before income taxes) are the difference between base revenues<sup>23</sup> and the

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<sup>20</sup> Both of the electric and gas studies are written up in *Prefiled Direct Testimony (Nonconfidential) of Dr. Michael J. Vilbert, on behalf of Puget Sound Energy, Inc.*, WUTC, Docket Nos. UE-121697 and UG-121705 (consolidated), Nov. 5, 2014.

<sup>21</sup> There are several different kinds of risk addressed by finance theory, and they are discussed below in Section III A.

<sup>22</sup> In general, investors expect payment of dividends and capital gains from changes in market prices. Both revenue decoupling and fixed variable rates eliminate or significantly reduce the variability of a utility's base revenues, as discussed above in Section II. This section will focus on a theoretical discussion of the cost of capital and revenue decoupling, a policy that has been more prevalent than FVR for electric utilities. Our empirical analysis considers the effect of both policies separately and in combination.

<sup>23</sup> Base revenues are those other than costs recovered in adjustable rate clauses such as fuel and

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sum of all prudent costs, including O&M, administrative and general (A&G), depreciation, and interest. The hypothesis that revenue decoupling reduces the cost of capital for a regulated company is therefore based on the expectation that revenue decoupling will reduce the short-term volatility of a regulated company's operating earnings. However, changes in operating earnings, an accounting variable, are not necessarily or even generally equal to changes in market returns. Market returns for common stock consist of dividends paid out and changes in the price of the stock. Stock prices change whenever market participants incorporate their assessments of future market conditions and investment performance.

Decoupling is often praised by credit rating agencies because it clearly reduces total risk (i.e., a company's total volatility of returns), which is the risk important to bond holders.<sup>24</sup> Adoption of decoupling could reduce the overall cost of capital for a company through a reduction in the cost of debt, but that would not justify a reduction in the allowed ROE. Only reductions in business risk (systematic risk) justify a reduction in a regulated company's allowed ROE, which is our next subject.

## A. TYPES OF RISK

In financial theory, volatility is closely related to risk, so some theorize that reduced revenue volatility alone will translate into reduced risk and, therefore, a reduced cost of capital. To analyze this theory, the concept of risk must be more carefully defined. There are three kinds of

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purchased power.

<sup>24</sup> See for example, "Fitch Rates DTE Electric Co.'s \$300MM General & Refunding Mtge Bonds 'A+': Outlook Stable," *FitchRatings*, 10 May 2016.

risk that are important to understanding the plausible, theoretical impacts of revenue decoupling:

- Systematic (a.k.a., non-diversifiable or business) risk,
- Unique (a.k.a., diversifiable) risk, and
- Financial risk.

Together, they comprise an investment's total risk, i.e., the total variability of market returns.

All three categories of risk are important and will be discussed in this section.<sup>25</sup> Finance theory explicitly distinguishes the type of risk that affects the cost of capital from risks that do not. The cost of capital is a function of the first: the systematic risk of the assets owned by the company. Another portion of the total risk is the unique risk, which can be eliminated through diversification and so does not affect the cost of capital. This distinction between diversifiable and non-diversifiable risk is based upon modern portfolio theory, which demonstrated that a portion of an investment's total risk can be eliminated or be "diversified away" when the investment is included in a well-designed portfolio of investments.<sup>26</sup> Only the remaining non-diversifiable risk affects the cost of capital, and its amount is typically measured by its beta.<sup>27</sup>

The portion of the risk that can be eliminated does not affect the cost of capital because capital markets do not reward investors for risks that can be avoided. Nonetheless, diversifiable risk should not be ignored by investors or policy makers. The price investors are willing to pay for an

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<sup>25</sup> Different names are often applied to the different types of risk, which is frequently a source of confusion. The different names for each category of risk are intended to identify the same risk.

<sup>26</sup> Well-designed in this context means the returns of the individual assets in the portfolio are not highly correlated.

<sup>27</sup> See Brealey, Myers, and Allen, *Principles of Corporate Finance*, 12<sup>th</sup> Edition, McGraw Hill Irwin, 2017, Chapter 8, "Portfolio Theory and the Capital Asset Pricing Model" for a discussion of the relationship between risk and return.

investment depends upon both types of risk. Unique events, good or bad, will affect a company's stock price, but they do not affect its cost of capital.

The third type of risk listed above is financial risk, which is additional risk borne by equity investors when a portion of a company's assets are financed with debt. There is no theoretical connection between the adoption of revenue decoupling and capital structure.<sup>28</sup> Our investigation into the effect of decoupling on the cost of capital for equity investors requires that any differences in financial risk be measured correctly. *Brattle* has experience in dealing with the financial risk in estimating the individual utility's cost of equity.

A bestselling textbook on corporate finance by Brealey, Myers, and Allen summarizes the relationship between capital structure and the company cost of capital:

The expected rate of return on the common stock of a levered firm increases in proportion to the debt-equity ratio (D/E) expressed in market values ....<sup>29</sup>

Consistent with the theory of financial risk above, the effect of each utility's capital structure on its cost of equity must be considered in our analyses. We consider differences in financial risk through the use of the After-Tax Weighted-Average Cost of Capital (ATWACC), as discussed below in Section IV.

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<sup>28</sup> There may be a future effect on capital structure from implementation of decoupling. Firms with less variable cash flows may increase their use of debt financing, although the effect is likely to be small for utilities which are already highly leveraged.

<sup>29</sup> Brealey, Myers, and Allen, *Principles of Corporate Finance*, 12<sup>th</sup> Edition, McGraw Hill Irwin, 2017, p. 443.

## **B. THEORETICAL REASONS FOR AND AGAINST REVENUE DECOUPLING LOWERING THE COC**

The hypothesis we test is whether revenue decoupling affects the COC, i.e. its ATWACC, for a regulated company. Revenue decoupling largely eliminates the volatility of base revenues collected. Therefore the expectation is that revenue decoupling will reduce the short-term volatility of a regulated company's operating earnings.

The distinction between diversifiable and non-diversifiable risks provides the first theoretical reason that a decoupling mechanism may not reduce the cost of capital. If variation in base revenues that is eliminated through decoupling is primarily diversifiable risk, there would be no effect on the cost of capital.

There is a second theoretical reason that the adoption of revenue decoupling may offset the increase in systematic risk from other regulatory policies so that the net result is no change in the company's COC. Revenue decoupling is never adopted in a vacuum but is a deliberate response to a set of circumstances that can increase the systematic risk of the utility. The implementation of decoupling neutralizes what may otherwise be a set of regulatory policy that increase the utility's systematic risk (and its cost of capital).

Consider two situations likely to be associated with the adoption of decoupling. In the first, the utility is tasked by state policy makers to achieve aggressive goals for its energy efficiency programs. The policy may come with the requirement for the state regulator to "address the utility's disincentives." If volumetric rates (\$ per kWh) recover a significant amount of the fixed costs from residential and small commercial customers, the regulated company has an obvious

monetary disincentive to facilitate a reduction in kWh consumption by customers. This is the so-called “throughput disincentive” for the utility. If aggressive energy efficiency goals are to be met, the utility must simultaneously reduce its own revenue and earnings. If the energy efficiency goals are not met, the utility may be violating state policy and incur public disfavor. By severing the link between recovery of revenues and sales, decoupling resolves the throughput disincentive.

The second situation arises when investment needs and revenue requirements continue to rise but kWh sales are stagnating for reasons not directly related to utility actions, such as building codes and standards, changing technology, and changing consumer tastes. This seems to be increasingly the norm in the U.S. as the long term relationship between growth in GDP and growth in the consumption of electricity has been fundamentally altered, as seen in Figure 2 above. Without a policy like decoupling, this situation could result in the utility filing serial rate cases that strain the resources of the commission staff, the utilities, and intervenors, as well as increasing the likelihood that the company cannot earn its cost of capital.

In summary, financial theory provides support for the hypothesis that revenue decoupling could lower the COC, but it also provides equally plausible reasons why it could leave the COC unchanged or even be associated with an increase in the COC.<sup>30</sup> Therefore, the effect of decoupling on the cost of capital cannot be determined solely based on theoretical reasoning.

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<sup>30</sup> Note that we are not suggesting that revenue decoupling alone increased the COC. Instead, we are acknowledging the possibility that the circumstances in which decoupling is proposed and adopted are ones in which the systematic risk of the utility has materially increased.

Empirical analysis is required. The question is important because revenue decoupling is a valuable policy in the current economic environment of aggressive EE and DG, low growth, but with the commensurate requirement for continuing substantial investment in the electrical system. Awarding the appropriate allowed ROE is critically important to achieve the regulatory policy goals as well as for maintaining the financial stability of utilities. In our view, any regulatory decision that considers the issue of whether to reduce the allowed ROE in conjunction with adoption of a decoupling mechanism should be based upon verifiable empirical evidence on the effect of decoupling.

Our empirical analysis investigates the effect on the COC from the adoption of revenue decoupling mechanisms. We also test the effect on the COC from adoption of fixed variable rates.

#### **IV. Creating a Decoupling Sample of Regulated Electric Utilities**

Our empirical work examines two significant changes to traditional ratemaking policies, revenue decoupling and fixed variable rates, to determine whether their adoption affects a regulated company's cost of capital.<sup>31</sup> Revenue decoupling is our primary focus, as discussed above, but our analyses deal with them jointly for two reasons. First, in different ways, both of these alternative rate policies substantially reduce the degree to which changes in kWh sales affect the recovery of fixed costs, i.e., they reduce revenue volatility. Second, although we developed our sample

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<sup>31</sup> As discussed above, we follow the definitions for these two innovative ratemaking approaches used by the EEI in their national (and Canadian) survey, which collects and categorizes policies for subsidiaries of electric and natural gas local delivery companies.

around state-regulated subsidiaries that were approved for a revenue decoupling policy, we found that in many cases, these holding companies also had state regulated subsidiaries in either the electric utility or the gas local distribution companies (“gas LDC”) businesses had fixed variable rates. Because of a similar effect on revenue recovery, we also consider FVR policies in developing our decoupling index for each holding company.

### A. IDENTIFYING UTILITIES WITH LINKAGE-RELAXING RATE POLICIES

In the past decade revenue decoupling and fixed variable rates have been increasingly adopted by states, especially those pursuing EE and DG. Figure 4 displays a list of the states that at present or in the recent past have had one of the three linkage-reducing ratemaking policies.

**Figure 4**  
**Range of States in U.S. with Linkage-Relaxing Policies for Electric Industry**

States with Linkage-Relaxing Ratemaking		
Category	Count of States	List of States Allowing for ARR's
Total States with Linkage-Relaxing Mechanisms	27	AR, AZ, CA, CT, DC, HI, ID, IN, KS, KY, LA, MA, MD, ME, MN, MT, NC, NH, NV, NY, OH, OK, OR, RI, SC, WA, WY
Revenue Decoupling	14	CA, CT, DC, HI, ID, MA, MD, ME, MN, NY, OH, OR, RI, WA
Fixed Variable Rate Design	3	CT, OK, WY
Lost Revenue Adjustment Mechanism (LRAM) for EE and DSM	17	AR, AZ, IN, KS, KY, LA, MA, MT, NC, NH, NV, NY, OH, OK, OR, SC, WY

Source is EEI Survey 2015 and Brattle.

The current sample dataset is an extension and enhancement of Brattle’s dataset used in our

previous studies.<sup>32</sup> An important duality ran through that analysis and is continued. Electric utility holding companies (“HCs”), not their subsidiaries, have publicly traded stock that provides the financial information necessary to estimate the cost of capital. On the other hand, only individual, state-regulated subsidiaries,<sup>33</sup> not the HCs themselves, apply for, and are granted, the policy of decoupling or FVR.

## B. SAMPLE CHARACTERISTICS

To select the sample, we start with public data on regulated U.S. electric company subsidiaries and their HCs and compile data on which subsidiaries have a linkage-reducing rate policy and when the policy was officially adopted by commission order. We limit the sample in two ways. First, we use subsidiaries and thus HCs that changed to revenue decoupling during the study period 2005 to 2015. Second, we eliminate certain HCs that primarily trade in foreign (i.e., non-U.S.) capital markets.<sup>34</sup>

The updated *Brattle* sample consists of

- 15 electric holding companies;
- 37 state-regulated electric and gas subsidiaries of the HCs (subsidiaries operate in 16 states

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<sup>32</sup> See footnotes 17, 18, and 19 above.

<sup>33</sup> A subsidiary is defined to mean first, the operations within one state, (e.g., Potomac Electric DC separately from Potomac Electric Maryland), and second, the separation of utilities by fuel type, since ratemaking is done independently (e.g., Baltimore Gas and Electric is considered to be two subsidiaries in our dataset, one for electric and one for gas). The legal definition of a subsidiary may differ.

<sup>34</sup> The California electric utilities and National Grid were not used in our sample. National Grid is the holding company for Narragansett Electric in Rhode Island and Massachusetts Electric Company and Nantucket Electric Company in Massachusetts. National Grid is a company based in the United Kingdom and is traded as an American Depositary Receipt (ADR) in U.S. capital markets, so it is excluded from the analysis. The major California utilities had the policy of decoupling or its equivalent starting in the 1980’s; therefore, there was no significant change in decoupling status across the study period 2005–2015.

and during some quarters in the study period had revenue decoupling or fixed variable rates);

- 44 quarterly observations from 1Q 2005 through 4Q 2015, covering the period when there was rapid growth in the policy of decoupling for electric utilities; and
- 465 observations, each pertaining to a holding company and consisting of the cost of capital in that quarter, the decoupling index value in that quarter, and a set of explanatory or dummy variables, as discussed below in Section V.

HC financial data are screened for potential bias, using a set of standard financial and other criteria that *Brattle* routinely uses when estimating the cost of capital. The criteria are discussed in Section V.

It is noteworthy that the electric HCs in the sample are not “pure play” holding companies.<sup>35</sup>

The necessary criterion for inclusion in the electric HC sample is the existence of an electric utility subsidiary that has received a revenue decoupling or fixed variable rate decision during the study period. If any such holding company also has gas subsidiaries with linkage-relaxing ratemaking, that is identified and incorporated into the database. About two-thirds of the total 37 subsidiaries with linkage-relaxing ratemaking are electric companies; one-third of the subsidiaries are their “sister” gas LDCs. There can be unregulated subsidiaries of the HCs as well, including independent power producers or retail marketers. This characteristic of the industry necessitates the use of a company specific dummy variable to control for differences in the asset composition of the sample companies which may affect the estimated cost of capital.

Figure 5 below shows the segmentation by ratemaking approach of the total of thirty-seven (37)

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<sup>35</sup> This contrasts with the more “pure play” holding companies in the gas LDC sample that *Brattle* has used in other studies. See for example, Joseph B. Wharton, Michael J. Vilbert, Richard E. Goldberg, and Toby Brown, *The Impact of Decoupling on the Cost of Capital: An Empirical Investigation*, The Brattle Group Report, Original Version March 2011, Revised July 2012.

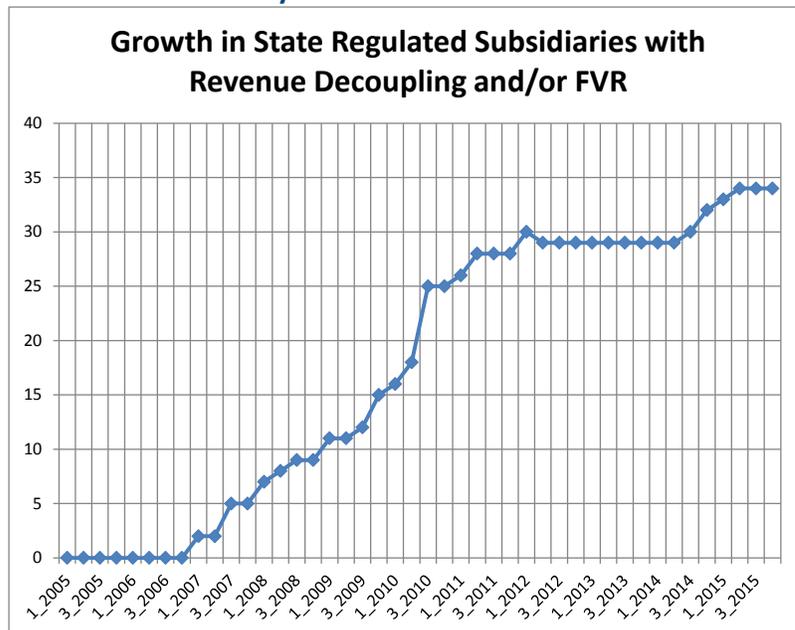
subsidiaries. Figure 6 shows the growth in linkage-relaxing policies in the sample during the study period. The total at the end of the study period is net of the three subsidiaries that had the policy reversed at some point. This pattern of growth reflects that our sample was designed around HCs that had a significant increase in the linkage-relaxing policies.

**Figure 5**  
**Breakdown of the Sample**

**Distribution of Linkage-Relaxing Policies in Sample**

	Revenue Decoupling with True Up	Fixed Variable Rates	Both policies, in sequence or combined	Total
Electric Subsidiaries	22	2	1	25
Gas Subsidiaries	8	3	1	12
<b>Total Subsidiaries</b>	<b>30</b>	<b>5</b>	<b>2</b>	<b>37</b>

**Figure 6**  
**State Regulated Subsidiaries in the  
 Study Period 2005–2015**



### C. DEVELOPING EACH HOLDING COMPANY'S DECOUPLING INDEX

The key independent or explanatory variable is the “decoupling index variable” calculated each quarter for each HC. Our methodology for calculating the decoupling index addresses the duality of HCs and subsidiaries mentioned above. We measure the degree of decoupling of each holding company by examining the decoupling policies of its subsidiaries. The decoupling index variable index is a weighted average of the decoupling index (either 0 or 1) values separately for the existence of approved revenue decoupling or FVR for each of the HC's subsidiaries, electric or natural gas. In each quarter, a value of 1 means the subsidiary has the policy by the end of the quarter; a value of 0 means that it does not. The weights in the numerator of the index are the total asset values of the subsidiaries with the linkage-relaxing policy. The denominator is the total asset value of the HC. For example, an HC with two subsidiaries, one decoupled representing 40 percent of the total assets and the other not decoupled, would have a decoupling index of 0.40 in the quarter. The timing information from the EEI report is supplemented with additional information on the specific date on which the regulatory policy of decoupling was adopted (or rescinded) for each state subsidiary.<sup>36</sup>

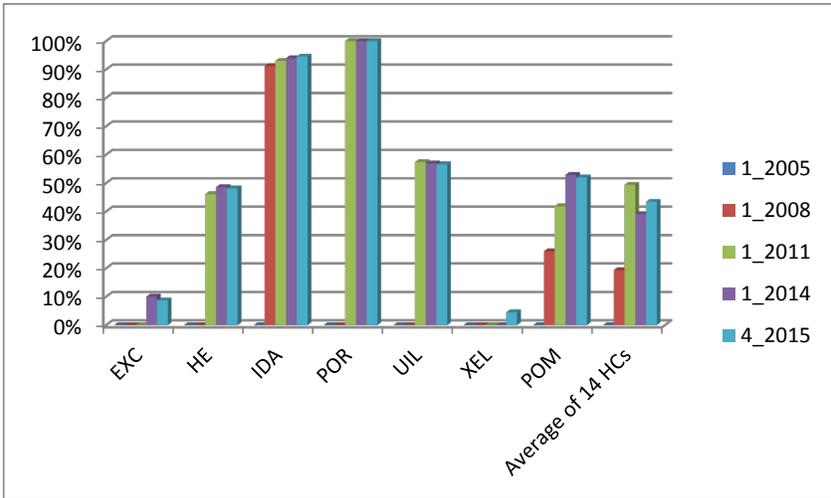
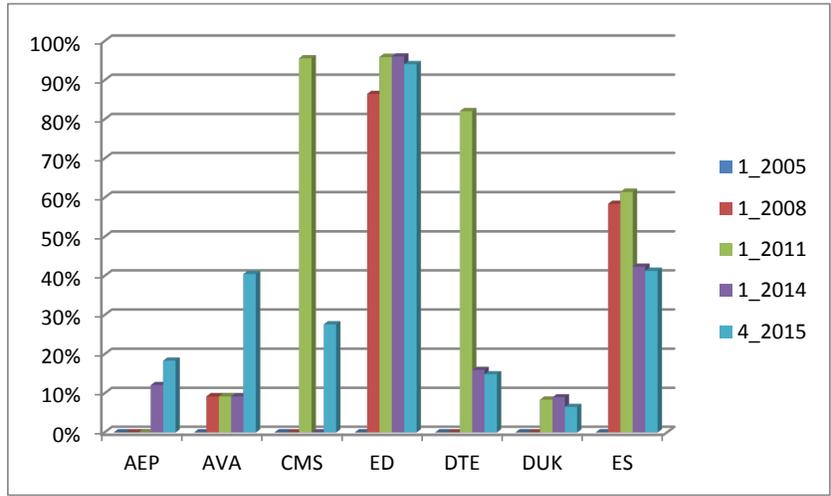
The calculation of the decoupling index is sometimes complicated by the fact that some regulated subsidiaries cover more than one state and could have decoupling in one state and not the other.

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<sup>36</sup> We assume that for a particular state subsidiary, this specific date of approval is the likely date when any uncertainty in capital markets about adoption of decoupling is fully resolved. This would in principle result in the reassessment of the future risk for the holding company that owned the state regulated electric utility at issue, which would continue as long as the policy is in effect. Capital markets are forward looking, and investors are aware of regulatory proceedings that potentially affect future risk.

In that circumstance, we estimate the percentage of assets that are decoupled for that subsidiary by reference to the percentage of MWh of electricity consumed in the separate jurisdictions compared to the total MWh for the entire subsidiary. This is necessary because the distribution of assets of a multistate subsidiary is not generally reported in their accounting statements. Figure 7 displays the decoupling index values for the holding companies at five selected times over the study period. This group of HCs had no decoupling at the beginning in 2005, but this changed substantially over the study period of eleven years. At 4Q2015, the end of the study period, the decoupling index across the holding companies ranges between 4.5% and 100%, with an average of 43.4%.

**Figure 7**  
**The Level of Decoupling Index in 5 Selected Quarters in Study Period**



Note: The names and tags of HCs portrayed in the figure are American Electric Power Co. Inc. (AEP), Avista, (AVA), CMS Energy Corp. (CMS), Consolidated Edison, Inc. (ED), DTE Energy Co. (DTE), Duke Energy Corp. (DUK), Exelon Corp. (EXC), Hawaiian Electric Industries Inc. (HE), IDACORP Inc. (IDA), Xcel Energy Inc. (XEL), Eversource Energy (ES), Pepco Holdings Inc. (POM), Portland General Electric Co. (POR), UIL Holdings Corp. (UIL). The 15<sup>th</sup> holding company Avangrid (AGR), formerly Energy East and then Iberdrola, is omitted from the figure for technical and data reasons.<sup>37</sup>

<sup>37</sup> A subset of observations for Avangrid holding company and its decoupled subsidiaries had to be omitted from the analysis because Avangrid’s predecessor Energy East in 2008 was acquired by Iberdrola, a Spanish holding company. Foreign companies not traded on a U.S. stock exchange are

Continued on next page

## V. Estimation of the Cost of Capital for the Electric Industry

This section explains the estimation of the cost of capital for the sample holding companies.

### A. ESTIMATING THE OVERALL AFTER-TAX WEIGHTED-AVERAGE COST OF CAPITAL

We estimate the cost of capital quarterly for the period quarter 1, 2005 to quarter 4, 2015. The dependent variable in the regression equation is the after-tax weighted-average cost of capital (“ATWACC”) as calculated below:

$$\begin{aligned} \text{After-Tax WACC} = & (\text{Equity Share}) * (\text{ROE}) \\ & + (\text{Debt Share}) * (\text{Cost of Debt}) * (1-\text{Corp Tax Rate}). \end{aligned}$$

The equity and debt share weights are based upon market values. ROE is estimated using the multistage version of the discounted cash flow (“DCF”) model.<sup>38</sup> We note that the focus of the regression analysis is detecting whether there were changes in the COC as the decoupling index changes<sup>39</sup> for the various holding companies over the study period. The multistage DCF methodology is well suited for this.<sup>40</sup> The Cost of Debt is set at the then current market yield on

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screened out as part of the Brattle standard COC methodology. Additionally, data on Iberdrola’s total assets and non U.S. subsidiaries are complicated to deal with or non-existent. In 2016, Avangrid, Inc. has become traded on the NYSE and the holding company can be included in future updates.

<sup>38</sup> Our analyses rely on the DCF model instead of the Capital Asset Pricing Model (CAPM) because the DCF model is the more forward looking model. The beta parameter in the CAPM is normally estimated using three to five years of historical data, but historical data would not capture the effect of a change in risk from the adoption of decoupling. In contrast, the DCF model relies upon the current stock price and a forecast of the future growth of earnings and dividends.

<sup>39</sup> The changes are generally step increases when decoupling or FVR are approved. However, decoupling and FVR policies are discontinued in three cases. Also, mergers can change the total assets of the HC and thus change the decoupling index.

<sup>40</sup> In particular, the study is not interested in the *level* of the cost of capital but in the *change* in the estimated cost of capital. This difference is important and the ordinary disputes in different DCF

Continued on next page

the comparably rated utility bond index as reported by Bloomberg. We use an estimate of the marginal Corporate Tax Rate of 40%.

## B. ESTIMATING THE COST OF EQUITY

The COE is the information of interest to regulators when they set the allowed ROE for a utility, so our focus is ultimately on whether there is a measurable reduction in the COE from the policy of decoupling.<sup>41</sup> In general, the COE increases not only with increased business risk but also increased financial risk.<sup>42</sup> Therefore, in testing for an impact on the cost of capital from decoupling, we systematically account for differences in the COE arising from different levels of financial risk in the sample HCs, but which has nothing to do with decoupling.

The cost of capital is estimated quarterly for the sample HCs. *Brattle* screened the universe to remove estimates that could be biased due to factors such as dividend cuts. These criteria are standard in *Brattle's* cost of capital analysis.<sup>43</sup> The cost of equity is the information of interest to regulators when they set the allowed ROE for a utility, so the focus is ultimately on whether

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methodologies are of secondary importance in our view.

<sup>41</sup> In general, the regulator sets the allowed return on equity equal to the estimated cost of equity (“COE”) in order to provide the regulated company a fair opportunity to earn its cost of capital. In some circumstances the regulator may set the allowed ROE above or below the COE to compensate for differences in risk between the regulated company and the sample companies.

<sup>42</sup> Financial risk, as distinct from business risk, is related to the degree to which the company’s assets are debt financed. The greater the share of debt in the capital structure, the greater the interest that must be paid out of operating revenues before any shareholder earnings are available.

<sup>43</sup> To be included in the sample for any quarter, the HC must meet all of the following conditions: no recent, substantial merger and acquisition (M&A) activity; must have an investment grade credit rating, i.e., BBB- or better; has not cut its dividend in the last two quarters; is a U.S. stock exchange traded company; the ROE estimate from the DCF model must exceed the market cost of debt; and there is no significant uncertainty over legality of the regulatory policy of decoupling.

there is a measurable reduction in the cost of equity from the policy of decoupling.<sup>44</sup> As discussed above, the cost of equity generally increases not only with increased systematic risk (i.e., non-diversifiable risk) but also with increased financial risk. Therefore, in testing for an impact on the cost of capital from decoupling, *Brattle* used the after-tax weighted average cost of capital to control for differences in the cost of equity in the sample HCs stemming from different levels of financial risk (i.e., different capital structures) but which has nothing to do with decoupling.

We use an average over 15 trading days for the current stock price and security analyst earnings five-year forecasts from Thomson-Reuters.

where  $r_D$  = market cost of debt,  
 $r_E$  = market cost of equity,  
 $T_C$  = corporate income tax rate,  
 $\% D$  = percent debt in the capital structure, and  
 $\% E$  = percent equity in the capital structure

- The cost of debt,  $r_D$ , is based upon the yield on utility debt from Bloomberg's utility bond index for companies of comparable S&P credit ratings.
- For  $T_C$ , we use a 40 percent combined federal and state corporate tax rate for all companies.<sup>45</sup>
- For those companies with preferred equity in their capital structures, we estimate the return on preferred equity as equal to the before tax return on the company's debt and weigh it by its share in the capital structure.<sup>46 27</sup>

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<sup>44</sup> The distinction between the cost of equity (COE) and the return on equity (ROE) is that the COE is the estimated cost of equity whereas the ROE is the allowed return set by the regulator. In most cases, regulators strive to set the allowed ROE equal to the estimated COE, but there are some circumstances when the regulator may set the allowed ROE higher or lower than the COE in recognition of differences in risk between the sample and the regulated company.

<sup>45</sup> Although state tax rates vary, a combined 40 percent rate is used for all to avoid any distortions in the results from attempting to model different tax rates.

<sup>46</sup> This is an approximation because we do not know of an index for the cost of preferred equity. The approximation is not likely to have a large effect because the percentage of preferred equity in the companies' capital structures is relatively small.

- The market value of equity,  $E$ , is calculated as the product of  $P$ , the market price of the stock, and the number of shares outstanding at the time.
- The market value of debt,  $D$ , is approximated by the book value of debt because the market value of debt and the book value were not substantially different.
- The market value of preferred,  $Pf$ , is also approximated by the book value of preferred equity if there is any in the capital structure.
- The total market value of the firm is the sum of the  $E$ ,  $D$ , and  $Pf$ .

The result of this process is an estimate of the ATWACC for each sample company for each quarter of the sample period.

## VI. An Empirical Test of the Effect of Decoupling on the Cost of Capital

Finally, we test the effect of decoupling on the overall cost of capital by regression analysis on the time series of our estimated ATWACCs for the sample of holding companies.

### A. REGRESSION MODEL

We estimate the following regression model:

$$ATWACC_{c,t} = \beta_0 + \beta_1 * HC Decoupling Index_{c,t} + \beta_2 * QTR_t + \beta_3 * HC Epoch Variable_{c,t} + \varepsilon_{ct} \quad (3)$$

In the regression equation, the dependent variable is the overall ATWACC of each holding company. The primary explanatory variable is the HC Decoupling Index. Other variables are time in quarters ( $QTR_t$ ) and the HC Epoch Variable.

Indexes:  $c$  = holding company;  $t$  = quarter.

In statistics, particularly in regression analysis, it is common practice to use a dummy variable (also known as an indicator variable, binary variable, or qualitative variable) to indicate the

absence or presence of some categorical effect that may be expected to shift the outcome.<sup>47</sup> This variable takes the value 0 or 1. As shown in formula above, to account for those other factors, we use two dummy variables, the time period QTR variable and the company-specific HC Epoch Variable. The time period variable changes every quarter to capture things that affect all HCs, like the prime rate or the inflation expectation.

The HC Epoch Variable is an enhancement of the standard company dummy variable for each HC. The HC Epoch Variable changes to account for known, significant changes. Each “epoch” is a sequence of observed values of pairs of cost of capital and the decoupling index with no major changes or interruptions. Changes come from the following four causes: substantial mergers or acquisitions, dividend cuts, credit rating changes, and major legal policy changes. Such changes for a HC result in starting a new epoch because they would be picked up by financial analysts and capital markets. This may trigger a change in the determination of the overall level of risk and the cost of capital for the HC, independent from changes in the decoupling index.

The equation is estimated with ordinary least squares and clustered standard errors to account for correlation in each company’s performance across time.<sup>48</sup> We consider two cases. The first case is to estimate the impact of revenue decoupling policy alone, adding no weight to a HC’s decoupling index for any subsidiaries that have FVR as a linkage-reducing policy. The second case treats revenue decoupling and FVR as equals that adds weight of any subsidiary that gets one

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<sup>47</sup> For example, we believe that the ATWACC is affected over time by many other factors, such as the prime rate, the level of inflation, state regulatory policy and regulatory risk, just to mention a few.

<sup>48</sup> Clustered standard errors are appropriate for this panel data set.

or the other or both forms of a linkage-reducing policy.

**B. STATISTICAL RESULTS**

The statistical results are clear. First, there is no statistically significant decrease or increase in the cost of capital from adoption of revenue decoupling alone (this is the first case which omits FVR from the decoupling index. For this first case, the regression coefficient on the decoupling index is -22.1 bps. The standard error is 22.7 bps, slightly larger in absolute value than the coefficient itself, giving rise to a p-value of 0.330 (meaning there is a 33% chance that the observed -22.1 bp decoupling index coefficient is not the case, but the true value is really zero or larger). Clearly,  $0.330 > 0.05$ , so this fails the p-value test, as discussed below. The tabulated results for the first case are shown in Figure 8.

**Figure 8**  
**Statistical Tests of First Case**  
**Null Hypothesis p-value less than or equal to 0.05**

<b>Linkage Relaxing Policy is Only Revenue Decoupling</b>	
<b>Multiple Stage DCF 1Q2005 to 4Q2015</b>	<b>Values</b>
<b>Decoupling Index Coefficient (bps)</b>	-22.1
<b>Standard Error of the Estimate (bps)</b>	22.7
<b>p-value, 2-sided (should be &lt; 0.05)</b>	0.330
<b>No. of Observations</b>	465
<b>R-squared, adjusted</b>	0.796

The second case treats both types of linkage-relaxing policies, revenue decoupling and FVR, as

determining the level of the decoupling index in the regression. The coefficient of the decoupling index variable is -20.9 bps. The standard error of the estimate is 22.7 bps, again relatively large. The p-value for this coefficient is 0.359 which is again much greater than the 0.05 p-value required to reject the null hypothesis that these link-relaxing policies do not affect the cost of capital. The tabulated results for the second case are shown in Figure 9.

**Figure 9**  
**Statistical Tests of Second Case**  
**Null Hypothesis p-value less than or equal to 0.05**

<b>Linkage Relaxing Policy is Both Revenue Decoupling and Fixed Var Rates</b>	
<b>Multiple Stage DCF 1Q2005 to 4Q2015</b>	<b>Values</b>
Decoupling Index Coefficient (bps)	-20.9
Standard Error of the Estimate (bps)	22.7
p-value, 2-sided (should be < 0.05)	0.359
No. of Observations	465
R-squared, adjusted	0.795

There is no material difference in the two cases in terms of the lack of statistical evidence of an impact of revenue decoupling on the COC. Again, the primary focus of our analysis is revenue decoupling, but we have systematically analyzed FVR because the two policies have a similar effect of reducing the variability of revenue collections around the target, and both policies are found in our sample. Therefore, we tested whether FVR and revenue decoupling together have an effect. We get the same results with and without FVR and believe that this strengthens the

statistical evidence that adoption of revenue decoupling does not reduce the cost of capital.

### C. EXPLANATION OF THE STATISTICAL RESULTS FOR THE NON STATISTICIAN

For the non-statistician reader, we now explain more fully the statistical test used in the first case, revenue decoupling is the sole linkage-relaxing policy. The decoupling index coefficient is an estimate of the number of basis points the COC would change, possibly fall, if the decoupling index increased from 0.00 to 1.00, and is estimated at -22.1 bps.<sup>49</sup> The regression equation does not determine the COC perfectly as there is considerable unexplained variance in the actual ATWACC observations from the fitted ATWACC values.<sup>50</sup> The regression results do provide the standard error of the estimated coefficient of decoupling, which is + 22.7 bps.

Hypothesis testing starts from null hypothesis - there can be a range of estimated impacts across empirical samples even when the impact coefficient is assumed to be zero in the population and this distribution is centered at zero (the null hypothesis). The p-value test is the basic way of determining if the key estimated parameter for the decoupling index has a large or small likelihood of being the estimated coefficient size – 22.1 bps (or larger in absolute value).

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<sup>49</sup> This is a 2-sided test, which means that null hypothesis can be disproven by strong results on either side of 0. This is a standard structure for statistical analysis. This is appropriate when, as discussed in the theoretical section above, the decoupling policy is not introduced in a vacuum and can be seen as part of a response to other conditions and policies that are increasing some risks, which may be those increasing the cost of capital.

<sup>50</sup> The adjusted R-squared is 0.795. Adjusted R-squared is the amount of the variation in ATWACC observations from the mean that is explained by the linear regression, in relation to the total variation, adjusted for the degrees of freedom. This just shows that there is unexplained variation. High or low R-squared alone are not determinative of statistical significance.

Standard p-value test levels are 0.01, 0.05, and sometimes 0.10.<sup>51</sup> We adopt a test level of 0.05, meaning our standard is the probability must be less than or equal to 0.05 that the estimated reduction of -22.1 bps is true when by working assumption of the null hypothesis, there is no such impact. The 0.05 test level translates into a t-value greater than 1.96.<sup>52</sup> We calculate the t-value of coefficient of decoupling:

$$\begin{aligned}
 \text{t-value} &= \text{Estimate} / \text{Standard Error of Estimate} \\
 &= -22.1 / 22.7 \\
 &= -0.976
 \end{aligned}$$

The estimated p-value of the decoupling coefficient is equal to the probability under the normal curve of t-values: outside the values + 0.976 and - 0.976. That p-value is 0.33, so the p-value test fails.

$$0.330 \gg 0.05$$

We use a standard two-sided hypothesis test. This is consistent with the discussion above that there is a possibility of non-diversifiable risk and the COC rising from other factors at the time that revenue decoupling is approved.<sup>53</sup>

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<sup>51</sup> See Daniel L. Rubinfeld, “Reference Guide on Multiple Regression,” Chapter in the book by the Federal Judicial Center National Research Council, *Reference Manual on Scientific Evidence*, Third Edition, 2011.

<sup>52</sup> The t distribution for our large number of 465 observations is essentially the normal distribution and, by the null hypothesis, is centered at zero (0).

<sup>53</sup> While not appropriate, a one-tailed hypothesis test would still show that the decoupling index coefficient was not statistically significant.

## VII. Summary and Conclusion

A cornerstone of traditional cost-of-service ratemaking is being questioned as to how well it fits in the “utility of the future.” This cornerstone is volumetric (per kWh) rates that change only at general rates cases while collecting the majority of the fixed costs of residential and small commercial customers. The modern problem with this cornerstone has two sides. The first is how to address the regulated company’s throughput incentive for greater sales when it directly conflicts with the regulatory policies for the company to promote energy efficiency and distributed generation. The second is how to address stagnant or falling revenues from stagnant or falling kWh sales from more general changes in technology and the economy. Both revenue decoupling and fixed variable rates are alternative ratemaking policies that are increasingly used or being discussed in the U.S. to solve the problems with the old cornerstone. But there is an important issue with the solution, especially for revenue decoupling.

In regulatory proceedings on the adoption of revenue decoupling, there is almost always an issue raised by some intervening parties: there should be a significant reduction in the allowed return on equity and thus the cost of capital because of the reduction in revenue volatility. In this report, we have updated and expanded our empirical study of the impact of these two ratemaking policies on the regulated cost of capital. The two part design of the study is to first, estimate the COC quarterly over the study period 2005 to 2015 for fifteen electric holding companies and, second, collect data on all of their regulated subsidiaries that have revenue decoupling or fixed variable rates to create an accurate “decoupling index.” The sample and study period have been designed so that the level of revenue decoupling for these holding companies exhibits

considerable change, which is preponderantly an increase.

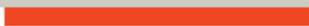
Using multivariate linear regression, we then test whether there is statistically significant evidence that the adoption of decoupling reduces the COC. The first regression considers only revenue decoupling as the linkage-relaxing rate policy. The second regression considers both revenue decoupling and FVR as linkage-relaxing policies.

The results for both regressions are very similar, and both fail to reject the standard null hypothesis that decoupling does not affect the cost of capital. Although the coefficient on the decoupling index is negative, it is not close to being statistically significant in either test. For statistical significance we required a p-value of less 0.05 (the 5% level). The p-values in the tests were 0.330 (33%) and 0.359 (36%), respectively. Therefore, our updated empirical study of the electric industry provides results consistent with Brattle's previous studies of the electric industry, as well as those of the natural gas local distribution industry.

Although linkage-relaxing ratemaking will reduce the volatility of revenues, there is no statistically significant evidence that it reduces the COC. Is this reasonable? Volatility in revenues from weather and economic cycles has always existed for utilities using traditional volumetric rates and general rate case paradigm, so the empirical evidence rejecting an effect on the COC may seem counter intuitive. However, the statistical evidence is consistent with the fact that linkage-relaxing ratemaking is not instituted in a vacuum (or to lower the cost of capital) but as a direct policy response to the rapidly emerging issues and risks of energy efficiency and distributed generation programs, and stagnant and falling kWh sales and revenues. These policies are likely to increase risk to utilities under traditional cost of service regulation.

In financial terms, this increasing risk can be either systematic and non-diversifiable (part of the cost of capital) or diversifiable (not part of the cost of capital). The lack of statistical significance in our tests is an indication that the adoption of linkage-relaxing ratemaking, and especially revenue decoupling, reduces risk that is diversifiable or offsets a comparable increase non-diversifiable risk or both.

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