REVENUE-SALES DECOUPLING IMPACT ON PUBLIC UTILITY CONSERVATION INVESTMENT

(currently submitted and under review – Energy Policy Journal)

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January 2019

Keywords: Decoupling, Public Utility Cost of Capital, Energy and Water Efficiency

JEL Classifications: G12, L94, L95

The paper has received partial funding from the Rutgers University School of Business – Camden, Summer Research Program. The authors thank the participants at the 2017 and 2018 Center for Research in Regulated Industries Eastern Conferences for helpful comments.

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HIGHLIGHTS

- Decoupling revenues from commodity sales for US public utilities is being increasingly adopted by regulators to remove the disincentive to promote energy and water efficiency that reduces sales, revenues and profits.

- This research estimates the impact of decoupling on US public utilities' investment risk and the cost of common equity capital.

- The results show that there are no measurable signals in the conditional means and volatilities of public utilities' stock returns.

- The key policy implication is that regulators should not impute a change on the allowed rate of return on common equity to reflect a change in investment risk from decoupling.

ABSTRACT

US public utilities and regulators are implementing various forms of regulatory mechanisms that decouple revenues from commodity sales to remove a disincentive incentive for utilities to invest in and encourage consumers to conserve electricity, natural gas and water. A major question is whether such regulatory mechanisms affect investor-perceived risk, the cost of common equity and the utility rates for such commodities. This is an important question as regulators in the US are and have been considering the impact of decoupling on investment risk and therefore the cost of capital. This matter is also important for regulators globally as they consider decoupling as a policy initiative in setting rates and rate of return. Empirical testing, based on the available data to date, consistently demonstrates that decoupling has no statistically measurable impact on risk and the cost of common equity. Therefore, at this juncture, policy is moving ahead, at least in the US, without evidence on whether it does have impact on risk and return.

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1. Introduction

Beginning in the late 1970's, US policymakers, legislators, regulators and public utilities began to focus on reducing consumers' demand for energy rather than increasing supply. This was mainly a reaction to the oil supply shock in the US in the early 1970's, which began with the National Energy Conservation Act of 1978. Europe was already much more efficient in the use of energy by the 1970's as the BTU content of GDP of many European countries were a substantially small fraction relative to the US.

More recently in the US, regulatory policy has required water utilities to encourage the reduction in water use by their consumers to promote the efficient use of water. A major financial impediment for investor-owned utilities to encourage conservation of energy and water is the profit disincentive associated with revenue reductions generated by falling sales volumes. Therefore, various regulatory policy mechanisms have been developed to provide utilities with a financial incentive, or, at least, remove the disincentive to utilities to encourage energy and water efficiency. Increasingly, revenues are being decoupled from sales volumes so that reductions in sales volumes in an effort to potentially stabilize profits rather than reduce them.[1] Decoupling revenues from sales volumes was first implemented in California in 1982 and also in New York in the early 1980's. Although decoupling did not gain momentum outside of California and New York for decades afterward, it has been recently implemented in various state regulatory jurisdictions across the US for electric, natural gas, and water public utilities.

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[1] In response to the challenges to achieving the allowed return on common equity due to expected significant capital expenditures to repair and replace utility infrastructure, as well as declining per capita commodity consumption, the National Association of Regulatory Utility Commissioners (NARUC) recommends that regulators carefully consider and implement appropriate ratemaking measures so that water and sewer utilities have a reasonable opportunity to earn their allowed rate of return on common equity. Decoupling, or revenue adjustment stabilization mechanisms (RAM) separate rates / revenues from electricity, gas or water volumes sold. Such mechanisms address the effects of the more efficient use of the commodity and declining per capita consumption, for water and to a lesser extent, electricity, while maintaining the financial soundness and viability of the utilities. With RAMs, utilities are made whole for revenue shortfalls from allowed revenues used to design rates, which generally result from weather and conservation efforts by customers. RAMs allow for recovery / crediting of differences between actual and allowed quantity charge revenues. RAMs have proven effective in mitigating the effects of regulatory lag and improving utilities' opportunities to earn their allowed returns on common equity while upgrading infrastructure, ensuring safe and reliable service, removing the incentive to sell more commodity, and helping to protect valuable natural resources. However, in base rate cases for utilities that have such mechanisms, the question often arises as to whether and to what extent the presence of such mechanisms reduces the utility's investment risk as well and to what extent such a perceived reduction in risk should be reflected in the allowed return on common equity.

A key consideration in many US rate proceedings and policy discussions is the impact of decoupling on the investment risk of a public utility and its cost of capital (and therefore the allowed rate of return set by regulators). Since decoupling disassociates revenues with sales volumes, it generates an increasingly stable and non-declining level of revenues and net income if sales do decline. Therefore, the public utility is perceived to have lower investment risk, which would lead to a lower cost of common equity capital, i.e., the investor required return.

This topic has been the subject of only a few empirical investigations so far by Wharton and Vilbert (2015) and Vilbert, Wharton, Zhang and Hall (2016) {collectively referred to as Wharton, et. al (2015, 2016)}. Moody's (2011) has estimated the change in business risk and credit metrics due to decoupling, but not the impacts on the cost of capital.

Wharton, et. al. (2015, 2016) developed an index of decoupling exposure for public utility and utility holding company stocks and estimated the after-tax weighted average cost of capital (ATWACC) using the dividend discount model to estimate the cost of common equity. They regressed the ATWACC on an index of decoupling intensity and observed the slope to estimate the impact. Although the slope of the regression is negative, it is not statistically significant. They concluded that decoupling has no statistically significant measurable impact on the utility cost of common equity. They found that decoupling may reduce revenue volatility, but it may not reduce investment risk. It may actually exacerbate risk as decoupling regulatory policy is viewed as a new and uncertain regime and may be used to promote other regulatory policy goals and create regulatory risk.[2]

Reductions in peak loads and the commodity sales impacts of consumer energy or water efficiency measures are difficult and expensive to estimate. This difficulty introduces an additional regulatory risk that may result in exposure to regulatory financial penalties due to the uncertainties associated with such efficiency estimation. Thus, Wharton, et. al. (2015, 2016) concluded that on a net basis, decoupling may increase investment risk of utilities.

Chu and Sappington (2013) developed a social welfare model that investigated under what conditions a utility would provide a welfare maximizing level of energy efficiency services to its consumers. Their investigation is important to our discussion as decoupling is implemented as a tool to incent utilities to cause consumers to invest in the optimal level of end-

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[2] Since multiple types of risk are discussed, we generically define risk as the chance of a disappointment in financial

use efficiency resources. In considering the use of decoupling, they found that, generally, decoupling alone is not sufficient to induce utilities to provide the socially optimal level, i.e., enough, of energy efficiency services. One problem is that end-use energy efficiency resources cause a rebound effect {Khazzoom (1980, 1987)} whereby lower utility bills causes consumers to increase their energy use as they buy more comfort with the savings.

Chu and Sappington (2013) also discuss that if the price of electricity is above private (in contrast to social marginal cost) marginal cost, falling sales reduce the utility's profits.[3] Since public utility ratemaking uses average cost to set rates, this is a highly unlikely occurrence. Depending on specific conditions facing a utility, decoupling may not generate a profit motive for utilities to reduce sales with energy or water efficiency. Utilities could be placed into a position of delivering the predicted amount of energy savings expected by regulators but possibly without any profit motive other than the avoidance of regulatory penalties for not meeting a goal. This disincentive has become a major topic relative to alternative ratemaking mechanisms, as the growth in electricity sales appears to be less correlated with the growth rate in the US GDP and with such sales growing more slowly than the general economy has been in recent years.[4]

Brennan (2010) develops a social welfare model to derive conditions under which utilities will be incented to provide energy efficiency services, showing that decoupling must

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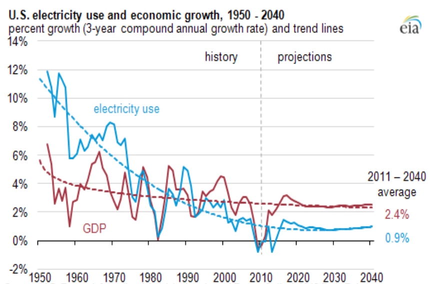
performance due to the type of risk being discussed.

[3] The key problem with the over-use of utility services is that public utility pricing is based on average versus marginal cost pricing. Utility services have an excess demand (over-consumed) and end-use efficiency resources have an excess supply (under-consumed) with general equilibrium not attained. The authors of this study are hard-pressed to find where the actual price of electricity is above the private marginal cost as is the case for a public utility.

[4] US electricity use is expected to experience an annual average growth rate of 0.9% compared with a 2.4% US GDP annual growth rate between 2011 and 2040, according to the US Energy Information Administration (EIA) forecast in 2013, as demonstrated in the EIA graph below:



Source: U.S. Energy Information Administration, Annual Energy Outlook 2013 Early Release.

separate revenues from the generation of electricity and not just revenues and sales from the distribution of electricity, leading to a highly complex form of electricity pricing regulation, rather than just the separation of sales to the consumer and the revenues collected.

Croucher (2011) finds that decoupling may be a form of Stigler (1971) regulatory capture as decoupling takes the price-setting control away from regulators as utilities can adjust price based on needed revenues relative to (falling sales) to maintain or increase their rate of return. Peltzman (1976) developed the buffering hypothesis that regulation shelters utility investors from risk. These theories of regulation are important for this research because if decoupling is a yet another form of regulatory capture or causes risk reduction through buffering, then the impact of decoupling should be detected in the cost of capital and risk.

Since decoupling, as a regulatory policy tool, is being adopted rapidly {Edison Electric Institute, the US electric utility trade association, EEI (2015)}, questions arise in rate proceedings relative to the impacts on the cost of capital. Due to the importance of this issues and the lack of related literature, we investigate the impact of decoupling on the investor perceived risk of public utilities and resultant cost of common equity capital. The next section discusses the models and approaches used to estimate these impacts. Section 3 discusses the data and empirical results. Section 4 presents concluding remarks and suggests future paths for related research.

2. Methodology

This paper uses the generalized consumption asset pricing model (GCAPM) developed by Michelfelder and Pilotte (2011) to estimate the impact of decoupling on the public utility cost of capital. The model is based on generalizing variants of intertemporal capital asset pricing models. The literature that discusses the development of the model based on more restrictive versions is voluminous and summarized by Michelfelder and Pilotte (2011) and therefore is not repeated. The GCAPM was empirically applied by Michelfelder and Pilotte (2011) to the full spectrum of assets on the US Treasury yield curve. The GCAPM is a recently developed financial valuation model that is an alternative to the CAPM and the dividend discount model for estimating the cost of common equity. Ahern, Hanley, and Michelfelder (2011) and

Michelfelder (2015) review and apply the GCAPM to estimate public utilities' cost of common equity.

The model has the following characteristics. It does not have restrictions on the coefficient of risk aversion in the investor's utility function as do most models. It allows for a negative relation between rate of return and volatility.[5] This relation will occur for assets that have prices that move in the opposite direction of the business cycle. Unlike the CAPM, the GCAPM prices the total risk actually faced by the investor and does not assume that all unsystematic risk is diversified away which is a key foundation of the standard CAPM. However, there is no perfect portfolio that removes all idiosyncratic risk that is assumed in the development of the CAPM. The risk is reduced but not completely alleviated and the standard CAPM understates the cost of common equity as it does not price all risk exposure. The priced risk in the GCAPM is based on the level of risk actually faced by the investor, not the risk theoretically imposed by the CAPM. Fama and French (2004) find that the CAPM understates returns and risk, based on a large empirical study of portfolios of stocks with a continuum of low to high betas. The GCAPM does not assume or require the efficient markets assumption as does the CAPM.

Ahern, Hanley, and Michelfelder (2011) find that the CAPM generates lower costs of common equity than the GCAPM. Michelfelder (2015) applied the GCAPM to estimate the cost of common equity capital to public utilities and also concluded that the CAPM does not price all risk faced by the investor and that the CAPM understates the cost of common equity for public utilities. The GAPM is specified as:

$$E_t[R_{i,t+1}] - R_{f,t} = -\frac{vol_t[M_{t+1}]}{E_t\left[M_{t+1}\right]} vol_t[R_{i,t+1}] corr_t[M_{t+1}, R_{i,t+1}], \qquad (1)$$

where the anticipated risk premium on an asset *i* depends on the conditional volatility of the

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[5] It seems counterintuitive, yet some investors are willing to pay (give up return) for more volatility in the asset's return rather than less, if the pattern of the volatility is desired by those investors. Some researchers confuse risk and volatility as synonymous. For example, gold returns have a tendency to spike upward during recessions and downturns in stock markets. Thus, gold can diversify and investor's portfolio and offset the reduction in income from employment. Therefore, systematic upward spikes in gold prices increase volatility. Such increases in volatility are generally associated with reductions in the market returns to gold. Such assets with negative relations among returns and volatility are business cycle hedges.

asset; $R_{i,t+1}$ is the ex ante return on asset i; $R_{f,t}$ is the rate of return on a risk-free asset at time t; M_{t+1} is the stochastic discount factor (SDF); vol_t is the conditional volatility of the rate of return; and $corr_t$ is the conditional correlation coefficient. The SDF is the intertemporal marginal rate of substitution in consumption, which is the ratio of expected future marginal utility to current marginal utility of consumption. This is an important factor to discuss as this model specification allows for the empirical estimation to determine if decoupling results in more stable revenues for utilities with falling sales volumes and therefore increased profits. If this holds true for a utility during a recession, then investment in the common stock of public utilities could be a business cycle hedge. The SDF is:

$$M_{t+1} = \left(\frac{1}{1+k}\right)\frac{U_{c,t+1}}{U_{c,t}}, \qquad (2)$$

where the U_c's are the marginal utilities of consumption and k is the discount rate for the period from t to $t+1$. The ratio M_{t+1} rises if expected future consumption falls below the current level due to the standard concave (to the origin) shape of the investor's consumption utility function. This property allows the model to accommodate the business cycle (represented by consumption expenditures) hedging property of a given asset.

If the conditional volatility of intertemporal consumption, or consumption risk, rises, investors will price a greater risk premium into the asset. The sign of the relation between risk premium and its conditional volatility is defined by the correlation ($corr_t$) of the risk premium and the SDF. The sign of the risk premium-to-volatility relation is opposite to the sign of the correlation of the asset return and the ratio of the marginal utilities. A decline in business cycle consumption increases investor's marginal utility. An asset that generates positive returns when the business cycle is in a contraction with falling consumption is a business cycle hedge. Therefore, a negative risk premium-to-volatility slope identifies the asset as a business cycle hedge.

This property allows us to infer whether decoupling causes a utility stock to be a business cycle hedge. If profits rise as GDP declines, with lower commodity sales and stable revenues, the stock price could systematically rise when the business cycle is contracting.[6] A public utility

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[6] One of the most effective "energy efficiency tools" to generate energy use reduction is a recession. Although the energy-use-US-GDP correlation has declined, it remains substantially positive {EIA (2013), as shown in the figure in footnote 4 above, www.eia.gov/todayinenergy/detail.php?id=10491}.

with a strong level of decoupling would conceivably experiencing stable revenues during a contraction in the business cycle. Therefore, utility profits may rise when commodity sales fall generated by consumer efficiency and due to the contracting business cycle.

To calibrate the GCAPM, we performed a simple test of this property by estimating the model with the risk premium on gold (percent change in the price of gold per troy ounce minus a risk-free rate). Gold is commonly known to be a business cycle and stock market hedging asset {Hillier, Draper, and Faff (2006)}. The correlation coefficient between the quarterly percent changes in the price of gold and real GDP (data are publicly available from the St. Louis Federal Reserve Database) from 1968 to 2017 is -0.058. Hillier, Draper, and Faff (2006) show that gold is a stock market hedge, especially during abnormally high periods of stock market volatility. We used the daily and monthly US gold commodity cash price data and futures price data to estimate the GCAPM. The risk-premium-to-volatility slope (see footnote 6) was either negative and significant or insignificant using daily and monthly data and rolling time frames for estimation. These calibration test results for the GCAPM show that the model does detect a hedging asset.[7]

The GCAPM can be applied to any asset that is traded in a financial market and therefore can be applied to all traded public utility stocks. The GCAPM has the added advantage that the decoupling impact on changes in stock returns as well as the conditional volatility of these returns can be estimated separately within the same model using the GARCH-in-Mean (GARCH-M) method initially developed for asset model estimation.

Decoupling is expected to lower the variance of the operating cash flows of a public utility due to the increased stability of revenues {Moody's (2011)}. The variance of operating cash flows should be driven mainly by the variance of costs as follows. Operating Cash Flows (*OCF*) is Revenues (*R*) – Cost (*C*), therefore the variance of *OCF* is $VAR\ (R - C) = VAR\ (R) + VAR\ (C) + 2COV\ (R,C)$. Since the volatility of revenues is theoretically equal to zero with decoupling, the covariance of revenues and costs is zero as revenues do not vary, volatility of *OCF* is purely driven by costs only as $VAR\ (R - C) = VAR\ (C)$. Therefore, in comparing the variance of operating cash flows with and without decoupling, the $VAR\ (OCF\ with\ decoupling) = VAR\ (C) < VAR\ (OCF\ without\ decoupling) = VAR\ (R) + VAR\ (C) + 2COV\ (R,C)$ as $VAR\ (R) = 0$

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[7] All empirical results on gold discussed are available on request.

and $COV\ (R,C) = 0$ with decoupling and $VAR\ (R) > 0$ and $COV\ (R,C) \neq 0$ without decoupling. This is essentially the model used by Moody's (2011) which found that utilities with decoupling had a reduction in their business risk as measured by the change in the standard deviation of the growth rate in gross profit before and after decoupling.

This study also involves estimating changes in perceived investment risk resulting from decoupling by estimating the change in the CAPM beta estimated by Center for Research in Security Prices database (CRSP) estimated with daily returns data for one year for each beta estimate. This short-term beta is a measure of systematic risk that should be more sensitive to regime changes for a stock relative to the standard betas estimated with five years of data typically employed to assess investment risk. Beta is expected to decline with decoupling.[8]

The only other studies on the impact of decoupling on the utility cost of capital, Wharton, et.al. (2015, 2016), estimated the impact of decoupling on the cost of capital for the overall electric and gas utility industries. They also addressed the issue that decoupled utilities may represent substantially less than the entire portfolio of assets reflected in the stock price of the holding company. Using the standard dividend discount model to estimate the cost of common equity capital portion of their weighted average cost of capital estimates, they regressed this cost of capital on an intensity index of decoupling for each publicly-traded utility stock as a one panel-data regression to estimate the industry impact. They found no statistically significant impact of decoupling on the cost of capital.

The present study estimates the impact on the decoupled firm individually rather than an industry as a whole. We use the GCAPM and changes in beta before and after the implementation of decoupling to estimate the impact on risk and the cost of capital.

3. Results

The GCAPM is estimated with the GARCH-in-Mean method.[9] GARCH-M specifies the

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[8] Systematic risk is defined as $\beta_i = \rho_{i,m}\ \sigma_i / \sigma_m$, where $\rho_{i,m}$ is the correlation coefficient of the individual stock (i) and the market (m) total rate of return and σ_i and σ_m are the standard deviations of the individual stock and market returns, respectively. Defining variables with superscript "D", to denote decoupling, $\sigma^D{}_i$ and $\rho^D{}_{i,m}$ are lower as the volatility of the utility's returns are lower with decoupling and the utility's return has a lower correlation with the market return as the utility's revenues and profits are decoupled from the business cycle. Therefore systematic risk is lower with decoupling and defined as $\beta^D{}_i = \rho^D{}_{i,m}\ \sigma^D{}_i / \sigma_m$. Therefore, $\beta^D{}_i$ is less than β_i as
$\rho^D{}_{i,m}\ \ \sigma^D{}_i / \sigma^D{}_m\ \ < \ \rho_{i,m}\ \sigma_i / \sigma_m$.

[9] The GCAPM was estimated with the GARCH-M method. The estimated models are:

conditional risk premium as a linear function of its conditional volatility, which is the specification of the GCAPM in equation (1). Since the returns data contain ARCH effects (available on request), another benefit of using GARCH-M is that it improves the efficiency of the estimates. Engle, Lilein, and Robins (1987) developed GARCH-M method and used it to estimate the relation between US Treasury and corporate bond risk premiums and their volatilities.

Two versions of the GCAPM-GARCH-M model are estimated. The first estimation includes a binary variable that reflects the implementation of decoupling for the specific utility ($D_i = 1$ if decoupled, 0 otherwise) in the risk premium equation only and the other equation the same:

$$R_{i,t+1} - R_{f,t} = \alpha_{i,t}\sigma^2_{i,t+1} + \alpha_{i,D}D_{i,t} + \varepsilon_{i,t+1} \tag{3}$$

The second estimation has the same variable in the volatility equation of the GARCH-M model only and the return equation is the same:

$$\sigma^2_{i,t+1} = \beta_0 + \beta_1\sigma^2_{i,t} + \beta_2\varepsilon^2_{i,t} + \beta_{i,D}D_{i,t} + \eta_{i,t+1} \tag{4}$$

$$\begin{aligned} R_{i,t+1} - R_{f,t} &= \alpha_{i,t}\sigma^2_{i,t+1} + \alpha_{i,D}D_{i,t} + \varepsilon_{i,t+1} \\ \sigma^2_{i,t+1} &= \beta_0 + \beta_1\sigma^2_{i,t} + \beta_2\varepsilon^2_{i,t} + \eta_{i,t+1}, \end{aligned}$$

And

$$\begin{aligned} R_{i,t+1} - R_{f,t} &= \alpha_{i,t}\sigma^2_{i,t+1} + \varepsilon_{i,t+1} \\ \sigma^2_{i,t+1} &= \beta_0 + \beta_1\sigma^2_{i,t} + \beta_2\varepsilon^2_{i,t} + \beta_{i,D}D_{i,t} + \eta_{i,t+1}. \end{aligned}$$

where *Ri* is the conditional total return on the stock, R_f is the risk-free rate of return, $\sigma^2_{i,\,t+1}$ is the conditional volatility of the risk premium for asset *i*. $\varepsilon_{i,t}$ and $\eta_{i,t+1}$ are the error terms for the mean and volatility equations, *D* is the dummy variable that equals 1 when decoupling is in place for utility *i*, and α_D and β_D are the slopes on the conditional returns and volatility decoupling dummy variable that represent the impact of decoupling on those variables.

The parameter, α_i, is the risk-premium-to-volatility slope. It is specified from equation (1) as:

$$\alpha_{i,t} = -\frac{vol_t[M_{t+1}]}{E_t[M_{t+1}]}corr_t[M_{t+1}, R_{i,t+1}]$$

It is positive for most assets that are not business cycle hedges as *corr*$_t$ is negative. A rising (falling) *M* {rising (falling) expected marginal utility from falling (rising) consumption in a recession} is associated with a fall (rise) in returns. The above empirical model specifies a 0 intercept in the risk premium equation as does the GCAPM. The estimation results support the 0 intercept specification (results available upon request).

These specifications provide separate empirical estimates of the impacts of decoupling on conditional utility stock returns and conditional volatility. As event studies, these and all financial market-based event studies face the question of when the event impacted asset prices. Asset prices can reflect forthcoming events before they are implemented. One example that is relevant for this investigation is when decoupling implementation was announced in a utility's regulatory decision. We find that using the date of implementation is a conservative approach to estimating the impact as it is most likely the latest date that a decoupling impact would be detected in a stock price and much of the impact may already have been priced in the asset. However, if a utility's revenues have been decoupled from sales to the extent that revenues are not affected by the business cycle, then the utility's stock price as a hedge would be detected in a zero or negative alpha. Also, if a sufficiently long pre-decoupling time period for observing returns and volatility is obtained, the change in the post-period should be detected as all of the post-decoupling period returns and volatilities are in a new business risk regime.

Data for the stock returns are the total monthly rates of return from the CRSP database from the University of Chicago. The pre-decoupling data reach back to all available monthly returns data in the CRSP and ends at December 2014 for consistency in the post-decoupling ending period for all utility stocks. Therefore, we include electric, electric and gas combination, and water utilities that were decoupled before 2014. The risk-free rate of return is the monthly Ibbotson income return on Long-Term US Treasury Securities {Morningstar (2015)}. We use this measure for the risk-free rate as it more closely matches the long-term horizon of stocks and excludes the added risk of capital gains or losses of long-term bonds. The CAPM beta data include all short-term betas available in the CRSP database and ends at 2014.

Table I presents the empirical results of the GCAPM estimates. The risk-premium-to-volatility slopes ("alpha") are shown along with the decoupling slope in the risk-premium and volatility equations for each electric, electric and gas combination, and water company stocks. The ticker symbols on the left are the stock symbols. We expect that the decoupling slope in the risk-premium equation would be negative as the risk premium should decline with a reduction in business risk. None of these slope estimates are statistically significant. The decoupling slope in the volatility equation should be negative. Two of the slopes are negative and significant at $p = 0.10$, yet the magnitudes of the slopes are very small.

All of the alphas for the energy utilities are positive and significant, yet none in the water utility group are significant. These results for the water group may indicate that they are business cycle hedging assets. The zero value for alpha implies that there is no relation between the business cycle as represented by expected changes in consumption and the return on water utility stocks. Water utility sales may not be correlated with the business cycle and real GDP as are electricity sales. Also, water use attrition is occurring across the US as households (water consumption per household is declining) use water efficient appliances (such as low-flow faucets and showerheads and efficient toilets) and change their water use habits to conserve water use.

Table II presents the pre- and post-decoupling changes in the systematic risk as represented by the short-term CAPM beta for all of the utility stocks. The betas drop after the implementation of decoupling but none of the changes in beta are statistically significant using a t-statistic at a $p = 0.05$. Additionally, the standard errors of the betas (σ_{pre} and σ_{post}) show no consistent pattern of increasing or decreasing after decoupling.

Our results do not show any statistically significant impacts of decoupling on the cost of common equity and risk. Therefore, we find no evidence to conclude that decoupling affects investor perceived risk or the cost of capital, i.e., investor required return. While electric and gas public utility stocks were not found to be business cycle hedges, we do find that water utility stocks may be business cycle hedges.

Our results are based on the moderate amount of data available to date. Although we would obviously prefer more data than we have at this juncture, there is no time to wait for a larger volume of data. Regulators have been and are implementing policy now as if decoupling does affect risk and the costs of capital when there is no evidence that it is. This paper serves as an early warning signal with the limited evidence that is available.

4. Conclusions and Policy Implications

We conclude that decoupling has no statistically measurable impact on the cost of common equity based on our empirical analysis for electric, electric and gas, and water utility stocks. Some researchers may view this result as a “non-result.” This is an important finding as it is consistent with the empirical findings of Vilbert, et. al. (2015, 2016). It is also important for policy globally as decoupling is being considered as a potential reducer to risk and the cost of capital by regulators in the US based in intuition and without any empirical evidence.

Moody's (2011) finds a reduction in business risk as measured by the change in the variability of gross profit after decoupling but did not estimate the impact on the cost of capital. Moody's (2011) did find that electric utilities were somewhat reluctant to adopt decoupling as electric utility executives anticipated that growth in sales would return to the industry after the steep recession where the business cycle trough occurred in June 2009 {NBER (2018)}. Since the US business cycle expansion post-June 2009, electricity sales have been almost flat, which may have caused the change in sentiment toward decoupling by electric utility executives. Growth in a utility's commodity sales above the level used to design regulated rates would increase the profit and rate of return on common equity. The US investor-owned electric utility industry also expected that the adoption of decoupling would cause state public utility regulators to reduce their allowed rate of return under the notion that it reduces risk. Moody's (2011) was written soon after the recession had ended but the anticipated growth in sales has yet not materialized over ten years into the US business cycle expansion. A few years later, the EEI found in a more recent report a change in sentiment {EEI (2015)} that electric utilities favor decoupling and that it has become more widespread across the US.

We conclude that decoupling has no statistically significant impact on investor perceived risk and the cost of common equity. This does not mean necessarily that decoupling has no impact on the risk and the cost of common equity of public utilities. We find that it cannot be isolated and estimated, given the many other factors affecting investor perceived risk for electric utilities. Some of these are flat or declining sales from customer-owned solar projects and energy efficiency resources; the requirement to buy back excess customer generated electric from such energy sources at full retail rates; requirements that a challenging proportion of a utility's sales are generated from renewable energy (known as renewable portfolio standards that have been adopted by many states and across Europe); increasingly stringent environmental regulations on coal plants; and the impact of falling low natural gas prices on the competitiveness of existing coal and nuclear plants.

Our results also show that the Croucher (2011) decoupling regulatory capture hypothesis may exist but is not a significant form of utility control to maximize profit. Our results also suggest the same for the buffering hypothesis. We cannot detect a signal in the cost of common equity capital or changes in risk due to decoupling.

For water utilities, we find that their stocks to be business cycle hedges. Since water utility sales are declining on a per capita basis and unassociated with the business cycle, decoupling does provide financial protection if water revenues decline. To the extent that there is positive growth in the number of water utility customers that offsets the declining per capita consumption, total revenues and sales may not be falling. The impact of decoupling on water utility investment risk and cost of common equity was not able to be detected in this study.

Another explanation for the lack of detection of a change in risk or the cost of common equity from decoupling is that whereas business risk may be allayed, other risks may be created with the implementation of decoupling and the net impact may not be clear as an increase or decrease in risk as Vilbert, et. al. (2015, 2016) concludes. They find that the implementation of decoupling is a new and alternative regulatory regime that may be a new source of regulatory risk for the utility.

Therefore, we do not recommend that public utility regulators in the US and globally reduce or increase authorized common equity cost rates following Wharton, et. al. (2015, 2016) in the presence of decoupling mechanisms based on the assumption of changed or reduced risk. The impact is *de minimis* and not statistically significant amongst all of the other investor perceived risk factors affecting the market prices of utility stocks. While an alternative research approach may attempt to isolate the impacts of these individual risk factors on the cost of capital and risk, decoupling does not have a major impact on risk or the cost of capital as we cannot detect a statistically significant impact of decoupling on the cost of capital or volatility in our approach without attempting to isolate the many other risk variable impacts. As a contrast, for example, the risk and cost of capital impact of owning nuclear power generation assets has a measureable impact on electric companies' cost of capital without attempting to isolate the myriad of other risk variable impacts. Hence, we find that no empirical justification to warrant a rate of return on common equity adjustment in regulatory rate proceedings. Therefore, decoupling as a regulatory policy mechanism to encourage public utilities to provide resources and funding to their consumers to conserve electricity, natural gas, and water (therefore also wastewater flows) has no *measurable* impact on the investment risk and the cost of common equity capital (either up or down). As a policy proscription, public utility regulators should not adjust the allowed rate of return and not affect the public utility’s rates as a spillover impact of using decoupling to promote environmental policy.

Finally, the US may be further ahead in rate mechanisms that address energy and water efficiency due to its long-term lag relative to Europe in the efficient use of energy and water and the recent “necessity-is-the-mother-of-invention” US driver of energy and water efficiency. Europe and regulators globally should go slow in adopting rate of return considerations as if decoupling affects risk as there is no evidence to date that it does.

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Table I
GCAPM Estimation Results[10]

Electric and Electric and Gas	$\boldsymbol{\alpha_i}$	$\boldsymbol{\alpha_D}$	$\boldsymbol{\beta_D}$
ED	1.460***	0.004	-0.000
PCG	1.781***	0.001	-0.001
EIX	1.379***	0.003	0.000
CHG	2.094***	0.004	-0.000
CMS	1.440***	0.011	-0.000
HE	1.607***	0.004	-0.000*
POR	0.461	0.010	-0.000
IDA	1.939***	0.003	-0.000
Water	$\boldsymbol{\alpha_i}$	$\boldsymbol{\alpha_D}$	$\boldsymbol{\beta_D}$
AWR	0.596	0.011	0.000
CWT	0.525	0.004	-0.000
CTWS	-1.008	0.009	0.000
ARTNA	3.006	-0.004	-0.002*

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[10] The GCAPM was estimated with the GARCH-M method. The estimated models are:

$$R_{i,t+1} - R_{f,t} = \alpha_{i,t}\sigma^2_{i,t+1} + \alpha_{i,D}D_{i,t} + \varepsilon_{i,t+1}$$
$$\sigma^2_{i,t+1} = \beta_0 + \beta_1\sigma^2_{i,t} + \beta_2\varepsilon^2_{i,t} + \eta_{i,t+1},$$

And

$$R_{i,t+1} - R_{f,t} = \alpha_{i,t}\sigma^2_{i,t+1} + \varepsilon_{i,t+1}$$
$$\sigma^2_{i,t+1} = \beta_0 + \beta_1\sigma^2_{i,t} + \beta_2\varepsilon^2_{i,t} + \beta_{i,D}D_{i,t} + \eta_{i,t+1}.$$

where *Ri* is the conditional total return on the stock, R_f is the risk-free rate of return, $\sigma^2_{i,\ t+1}$ is the conditional volatility, *D* is the dummy variable that equals 1 when decoupling is in place, and α_D and β_D are the slopes on the conditional returns and volatility decoupling dummy variable that represent the impact of decoupling on those variables. Monthly returns data are from the CRSP database and includes all data available from the CRSP database and ends at 12/2014. The monthly risk-free rate of return is the Ibbotson income return on Long-Term US Treasuries. ***, **, * refers to statistical significance at p values of 0.01, 0.05 and 0.10 respectively.

Table II

Changes in Systematic Risk from Decoupling[11]

Electric and Electric and Gas	**Mean β_{PRE}**	**Mean β_{POST}**	**σ (β_{PRE})**	**σ(β_{POST})**	**t-Statistic**
ED	0.608	0.427	0.172	0.064	-1.329
PCG	0.522	0.535	0.174	0.373	0.112
EIX	0.588	0.582	0.199	0.294	-0.051
CHG	0.680	0.401	0.279	0.326	-0.759
CMS	0.758	0.559	0.198	0.140	-0.815
HE	0.619	0.570	0.253	0.155	-0.171
POR	0.637	0.658	0.069	0.052	-0.151
IDA	0.905	0.728	0.251	0.125	-0.818
Mean	0.670	0.560			
Water	**Mean β_{PRE}**	**Mean β_{POST}**	**σ (β_{PRE})**	**σ(β_{POST})**	**t-Statistic**
AWR	0.975	0.623	0.535	0.279	-1.430
CWT	1.192	0.520	0.544	0.257	-2.735***
CTWS	0.664	0.502	0.235	0.176	-1.232
ARTNA	0.075	0.146	0.100	0.161	0.909
Mean	0.434	0.475			

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[11] Beta is the annual year-ending beta from the CRSP database. The data timeframe is different for each utility with an equal number of pre- and post-decoupling beta data observations for the specific stock in the CSRP database and ends in 2014. Each single beta was estimated with one year of daily rate of return data. ***, **, * refers to statistical significance at 0.01, 0.05, and 0.10 respectively.