THE JOURNAL OF FINANCE • VOL. XXXV, NO. 2 • MAY 1980

The Effect of Fuel Adjustment Clauses on the Systematic Risk and Market Values of Electric Utilities

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IN RECENT YEARS, the substantial increase in the price of energy[1] has resulted in financial problems for regulated electric utilities because prices have often increased faster than rates have been adjusted to charge consumers. In the presence of this regulatory lag, stockholders have had to absorb the difference between revenues and the unexpected increases in energy costs. In an effort to reduce the regulatory lag, many states have allowed regulated utilities to pass through increased costs of fuel automatically with the use of a fuel adjustment clause (FAC).[2] The clause typically allows the firm to adjust the price of electricity charged to consumers at frequent intervals whenever the price of fuel deviates from some fixed base price.[3]

This paper suggests that the use of the FAC tends to decrease the systematic risk of the firm and tests for the change in systematic risk. The basic results indicate that the use of the FAC in the early part of the 1970's reduced the systematic risk of electric utilities in general by approximately 10 percent. The decline in systematic risk was much greater for firms with a heavy dependence on oil and gas as a source of fuel than for firms with a heavy dependence on coal. The first section of the paper gives some justification for the change in systematic risk for the firm while the second section provides a framework for the empirical tests. The third section examines the residual returns for the group of firms able to use the FAC. The results indicate that actual returns to stockholders after the use of the FAC tended to be less than expected but this was due mainly to the fact that utilities as a whole had negative residuals returns. However, even after adjusting for these average negative residual returns, there appears to be little perceptible impact of the FAC on the value of the firms.

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[1] From the first quarter of 1970 to the first quarter of 1974, the U.S. Department of Labor's index of coal prices rose at an annual rate of 19 percent while oil prices rose at an annual rate of 30 percent. The Consumer Price Index rose at an annual rate of 6 percent during that same period.

[2] See [11] and [12] for a brief review of the history of fuel adjustment clauses. A number of authors have also discussed the legal ramifications of the clauses in [1], [3], [4], [9], and [13] relating to the automatic adjustments without a general rate hearing.

[3] The Federal Power Commission publishes the rate schedules for most private electric utilities in [10] which indicates the form of the fuel adjustment clause.

The Change in Systematic Risk

In [2], the model of a regulated firm with the ability to use the FAC is derived drawing on a valuation framework developed by Litzenberger and Grauer [5], which takes account of uncertain relative prices of commodities.

In this framework, the value of the firm is equal to

$$V = \frac{E(\pi I^{-1})}{R_r + \beta^*[E(R_m I^{-1}) - R_r]} \tag{1}$$

where $E(\pi I^{-1})$ is the expected real profit of the firm, I^{-1} is the price deflator related to uncertain future relative prices of commodities, R_r is the gross real riskless rate of interest, R_m is the gross return on the market and β^* is the real systematic risk of the firm. An equivalent way of writing equation (1) is

$$E(RI^{-1}) = R_r + \beta^*[E(R_m I^{-1}) - R_r] \tag{2}$$

indicating that the expected gross real return on the firm is equal to the real riskless rate plus a risk premium equal to the firm's real systematic risk times the real risk premium on the market. Under the assumption that the nominal return on the market is uncorrelated with the price deflator,[4] the relationship in equation (2) can be expressed in nominal terms as[5]

$$E(R) = \gamma R_n + \beta^*[E(R_m) - R_n] \tag{3}$$

where R_n is the gross nominal riskless rate of interest and γ is a constant specific to each individual firm.

As indicated previously, the FAC generally allows the firm to pass through changes in fuel prices to consumers more quickly than the firm could seek adequate rate relief through a full rate hearing since it is not uncommon for a full rate hearing to require a year or more before a decision is reached. The ability of the firm to pass through price changes quickly shifts some of the risk of fuel price changes from stockholders to consumers and tends to decrease the total risk of the firm. To the extent that changes in fuel prices are negatively correlated with

[4] Over the period of time covered by the study from January 1965 to January 1974, the nominal return on the market had a negative correlation with the change in the consumer price index of −0.14 but could not be distinguished as significantly different from zero at the 5 percent level.

[5] In [5], the relationship between the real and nominal rate of interest is shown to be

$$\frac{R_r}{R_n} = E(I^{-1})(1 + g)$$

where g is a constant related to the marginal utility of real wealth. From the definition of covariance, the expected real return on the market is given by

$$E(R_m I^{-1}) = E(R_m)E(I^{-1}) + \text{cov}(R_m, I^{-1}).$$

Substituting these expressions into that for the expected real return on the firm under the assumption that the nominal return on the market is uncorrelated with the price deflator gives

$$E(R) = \gamma R_n + \beta^*[E(R_m) - R_n]$$

where $\gamma = 1 + g(1 - \beta^*) - (1 + g)\text{cov}(R, I^{-1})/R_r$.

the return on the market, the use of the FAC will decrease not only the total risk of the firm but also decrease the firm's systematic risk.

The U.S. economy is highly energy dependent. Increases in the price of energy, particularly if they are due to influences from outside the country, would tend to increase the cost of production in this country and have a depressing effect on business activity and profitability. There is evidence that this was the case during the period of the early 1970's during which the FAC's were introduced. From 1970 to 1974, when most firms began to use the FAC fully, the change in oil and coal prices had a negative correlation with the overall market return of −.45 and −.30 respectively. Consequently, since the cost of fuel is a major component in determining the firm's profitability and since it is correlated with the return on the overall market, we would expect that the ability to shift the risk of adverse price changes in fuel to consumers would have an effect on the firm's systematic risk. Furthermore, since fuel price changes in recent years have been negatively correlated with the market's return, the ability to shift the risk of price changes to consumers should decrease the systematic risk of the firm.

In particular, if regulators hold expected real profits constant when the firm is allowed to use the FAC, the change in systematic risk for the firm is equal to[6]

$$\Delta\beta^* \equiv \beta^* - \bar{\beta}^* = \frac{-E(\pi I^{-1})\Delta V}{V\bar{V}[E(R_m I^{-1}) - R_r]} \tag{4}$$

where $\bar{\beta}$ and $\bar{V}$ represent the systematic risk and value of the firm before the use of the FAC. Consequently, the change in the firm's systematic risk is negative if the change in the value of the firm ΔV is positive when the firm is allowed to use the FAC. It is shown in [2] that in many cases the value of the firm will increase, resulting in a decrease in systematic risk.

Testing for the Change in Systematic Risk

The firms investigated in this study are large electric utilities whose stock has been traded on the New York Stock Exchange since at least 1965 for which it could be established that the firm was allowed to initiate the use of the clause or extend it to additional classes of customers sometime after January 1970. Many of the firms in the sample have been able to use the FAC with commercial or industrial customers for some time prior to 1970 but have only recently been able to extend the use of the clause to residential customers. For those firms undergoing a change in the use of the FAC the new customers covered by the clause contributed an average of 38.4 percent of the firm's revenues. There were 39 firms traded on the NYSE which could be identified with a change in the use of an FAC after January 1970. An additional group of 11 firms was also identified which have been able to use an FAC with all classes of customers since at least January 1965.

The measurement of the impact of the FAC on an individual firm's systematic

[6] Since the expected real profits of the firm are held constant, equating them before and after the use of the clause in equation (1) and solving for the change in systematic risk gives the desired expression.

risk during the early part of the 1970's is complicated by the fact that there were many other events occuring in the utility industry during that period of time which might obscure any impact of the use of the FAC. Consequently, any change in the systematic risk of the industry as a whole would make it difficult to distinguish between a change in the systematic risk of an individual firm due to the use of the FAC and changes due to other causes.

An alternative to estimating the change in systematic risk directly for each individual firm is to net out the average change in systematic risk from other sources by forming a hedge portfolio with a long position in firms that cannot use the FAC fully and a short position in firms that can use the clause. Holding these long and short positions would eliminate changes in systematic risk due to events common to the industry as a whole. By segregating firms based on their ability to use the FAC, the systematic risk of the hedge portfolio will measure the difference due to the FAC. Since the long position is taken in those firms expected to have a higher systematic risk, the systematic risk of the hedge portfolio should be positive if use of the clause does decrease the firms' systematic risk on average. If there were no significant difference between the systematic risk of the two groups, the systematic risk of this hedge portfolio would be equal to zero. The advantage of this formulation is that the estimation is not sensitive to the level of systematic risk for the industry as a whole. Only relative levels are measured. A shift in the level of systematic risk for the industry as a whole during the estimation period would distort the estimates for changes in the systematic risk of the individual firms. But as long as all firms in the industry move together as the risk of the industry changes, the difference in systematic risk between firms in the two groups would not change.

To form the hedge portfolio an equally weighted long position was taken in the firms which could not use the clause for all classes of customers before December 1970. As noted earlier there were an additional 11 firms identified that have been able to use the FAC fully since at least January 1965. An equally weighted short position was also taken in these firms each month from January 1965 to January 1974. A firm was switched from a long position to a short position in the month when it was announced by the state regulatory commission governing the firm that the clause would be extended to additional customers. The excess return on this hedge portfolio was regressed on the excess return on the market over the period to estimate the systematic risk of the hedge portfolio. There are 11 firms which start out in the short position and 39 firms that start out in the long position with most of them having switched to the short position by January 1974.

The first set of estimates in Table 1 are for the time period from January 1965 to January 1974. The second set of estimates are calculated for the period January 1970 to January 1974 to correspond to the time period when the switching first begins. Since the change in fuel prices has had a substantially greater negative correlation with the change in the market return after January 1970 than before,[7]

[7] In the 1965 to 1970 period the change in oil and coal prices had correlations with the market return of only .17 and −.04 respectively.

Table 1

Estimated Systematic Risk of the Hedge Portfolio Assuming Equal Weights

	Estimation Period	
	Jan 1965–Jan 1974	Jan 1970–Jan 1974
$\hat{\beta}$	0.005	0.060
t	(0.159)	(1.478)*

* Significant at the .10 level.

Table 2

Estimated Systematic Risk of the Hedge Portfolio Assuming Unequal Residual Variances

	Estimation Period	
	Jan 1965–Jan 1974	Jan 1970–Jan 1974
$\hat{\beta}$	0.002	0.063
t	(0.078)	(1.695)**

** Significant within the .05 level.

we would expect the difference in systematic risk to be greater during this later period as the following estimates suggest.

The null hypothesis is that the systematic risk of the hedge portfolio is equal to zero. This would imply that the use of the FAC makes no significant difference in the systematic risk of the firms. The results in Table 1 show that when the firms are weighted equally in each short and long position, the hedge portfolio has a systematic risk which is indistinguishable from zero over the period January 1965 to January 1974 since the t statistic is not significant within the 10 percent level.

The difference in systematic risk is much larger during the period January 1970 to January 1974 as expected. The hedge portfolio has a positive systematic risk which would be indicative of a decrease in risk for those firms that are able to fully use the FAC. The t statistic is significant at the 10 percent level for a one-tailed test.

Equally weighting each of the firms in the hedge portfolio may not give the most efficient estimate of the portfolio's systematic risk if firms have unequal variances of unsystematic returns. If the residuals are uncorrelated between firms, the estimate of the systematic risk can be minimized by weighting the firms in the hedge portfolio in proportion to the inverse of each firm's residual variance. Table 2 gives the comparable estimates to those in Table 1 when the firms are given these weights.

The reestimated results in Table 2 also indicate that the hedge portfolio has a systematic risk which is indistinguishable from zero over the period January 1965 to January 1974. The value of the estimate of the difference in systematic risk

Table 3

Estimated Systematic Risk of the Hedge Portfolio Assuming Cross Correlations

	Estimation Period	
	Jan 1965–Jan 1974	Jan 1970–Jan 1974
$\hat{\beta}$	0.002	0.061
t	(0.066)	(1.632)*

* Significant within the .10 level.

Table 4

Estimated Systematic Risk of the Hedge Portfolio Jan 1970–Jan 1974

Estimation Method	Coal	Oil and Gas
Equal Weights	.004	.233
	(.074)	(2.70)***
Unequal Residual	.052	.168
Variances	(.938)	(2.20)***
Cross Correlations	.055	.156
Estimated	(.99)	(2.02)**

** Significant at the .05 level
*** Significant at the .025 level

over the period January 1970 to January 1974 is now significant at the 5 percent level. Over this period of time the hedge portfolio again has a positive systematic risk indicating that firms without the full use of the FAC would have a greater systematic risk than they do after the full use of the clause.

Both of the previous weighting procedures are special cases of a more general weighting procedure. If the error terms for each firm are correlated, a more efficient estimate can be obtained by taking advantage of this correlation. These weights are calculated to minimize the variance of the estimate of the portfolio's systematic risk while the weights are constrained to sum to one and minus one for the firms held long and short respectively so that the combined weights sum to zero. Since the weighting is chosen to minimize the variance of the estimate of the portfolio's systematic risk, this procedure is equivalent to using generalized least squares to estimate the hedge portfolio's systematic risk.[8] With this weighting procedure the systematic risk of the hedge portfolio was estimated again. The residuals for the firms were assumed to be correlated contemporaneously with a common industry index. Moody's Index of 24 Utilities was used to estimate the cross sectional correlations for the firms. The results of this procedure are given in Table 3.

The estimate of systematic risk with this weighting procedure during the period January 1965 to January 1974 is again not significantly different from zero.

[8] See Johnston [6] for a discussion of this technique. To conserve space the derivation of these more general weights is not included here. The exact deviation which includes the special cases used in the paper can be obtained from the author.

During the later period the estimate is positive and significant at the 10 percent level for a one-tailed test.[9]

From these three estimation procedures, the evidence for the timing of the change in the use of the FAC suggests that extending the use of the clause to additional classes of customers has reduced the systematic risk of firms by approximately 0.06. The average level of systematic risk for these firms as of January 1970 before changes began to be made in the use of the FAC was 0.62. Consequently, extending the use of the clause to additional customers has decreased the systematic risk of these firms by approximately 10 percent of the initial level of systematic risk.[10]

However, the size of the change in systematic risk depends on the source of the firm's energy supply. Further testing indicates that those firms whose major source of fuel is oil or gas had a much greater change than those whose major source of fuel is coal. To test this, the fifty firms in the sample were identified as to the major source of fuel for power generation. There were twenty four firms whose major source of fuel is coal and fifteen firms whose major source is oil or gas.[11] The remaining eleven did not show a predominance of any one source of fuel.

The empirical tests were redone on these two subgroups by again forming a hedge portfolio and estimating the portfolio's systematic risk. Table 4 shows the results estimated over the 1970–1974 period using the same procedures as before. The numbers in parentheses are the *t*-values for the estimated systematic risk.

Notice that for the twenty-four firms using coal as a major source of fuel, the estimates of the change in systematic risk are all positive as expected but not significant within the .10 level. However, the estimated changes in systematic risk for the fifteen firms using oil and gas as a major fuel source are much larger and two of the three estimates are significant at the .025 level. These results suggest that the change in systematic risk detected for the fifty firms in the previous section is due in a large part to the influence of those using oil and gas as a source of fuel. The change in systematic risk for these firms has been sizeable, while the change for those using coal has not been as large. The average systematic risk as of January 1970 for the firms using oil or gas was .64, while

[9] Besides using the announcement date for each individual firm as the switching point between portfolios, we also tested for the change in systematic risk based on the announcement date for the first firm in the regulatory district which was allowed to use the FAC. This was done to test for any announcement effects on other firms in the state since if one firm was allowed to use the FAC, it might be expected that all firms in the state would eventually be able to. Estimates of the change in systematic risk were less significant in this case. For example, the estimate of the change in systematic risk during the period 1970–1974 using the full cross correlations was .044 with a *t*-statistic of 1.230. This would not be significant within the .10 level.

[10] This doesn't imply that the average systematic risk after the use of the clause should drop to .62 − .06 = .56. The systematic risk of the firms may have increased during this same period from other causes so that without the use of the FAC the systematic risk might rise to .68, but because of the FAC the firms' systematic risk might drop back to .68 − .06 = .62 giving the appearance that the risk hasn't changed. In actuality, the use of the FAC has allowed the firm to hold its risk close to its former level by shifting the change in systematic risk from fuel-related causes onto consumers.

[11] Coal supplied an average of 91 percent of the fuel needs of the 24 firms indentified as coal firms and oil or gas supplied an average of 65 percent of the fuel for the 15 firms identified as oil or gas.

that for the firms using coal was .60. A change in systematic risk of about .16 for the firms using oil or gas is approximately 25 percent of the initial level of systematic risk.

Investors' Residual Returns

A decrease in the firm's systematic risk resulting from the use of the FAC will decrease the firm's cost of equity if other things are held constant. If the firm's expected level of profit stays the same, the firm would suddenly offer a chance for investors to get the same expected return for less risk. In an efficient market, investors would bid up the price of the firm's shares until the expected return conformed to its corresponding risk. The sudden upward movement in the price of the firm's shares would result in a windfall gain to existing shareholders. In general, there is no reason to expect that this gain will actually come about. Regulators could capture much of this windfall gain for consumers and avoid a sudden increase in the value of the firm by appropriately adjusting the firm's allowed return downward at the same time the FAC is allowed to be used.

To test for any possible windfall gains we will examine the residual returns of stockholders where the residual return for firm i in period t is given by

$$\begin{aligned} u_{it} &= R_{it} - E(R_{it} \mid R_{mt}) \\ &= R_{it} - R_{zt} - \beta_i(R_{mt} - R_{zt}). \end{aligned} \tag{5}$$

The expected return on firm i in period t given a market return of R_{mt} is given by the zero-beta form of the CAPM where R_{zt} is the return on the zero-beta portfolio in period t.[12] The firm's beta is estimated by regressing the firm's actual return on the market return over the months following the use of the FAC but excluding the 12 months immediately following during which the residual returns will be calculated.

To examine these residuals, we define the cumulative average performance index for month k to be

$$\text{CAR}(k) = \frac{1}{N} \sum_{i=1}^{N} \sum_{m=t_i}^{t_i+k} u_{im}$$

where N is the number of firms whose residuals have been used in the index and t_i is the calendar month firm i can begin using the FAC. The CAR(k) shows the cumulative effects of the firms' average deviation from the normal market relaionship for k months after being able to use the FAC. If there are no windfall gains to investors after the use of the FAC, we would expect these residuals to be zero on average. Positive average residuals would indicate that investors received some windfall gain after the use of the FAC while negative average residuals would indicate that investors received a windfall loss.

Under the assumptions that monthly security rates of return are multivariate, normally distributed, and serially independent, a parametric significance test may

[12] I am grateful to Krishna Ramaswamy and Robert Litzenberger for providing the maximum likelihood estimates of the returns on the zero-beta portfolio in each period t from a previous study done by them in [8].

Table 5

Adjusted Cumulative Average Residual Returns For Months Following the FAC Adoption

Month	39 Total Firms		12 Oil & Gas Firms		18 Coal Firms	
k	CAR(k)	t	CAR(k)	t	CAR(k)	t
1	−.017	−1.93**	−.026	−1.85**	−.018	−1.35**
2	−.002	−0.12	.008	0.39	−.006	−0.30
3	−.008	−0.43	.015	0.61	−.013	−0.51
4	−.005	−0.21	.007	0.25	−.010	−0.33
5	−.019	−0.72	−.005	−0.16	−.037	−1.13
6	−.006	−0.20	−.004	−0.11	−.014	−0.38
7	−.015	−0.46	−.011	−0.26	−.028	−0.69
8	−.013	−0.36	−.008	−0.17	−.035	−0.79
9	−.021	−0.52	−.010	−0.21	−.038	−0.80
10	−.041	−0.95	−.020	−0.38	−.072	−1.40*
11	−.025	−0.53	−.018	−0.32	−.039	−0.71
12	−.018	−0.36	−.015	−0.25	−.022	−0.38

** Significant at the .05 level

* Significant at the .10 level

be applied to the CAR results.[13] In determining the sample errors associated with CAR(k) values, the time series properties of the residual rate of return estimates rather than those of the cross-sectional estimates are exploited. Under the assumptions that the marginal u_{im}'s are serially uncorrelated and have a stationary distribution over the study period,

$$\text{var}(\text{CAR}(k)) = \frac{1}{N^2} \sum_m \text{var}(\sum_i \delta_{im} u_{im})$$

where δ_{im} is a (0, 1) variable depending on whether the cumulative residuals for firm i span the period which includes month m. If month m falls within the k months following the month firm i is allowed to use the FAC, $\delta_{im} = 1$; otherwise, $\delta_{im} = 0$.

The residuals associated with equation (5) were unusually large and negative for all of the electric utilities. These cumulative residuals may not reflect the residual returns due just to the influence of the FAC because the residuals capture all of the other unsystematic influences surrounding the utility industry. During this period of time utilities were under tremendous financial pressures as a group and it is not surprising to see the substantial negative residual returns. To correct for these influences the previous residuals were adjusted by subtracting from each an amount due to the influence of the industry in general. The adjusted residuals were given by

$$\begin{aligned} e_{it} &= R_{it} - R_{zt} - \beta_i(R_{mt} - R_{zt}) - \beta_i^u R_{ut} \\ &= u_{it} - \beta_i^u R_{ut} \end{aligned} \tag{6}$$

where β_i^u is estimated by regressing the firm's return R_i on that of the market R_m

[13] These tests are similar to those used by Joy, Litzenberger and McEnally in [7].

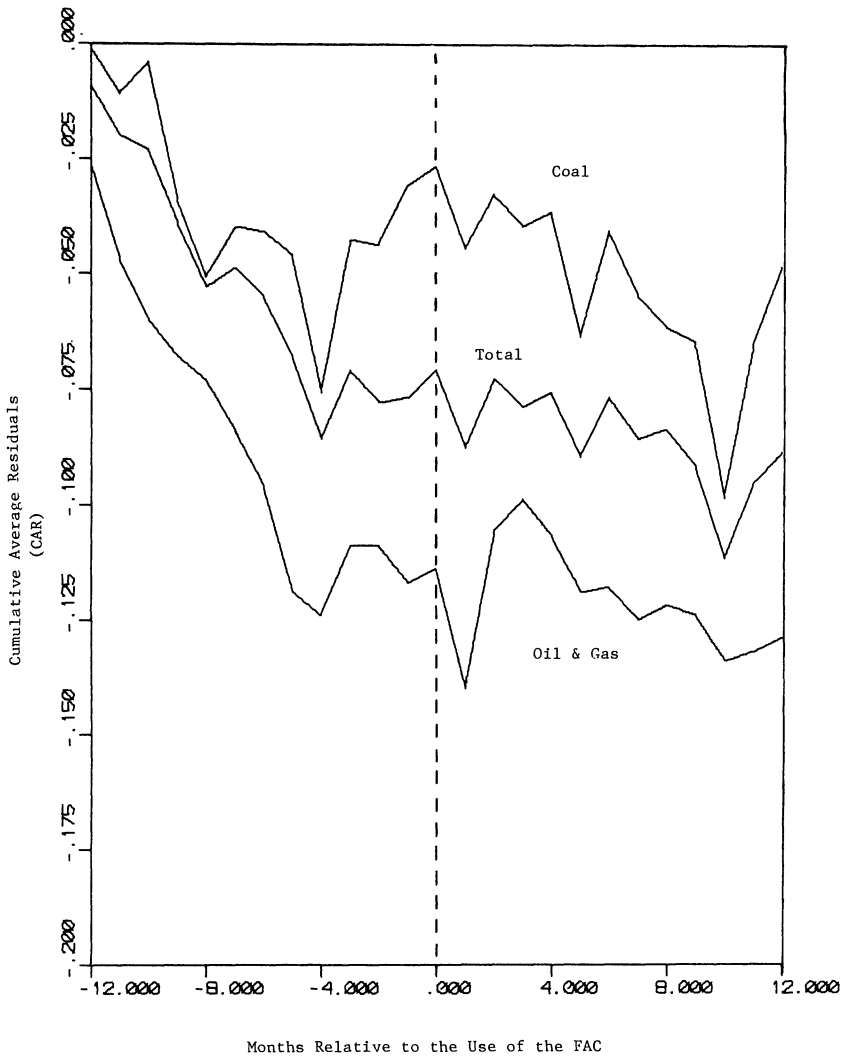

Figure 1. Cumulative Average Residuals Relative to the Use of the FAC

and on the return of Moody's index of 24 utilities R_u. The estimation was done covering the months following the use of the FAC but excluding the first 12 months immediately following. The cumulative average residuals with this adjustment to eliminate general industry influences are given in Table 5. The adjusted residuals are still predominately negative but they are uniformly less negative than before. They are also much less significant. This would indicate that investors probably received no windfall gains from the use of the FAC in the months following its adoption.

However, the market may have anticipated the use of the FAC before its adoption giving investors windfall gains prior to the month of the adoption. Figure 1 shows the cumulative average adjusted residuals for 12 months prior to

Table 6

Adjusted Cumulative Average Residual Returns For Months Prior to the FAC Adoption

Month	39 Total Firms		12 Oil & Gas Firms		18 Coal Firms	
k	CAR(k)	t	CAR(k)	t	CAR(k)	t
−3	.015	1.66*	.014	1.01	.033	2.56***
−2	.008	.57	.015	.74	.032	1.62*
−1	.009	.47	.006	.25	.045	1.81**
0	.015	.68	.009	.30	.049	1.69*

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .025 level

the adoption of the FAC and for 12 months following the adoption. In Figure 1 the cumulative average residuals appear to reverse themselves from their downward trend about 3 months before the adoption of the FAC indicating positive residual returns. These partial cumulative average residuals are given in Table 6 with their t values. For the entire sample of 39 firms and the 12 oil and gas firms the cumulative average residuals starting three months before the adoption of the FAC are positive but not significant. The residuals for the 18 coal firms are positive and significant indicating some positive residual returns during the months just prior to the adoption of the FAC.

Conclusions

The empirical results from the paper indicate that the use of the fuel adjustment clause by electric utilities in the early part of the 1970's did have an impact on these firms' systematic risk as expected. Based on 39 firms which were allowed to extend the use of the FAC to additional classes of customers after January 1970, the empirical results indicate that the use of the FAC decreased the systematic risk of these firms by .06 or approximately ten percent of the firms' initial systematic risk. Segregation of the firms by the major source of fuel indicates that the change in systematic risk for firms using oil or gas was much larger than the change for those firms using coal as a major source of fuel.

The ability of the firm to use the FAC essentially shifts risk from the stockholders of the firm onto consumers and speeds up the general ratemaking process. However, regulators do have to guard against windfall gains to shockholders when the clauses are allowed to be used. A reduction in the systematic risk of the firm would generally increase the firm's value resulting in windfall gains to stockholders unless the firm's allowed return is adjusted by regulators. In actual practice during the early 1970's, allowed returns generally lagged substantially behind expected market returns so that the use of the FAC may have relieved some of the financial pressure on utilities by allowing firms to shift much of the risk of fuel price increases to consumers.

From this study there is little evidence to support the hypothesis that the use of the fuel adjustment clauses generally resulted in windfall gains to stockholders.

Analysis of the residuals indicated a positive residual return in the three-month period just previous to the adoption of the FAC but these residuals were statistically different from zero for only the subset of 18 coal-fueled firms. The cumulative average residuals were not statistically significant for the subset of 12 oil or gas fueled firms.

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