



**New Approach to Estimating the Cost of Common Equity Capital for
Public Utilities**

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Abstract

The regulatory process for setting public utilities' allowed rate of return on common equity has generally used the Gordon DCF and CAPM specifications to estimate the cost of common equity. Despite the widely known problems with these models, there has been little movement to adopt more recently developed asset pricing models to provide additional evidence for estimating the cost of capital. This paper presents and empirically validates a general yet simple consumption-based asset pricing specification to model the risk-return relationship for public utility stocks that could be applied to provide additional information for estimating the cost of common equity and the allowed rate of return. Additionally, estimates of the model suggest whether an asset such as utility stocks are a consumption (business cycle) hedge.

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1. Introduction

The importance of issues involving public utility regulation is growing again as researchers and practitioners have concluded that deregulation in the electric and gas industries have failed to deliver on lower prices and cost. Electric and gas prices have risen faster than any time in their history after industry deregulation.

A critical component of the utility rate-of-return regulatory process is the estimation of the cost of common equity capital. Since the cost of common equity is not observable in capital markets, it must be inferred from asset pricing models. The models that are commonly applied in regulatory proceedings are the Gordon (1974) Discounted Cash Flow (DCF), the Capital Asset Pricing (CAPM) and Risk Premium Models. There are other tools used to estimate the cost of common equity such as comparable earnings or earnings-to-price ratios, but they are not asset pricing models. The empirical literature on the CAPM is vast {Fama and French (2004)}and the CAPM is used by a number of US regulatory jurisdictions. The DCF model has not been tested to the same extent as the CAPM yet it is considered by many US regulatory jurisdictions.

The purpose of this investigation is to present and empirically test a recently developed general consumption-based asset pricing model that estimates the risk-return relationship directly and, when estimated with recent time series methods, produces a prediction of the risk premium driven by its predicted volatility. The predicted risk premium could be added to a risk free rate of return to provide an estimate of the cost of common equity.

2. Risk Premium Approach, Consumption Asset Pricing Models, and GARCH¹

A widely used model to estimate the cost of common equity capital for public utilities is the risk premium approach. This approach often estimates the expected rate of return as the long-term historic mean of the realized risk premium above an historic yield plus the current yield of the relevant bond yield applicable to a specific utility or peer

¹ GARCH refers to the generalized autoregressive conditional heteroskedasticity regression model.

group of utilities. Litigants in public utility proceedings debate the choice of inputs to estimate the risk premium as well as how far back to reach into history to collect data to estimate a forward-looking premium.

It is surprising that, as popular as the risk premium method is in public utility rate cases, that the intuitively appealing general consumption-based asset pricing model, with its minimal assumptions, has not been applied to estimate the cost of common equity capital. The model provides projections of the conditional expected risk premium on an asset based on its relation to its predicted conditional volatility. This model generalizes the well known special case asset pricing models as the Merton (1973) intertemporal capital asset pricing model, Campbell (1993) intertemporal asset pricing model, and the habit-persistence model of Campbell and Cochrane (1999), which are special cases of the general model. The relation of the model to their specialized cases can be found in Cochrane (2006) and Cochrane (2007). The approach of consumption asset pricing models is to make investment decisions that maximize utility from the consumption that investors ultimately desire, not returns.

Even if the model is not used to directly project the expected risk premium, it can, at a minimum, be used to verify that the risk premia data for estimating the cost of capital is empirically validated by fitting the model. The general consumption-based asset pricing model developed in Michelfelder and Pilotte (2008) and based on Cochrane (2004) provides the relationship of the ex ante risk premium to an asset's own volatility in return:

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

where vol_t is the conditional volatility, $corr_t$ is the conditional correlation, and M_{t+1} is the stochastic discount factor (SDF). The SDF is the intertemporal marginal rate of substitution in consumption, or, $M_{t+1} = \beta \frac{U_{c,t+1}}{U_{c,t}}$, where the U_c 's are the marginal utilities of consumption in the next period, $t+1$, and the current period, t , and β is the discount factor. Equation 1 shows that the algebraic sign of the relation between the expected risk premium and its conditional volatility of an asset's return is determined by the correlation between the asset's return and the SDF. That is, the direction of the relation between the asset return and the ratio of intertemporal marginal utilities in consumption inversely determines the relation between the expected risk premium and conditional volatility. When the correlation is equal to negative one, the asset's conditional expected risk premium is perfectly positively correlated with its conditional volatility. A positive relation between the conditionally expected risk premium and volatility obtains when $-1 < corr_t < 0$. A negative relation obtains when $0 < corr_t < 1$. For an asset that represents a perfect hedge against shocks to the marginal utility of consumption, with $corr_t = 1$, there will be a perfect negative correlation between the conditionally expected risk premium and its volatility.² Therefore, estimates of the relation between the first two conditional moments of a public utility stock's returns provide a direct test of the effectiveness of a public utility stock, or any asset, as a consumption hedging asset. In equation 1, $vol_t[M_{t+1}]/E_t[M_{t+1}]$ is the slope of the mean-variance frontier. If this slope changes over time, the estimated relation between the stock's risk and return will vary over time. This

² A hedging asset is one that has a positive increase in returns that is coincident with a positive shock in the ratio of intertemporal marginal utilities of consumption. Note that if we assume a concave utility function in consumption, as consumption declines, the marginal utility of consumption rises relative to last period marginal utility. If we think of a decline in consumption as a contraction in the business cycle, the hedging asset delivers positive changes in returns when the business cycle is moving into a contraction, and therefore the asset is a business cycle hedge.

model can also be viewed simplistically as the projected expected risk premium as a function of its own projected risk, given information available at time t .

Note that the model allows for the expected risk premium to be negative if the asset hedges shocks to marginal utility of consumption. Investors are willing to accept an expected rate of return lower than the risk-free rate of return if the pattern of volatility is such that returns are expected to rise with expected reductions in consumption. Simply, investors are willing to *pay* a premium for a higher level of returns volatility that has the desired pattern of returns. These desired returns patterns have a tendency to offset drops in consumption. Therefore, this model shows that investors may not be adverse to volatility, but rather to the timing of expected changes in returns.

Summarizing, several conclusions can be drawn from the general model of asset pricing. First, the sign of the relation between a stock's excess return and conditional volatility depends on the extent to which the stock serves as an intertemporal hedge against shocks to the marginal utility of consumption. Second, the relation between stock risk and return may be time-varying depending on changes in the slope of the mean-variance frontier. Third, hedging assets have desired patterns of volatility that result in expected rates of return that are less than the risk-free rate. We do not expect that public utility stocks serve as a hedging asset as they are not viewed as a defensive stock (do not dampen downturns in the stock market returns) due to asymmetric regulation and returns as discussed in detail in Kolbe and Tye (1990). Under asymmetric regulation, utility regulators have a tendency to allow the return on equity to fall below the allowed return during downturns in the business cycle and to reduce the return when it rises above the allowed during expansions. Therefore we expect that the parameter estimate of the return-risk relationship to be positive as utility stocks are hypothesized to not be hedges.

We use the GARCH model to estimate the general asset pricing model since the GARCH model accommodates ARCH effects that results in the improvement of the efficiency of the parameter estimates. It also provides a volatility forecasting model for the conditional volatility of the asset's risk premium. The conditional volatility projection is used, in turn to predict the expected risk premium. We use the GARCH-in-Mean model (GARCH-M) since it specifies that the conditional expected risk premium is a linear function of its conditional volatility. There is a vast body of literature that estimates asset pricing models with the GARCH and GARCH-M methods and therefore we will not attempt to summarize them here.

The GARCH-M model was initially developed and tested by Engle, Lilein, and Robins (1987) to estimate the relationship between US Treasury and corporate bond risk premia and their expected volatilities. The GARCH-M model as specified for public utility stocks for this paper is:

$$R_{t+1} - Y_{t+1} = \alpha \sigma_{t+1}^2 + \varepsilon_{t+1} \quad (2)$$

$$\sigma_{t+1}^2 = \beta_0 + \beta_1 \sigma_t^2 + \beta_2 \varepsilon_t^2 + \eta_{t+1} \quad (3)$$

$$\varepsilon_t | \psi_{t-1} \sim T(0, \sigma_t^2) \quad (4)$$

Where:

R_{t+1} is the total return on the public utility stock index or individual utility stock, Y_{t+1} is the yield on an index of public utility bonds of a specified bond rating, σ_{t+1}^2 is the conditional or predicted variance of the risk premium that is conditioned on past information (ψ_{t-1}) and ε_t is the error term that is conditional on ψ_{t-1} . Alternatively, the risk-free rate could substitute the yield with the Fama-French specified risk-free rate (R_f),

which is the holding period return on a one-month US Treasury Bill. This return would be less relevant for public utility cost of common equity estimation in our application since we differentiate risk by the bond rating of an index of utility bonds . The conditional distribution of the error term is specified as the student's T distribution due to the thick-tailed distribution of the risk premia data. If the error distribution is thick-tailed, using an approximating distribution that accommodates thick tails improves the efficiency of the estimates. The parameter, α , is the return-to-risk coefficient as specified in equation (1) as:

$$\alpha = -\frac{vol_t[M_{t+1}]}{E_t[M_{t+1}]} corr_t[M_{t+1}, R_{i,t+1}] \quad (5)$$

Note that the coefficient will be positive if the conditional correlation between the SDF and the asset return is negative, indicating that the stock is not a hedging asset. Recall that the SDF is the ratio of intertemporal marginal utilities. Assuming a concave utility function, an upward shock in the ratio implies falling consumption, therefore an associated rise (positive correlation) in the return (R_i) would offset the reduction in consumption, thereby causing the sign of α to be negative. The parameter, α , is also the ratio of risk premium to variance, or, the Sharpe ratio.

The intercept in equation (2) is restricted to zero as specified by the general asset model specification. The restriction on the intercept equal to zero has been found to be robust in producing consistently positive and significant relationships between equity risk premia and risk in GARCH-M models. This is discussed in Lanne and Saikkonen (2006) and Lanne and Luoto (2007). Therefore we specify the prior assumption that the intercept, or, the risk premium not associated with risk to be equal to zero and drop the intercept from the model.

The consumption asset pricing model is estimated in the empirical section of the paper. The model is tested to determine, (1) if risk premium indices for utilities of differing risk specified by differing bond ratings are validated by the asset pricing model and therefore have some empirical support for application to utility cost of capital estimation, (2) empirically test the consumption asset pricing model, and (3) ascertain whether utility stocks are assets that hedge shocks to the marginal utility of consumption. If utility stocks are hedging assets then the cost of common equity should reflect a downward adjustment to a specified risk free rate to reflect investors' preferences for a hedge and the compensation that they are willing to pay for it.

3. Data and Empirical Results

We use portfolios as represented by public utility stock and bond indices to estimate the conditional return-risk relationship. The data employed for estimating equation 1 with the GARCH-M conditional return-risk regressions are monthly total returns on the Standard and Poor's Public Utilities Stock Index (utility portfolio), and the monthly Moody's Public Utility Aa, A, and Baa yields for the risk-free rate. We also obtained risk premia for the utility portfolio using the Fama-French specified risk free rate of return, which is the holding period return on a one-month US Treasury Bill. The data range from January 1928 to December 2007 with 960 observations. The return-risk relationships are risk-differentiated by their own bond rating.

As a check, we also estimate equation 1 with the GARCH-M for large common stock returns using the monthly Ibbotson Large Common Stocks Portfolio total returns and the Ibbotson US Long-Term Government income returns as the risk free rate for comparison. Additionally, as another check, we do the same for the University of Chicago's Center for Research in Security Prices value weighted stock index (CRSP)

using the Fama-French risk free rate. The data ranges from January 1926 to December 2007 with 984 observations for the Large Stock estimation and the data ranges from January 1928 to January 2007 with 960 observations (same as utilities) for the CRSP estimation.

Table 1 displays the descriptive statistics for these data. We have estimated the mean and standard deviation as well as the skewness, kurtosis, and Jarque-Bera (JB) statistics to test the distribution of the data. Note that the utility risk premia are returns net of bond yields of differing risk. The means of the risk premia fall as the risk (bond rating) declines. This is consistent with the notion that larger yields are subtracted from stocks returns the lower the bond rating. Intertemporally, there is an inverse relationship between risk premia and interest rates (See Brigham, Shome, and Vinson (1985) and Harris, Marston, Mishra, and O'Brien (2003)). The mean for risk premia will have a tendency to be larger during low interest rate periods.

Large common stocks not surprisingly have the highest mean as the majority of these firms are not rate-of-return regulated firms with a ceiling on their ROE's close to their cost of capital. Interestingly, the standard deviations of the utility stock returns are similar and slightly higher than large common stocks. Skewness coefficients are small and positive except for Ibbotson large common stock return and CRSP returns that have large positive skewness. This suggests that large unregulated stocks have a tendency to have more and larger positive shocks in returns than do utilities that are return regulated. The kurtosis values show that all of the risk premia are thick-tail distributed. This is also found in the significant JB statistics that test the null hypothesis that the data are normally distributed. The null hypothesis is rejected for all assets. The high kurtosis, low skewness, and significant JB statistics show that the risk premia data are substantially

thick-tailed, except for non-utility stocks that are both skewed and thick-tailed. Therefore, robust estimation methods are required to produce efficient regression estimates with non-normal data. Additionally, although not shown but available upon request, the serial correlation and ARCH Lagrange Multiplier tests show that residuals from OLS regressions of risk premia on volatilities follow an ARCH process. Therefore, the GARCH-M method will improve the efficiency of the estimates. We specify the regression error distribution as a student's T so that thick-tails could be accommodated in the estimation and therefore produce more efficient parameter estimates.

Table 2 shows the GARCH-M estimations for consumption asset pricing equation 1. We have estimated equation 1 for the utility stock returns using the Fama-French risk-free rate in addition to the risk differentiated bond yields. The chosen measure of volatility is the variance of risk premium. The slope, which is the predicted return-to-predicted risk coefficient and Sharpe ratio, is positive and significant at the 99% level for all assets except the utility stock returns with Baa bonds, which is significant at the 95% level. Given that all slopes are positive, public utility stocks are not found to hedge shocks to the marginal utility of consumption. Note that the reward-to-risk slope rises as bond rating rises. This suggests that lower risk utility stocks provide a higher incremental risk-premium for an increase in conditional volatility. This is consistent with other studies that find that lower risk assets, such as shorter maturity bonds, have higher Sharpe Ratios than long-term bonds and stocks. See Pilotte and Sterbenz (2006) and Michelfelder and Pilotte (2008).

The variance equation shows that all GARCH coefficients (β 's) are significant at the 1% level and the sums of β_1 and β_2 are close to but less than 1.0, indicating that the residuals of the return equation follow a GARCH process and that the persistence of a

volatility shock on required returns and prices for utility stocks is temporary. The estimates of the T distribution degrees of freedom parameter are low and significant, indicating that the residuals are well approximated by the T. Similar values for the log-likelihood functions (Log-L) show that each of the regressions have a similar goodness-of-fit. Chi-square distributed likelihood ratio tests (not shown but available upon request) that compare the goodness of fit among the T and normal specifications of the likelihood function of the GARCH-M regressions show that the T has a significantly better fit than the normal distribution.

The GARCH-M results for the large common stocks portfolio are similar to those of the utility stocks. Large common stocks do not hedge shocks to marginal utility, and volatility shocks temporarily affect their valuations. The exception is that the return-risk slope is substantially higher than the utility stocks. This is partially due to the risk-free nature of the risk-free rates used with the non-utility stock returns compared to the utility bond yields that reflect risk. The utility value of 2.1428 using the Fama-French risk-free rate compares with the higher CRSP value of 3.3873 that is also based on the Fama-French risk free rate. This is inconsistent with previous results herein and in other papers that find that Sharpe Ratios are lower for higher risk assets. However, similar model estimates of portfolios of common stocks yield unstable results, such as negative as well as positive return-risk slopes when the intercept is not restricted to zero. See Campbell (1987), Glosten, Jaganathan, and Runkle (1993), Harvey (2001), and Whitelaw (1994).

Stock market results are highly sensitive to empirical model specification. Many studies do not consider the impact of a zero-intercept prior restriction on the stability of their results. This simple innovation has led to more consistent results in modeling stock market risk-return relationships, and therefore we have included it in this paper.

The estimation of the consumption asset pricing model for utility stock risk premia shows that the use of bond-rating risk-differentiated utility stock risk premia are validated as their risk-return relationships are well-fitted by theoretical and empirical models of risk and return. Therefore, these data impound good representations of the risk and reward relationship.

One concern is the intertemporal stability of the alphas. Graph 1 plots the utility stock portfolio alpha (using the Fama-French R_f to calculate the premium) and its standard error for 240 month rolling regressions of the model with GARCH-M to review the intertemporal stability of the alpha. A 20 year period was used for each estimation to trade off timeliness with sufficient observation of up and down stock market regimes and business cycles. This resulted in 720 estimated alphas from 1947 to 2007. The results show that the utility alpha is stable to the extent that the algebraic sign is always positive and generally significant, therefore the nature of utility stocks are assets that are not and have never been hedges during the second half of the 20th century up to the present. The value of the alpha does change substantially. The mean of the alpha is 4.40 with a range from -0.11 (insignificantly different from 0) to 11.66. As a comparison, the alpha for the CRSP value-weighted stock index was also estimated with rolling regressions in the same manner and for the same time period. Graph 2 is a plot of the CRSP alpha and standard error. Note that the general stock market alpha is similar to that of utility stocks. They are all positive and almost all statistically significant and follow a strikingly similar cycle. Graph 3 plots both the utility and stock market alphas and demonstrates the similarity. The correlation coefficient between the utility and stock market alphas is 0.88. Recalling that the alpha is a Sharpe Ratio, we see that return to risk ratio does change substantially. This is consistent with the results in Pilotte and Sterbenz (2006).

One other interesting observation is that the standard errors of the volatilities are highly stable over the study period and are very similar in magnitude regardless of the size of the corresponding alpha. Whereas the alpha follows a cyclical pattern, the volatility in alpha is highly stationary around a constant, long-run mean.

The GARCH-M model estimations of the consumption asset pricing model were specified with variance as the measure of volatility. We also performed the same model estimations with alternative specifications of volatility such as the standard deviation and the log of variance and the results were not sensitive to this specification.

4. Conclusion

The purpose of this paper is to introduce and empirically test a general consumption based asset pricing model that is based on a minimum of assumptions and restrictions that can be used to predict the risk premium to be applied in estimating the cost of common equity for public utilities in regulatory proceedings. The results support the simple consumption-based asset pricing model that predicts the ex ante risk premium with a conditionally predicted volatility in risk premium. Therefore the model should be considered for providing additional evidence on the cost of common equity in general and specifically in public utility regulatory proceedings. Secondly, the use of bond-rated yields to predict risk differentiated equity risk premia is supported by the empirical evidence and therefore should be applied in estimating the cost of common equity. Finally, the robust empirical evidence on the positive risk-return relationship also shows that utility stocks are not a consumption hedge and are not good hedging securities against contractions in the economy. The model and estimation methodology presented

in this paper provides a relatively simple tool to determine whether any asset is a hedge to adverse changes in the business cycle through the level of consumption in the economy.

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Table 1
Descriptive Statistics: Public Utility and Large Common Stocks Equity Risk Premia

The public utility risk premia monthly time series is from January 1928 to December 2007 with 960 observations. The monthly time series for the Large Common Stocks is from January 1926 to December 2006 with 972 observations. The public utility stocks risk premia are calculated as the total return on the S&P Public Utilities Index of stocks minus the Moody's Public Utility AA, A, and Baa Indices yields to maturity. The Large Common Stock returns are the monthly total returns on the Ibbotson Large Common Stocks Portfolio. The bond yield is the Ibbotson Long-Term US Government Bonds Portfolio income yield. The Jarque-Bera (JB) statistic is a goodness-of-fit measure of the departure of the distribution of a data series from normality, based on the levels of skewness and excess kurtosis. The JB statistic is χ^2 distributed with 2 degrees of freedom. *** significant at 0.01 level, one-tailed test.

| Utility Bond Rating | Mean | Std. Dev. | Skewness | Kurtosis | JB |
|--|--------|-----------|----------|----------|------------|
| AA | 0.0037 | 0.0568 | 0.0744 | 10.07 | 2,001.2*** |
| A | 0.0035 | 0.0568 | 0.0632 | 10.06 | 1,991.8*** |
| Baa | 0.0031 | 0.0568 | 0.0375 | 10.02 | 1,973.6*** |
| Ibbotson Large Common Stocks | 0.0054 | 0.0554 | 0.4300 | 12.84 | 3,954.7*** |
| CRSP Value- Weighted Stock Index | 0.0062 | 0.0544 | 0.2309 | 10.92 | 2,519.1*** |

Table 2
Estimation of Return-Risk Relation: Public Utility and Large Common Stocks

The results below are the GARCH-in-Mean regressions for the common equity risk premium ($R_{t+1} - Y_{t+1}$) on the conditional variance of the risk premium (σ_{t+1}^2) in the mean equation. The intercept in the mean equation is restricted to be equal to zero. The risk premium is defined as the total return (R_{t+1}) on the S&P Public Utilities Stock Index minus the yield (Y_{t+1}) on the Moody's Public Utilities Bond Index for the specified bond rating. The data are range from January 1928 to December 2007 with 960 monthly observations and for Large Common Stocks from January 1926 to December 2006 with 972 observations. The public utility stocks risk premia are calculated as the total return on the S&P Public Utilities Index of stocks minus the Moody's Public Utility Aa, A, and Baa Indices yields to maturity. The Large Common Stock returns are the monthly total returns on the Ibbotson Large Common Stocks Portfolio and bond yield is the Ibbotson Long-Term US Government Bonds Portfolio income yield. An additional model specifies the yield as the Fama-French risk free rate that is the yield and monthly holding period return on a one-month US Treasury Bond. The estimated model is:

$$R_{t+1} - Y_{t+1} = \alpha \sigma_{t+1}^2 + \varepsilon_{t+1} \quad \text{where} \quad \alpha = -\frac{vol_t[M_{t+1}]}{E_t[M_{t+1}]} corr_t[M_{t+1}, R_{t+1}]$$

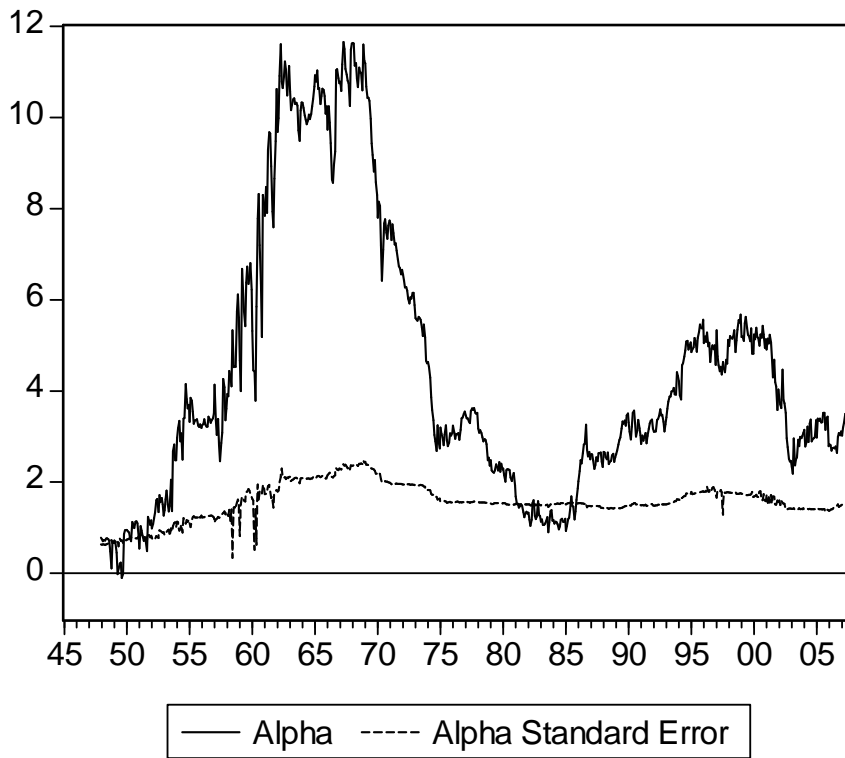
$$\sigma_{t+1}^2 = \beta_0 + \beta_1 \sigma_t^2 + \beta_2 \varepsilon_t^2 + \eta_{t+1}$$

The conditional distribution of the error term is the student's T to accommodate the kurtosis of the risk premia and error term. Standard errors are in parentheses. ***, **, * denote significance at the 0.01, 0.05, and 0.10 levels, respectively for two-tail tests.

| Utility Bond Rating | α | β_0 | β_1 | β_2 | Log-L | T Dist. D.F. |
|---------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|---------|-----------------------|
| AA | 1.5183*** (0.5308) | 0.0000** (0.0000) | 0.8791*** (0.0230) | 0.1031*** (0.0219) | 1,604.4 | 9.9254*** (3.0272) |
| A | 1.4536*** (0.5308) | 0.0000** (0.0000) | 0.8790*** (0.0230) | 0.1033*** (0.0220) | 1,605.0 | 9.9381*** (3.0408) |
| Baa | 1.3318** (0.5303) | 0.0000** (0.0000) | 0.8789*** (0.0229) | 0.1040*** (0.0220) | 1,605.2 | 10.0*** (3.0540) |
| Fama-French R_f | 2.1428*** (0.5318) | 0.0000** (0.0000) | 0.8811*** (0.0232) | 0.0979*** (0.0212) | 1,601.0 | 9.8773*** (2.9700) |
| Ibbotson Large Common Stocks | 2.7753*** (0.5513) | 0.0001*** (0.0000) | 0.8381*** (0.0269) | 0.1186*** (0.0332) | 1,620.8 | 8.8457*** (2.1613) |
| CRSP Value-Weighted Stock Index | 3.3873*** (0.5673) | 0.0001*** (0.0000) | 0.8330*** (0.0270) | 0.1149*** (0.0358) | 1,598.9 | 8.8571*** (1.9505) |

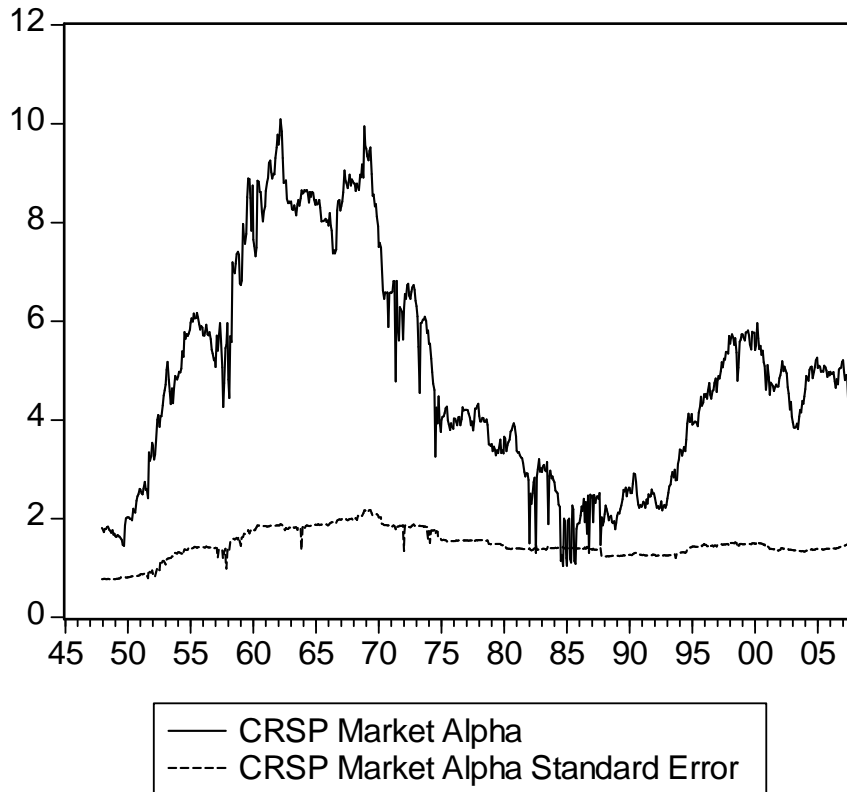
Graph 1

Rolling 240 Month Utility Stock Alphas 1947 – 2007



Graph 2

Rolling 240 Month CRSP Value-Weighted Stock Alphas 1947 – 2007



Graph 3

Rolling 240 Month CRSP and Utility Alphas 1947 – 2007

