Central Air Conditioners: An Analysis of the Relationship Between Cost and Efficiency

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Introduction

The cost of conservation or energy efficient technologies is crucial in evaluation of the cost effective of DSM programs and utility planning. It determines the cost effectiveness of DSM technologies from the Total Resource Cost perspective. It also is a major determinant of the penetration of programs. Unless the utility pay all the expenses of installing a technology, the more expensive the measure the less market penetration it is likely to achieve. The California Energy Commission in cooperation with California utilities is attempting to construct a database of the costs of DSM technologies as part of its Conservation Inventory project mandated by the California Legislature.

Evaluating the Quality of Measure Cost Data

The following is an evaluation of the estimates of costs prepared by Xenergy for the Energy Commission. One would expect that the cost data on air conditioners would exhibit certain traits. The data can be tested by determining if it exhibits the traits one would expect. One trait we would expect to see is that high efficiency air conditioners would cost more than standard efficiency air conditioners. The reasonableness of the data on central air conditioners can be evaluated by seeing if, other things the same, the cost of the high efficiency air conditioners exceeds that of standard efficiency air conditioners in their sample.

Approach

The plan was to estimate an equation relating the total cost of an air conditioner to its Seasonal Energy Efficiency Rating (SEER) rating from the Conservation Inventory data. Air conditioners differ in other ways than their SEER rating and it was desired to control for other factors that could affect the cost of the air conditioner. As a result, it was decided to include the capacity in tons and the SEER rating as a measure of efficiency of the air conditioner in the equation with cost as the dependent variable. This involves estimating a relationship of the following form:

$$CACC = A + b_1 SEER + B_2 Tons$$

where CACC = logarithm of the installed cost of a central air conditioner

SEER = logarithm of the SEER of the air conditioner

Tons = logarithm of the tons of cooling capacity of the air conditioner

The above relation of efficiency to technology cost of the air conditioner was estimated by linear regression using the CCIG data.

The variables used in the equation were logarithms because in this form the coefficients are elasticities of the right hand side variable to the left side variable, which is the cost of installing an air conditioner.

If $b_1 = .1$, then the cost of a SEER 11 central air conditioner is expected to be one percent higher than for a SEER 10 air conditioner.

The coefficient on SEER can be tested to see if the hypothesis that it is greater than zero can be rejected. If the hypothesis that it is greater than zero is rejected the data from Xenergy shows that more efficient air conditioners do not cost more than less efficient air conditioners. Such a rejection would suggest that the CCIG data is not reasonable as a representation of the cost of central air conditioners with different efficiencies.

Data

The data for central air conditioners was examined and sorted into groups of different capacities and SEER rating. The average costs for capacities of from 2 to 4 tons were computed for SEER ratings of 10 to 15. This resulted in a sample with 21 observation of average cost for each combination of SEER and tons of capacity as shown in Table 1.

Table 1. Central Air Conditioner Data

Level SEER	Sample Cost	Tons
10	1,540	2.0
11	2,387	2.0
12	2,291	2.0
13	2,346	2.0
15	5,324	2.0
11	2,499	2.5
12	4,071	2.5
13	2,144	2.5
10	1,787	2.5
11	2,663	3.0
12	3,360	3.0
13	4,142	3.0
10	2,178	3.0
11	3,893	3.5
12	3,684	3.5
13	2,270	3.5
10	2,191	3.5
11	2,926	4.0
12	4,157	4.0
13	3,400	4.0
10	2,421	4.0

Results

The logs of all the data were computed and the log of cost CACC was regressed against the logs of the independent variable. The results were:

$CACC = A + 1.86SEER + .47Tons$

T Value (3.96) (2.24)

R Squared = .5

The relationship this equation implies between cost and efficiency of air conditioners is shown in Figure 1 for three ton air conditioners. The line is the estimated relationship between cost and efficiency. The shaded bars are the plot of the actual averages of installed cost at different SEER levels we found plotted against SEER. Apparently our equation understates the additional cost associated with high efficiency air conditioners.

The results show that the cost of a central air conditioner increases by .47% for a 1% increase in capacity or tons and 1.86% for a 1% increase in efficiency or SEER. Also, the hypothesis that cost does not positively relate to efficiency is rejected by the data which suggests the data conforms with our expectations. There is less than a .5% chance that rejection of the hypothesis that cost falls with efficiency would be a type I error.

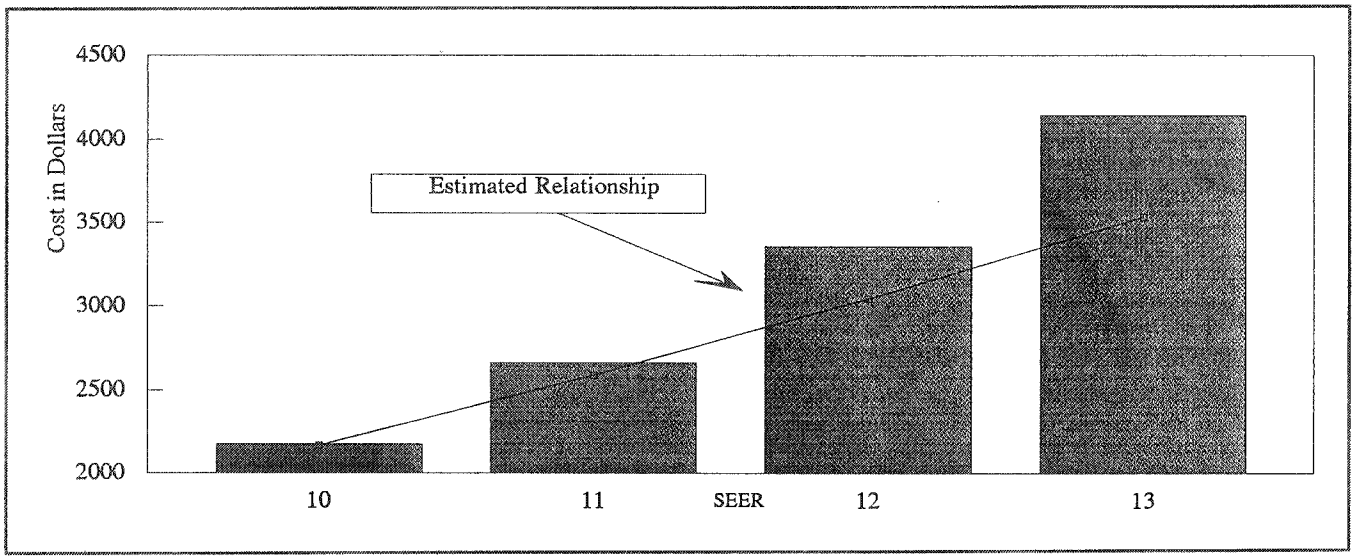

Figure 1. Three Ton Central Air Conditioner Costs at Different SEER Ratings