# More Bulb for the Buck? Verifying Ratepayer Value in an Upstream Lighting Program 

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#### Abstract

In 2014, Cadmus conducted an in-store shelf stocking study of 24 retail stores across two states: (1) a Program State, where an upstream residential lighting program is offered and (2) a Non-Program State, an adjacent state where no such program operates. We investigated whether the program influenced prices of efficient lighting products beyond the incentive amount specified in program contracts with participating retailers. For program lamps in the Program State, we compared the implied original package price (IOPP) - the observed price of the lamp, plus the program incentive - with the observed price of a lamp with the same model number and/or stock-keeping unit (SKU) sold by the same retailer in the Non-Program State.

We verified that retailers in the program state generally discounted eligible lamps in accordance with the program incentive contracts. However, we found that a substantial number of these discounted lamps had IOPPs higher than the prices of matching lamps in the Non-Program State. In contrast, retailers in both states nearly always sold program-ineligible lamps for the same price. When we compared the undiscounted lamp prices indicated in the incentive contracts with the observed prices of matching lamps in the NonProgram State, we found in many cases the latter prices were lower for the same lamps.

This paper describes Cadmus' sampling and analysis methodologies and examines potential drivers of the results. Our approach to comparative price research provides a critical perspective on administration of upstream lighting programs and illustrates the importance of monitoring pricing in these programs.


## Introduction

Cadmus conducted an in-store shelf stocking study in May and June 2014. Field staff visited retail stores in two states: one that had a statewide upstream residential lighting program and one that did not. The study compared pricing practices for lighting products and investigated the influence of the state's upstream lighting program on lamp pricing. Cadmus built upon experience conducting four previous in-store lighting studies in the same Program State to develop the sampling and analysis methodologies applied in this study. ${ }^{1}$

The study aimed to determine whether the upstream lighting program in the Program State was influencing lamp pricing beyond the dollar value of the incentive. If the program reduced prices commensurate with the incentive, then the observed price of a discounted lamp in the Program State, plus the value of the incentive, would equal the price for the same lamp sold by the same retailer in the NonProgram State. However, our previous studies in the Program State (which relied on an in-state sample of nonparticipating retailers) suggested that the program was further depressing prices beyond the incentive value. With the current study, Cadmus sought to determine whether the same effect was observed with a matched sample in a nonparticipating, neighboring state.

This paper details our findings regarding comparative lamp prices between stores located in the Program State and Non-Program State. It is organized into the following sections:

1. Sampling Methodology
${ }^{1}$ Cadmus conducted the previous lighting studies in October 2012, May 2013, September 2013, and February 2014.
2. Data Collection and Glossary
3. Lighting Sample Summary
4. Data Analysis and Results
5. Discussion of Findings

## Sampling Methodology

During Cadmus' previous in-store studies of the Program State's upstream lighting program, we compared results from program-participating retailers with a selection of nonparticipating retailers in the same state. As a part of this research, we investigated whether the program's effects on lamp prices might be greater than the incentive amount paid by utilities, which could indicate a possible program spillover effect. In these earlier studies, however, we encountered challenges in controlling for fundamental disparities between participating and nonparticipating retail samples due to widespread participation in the program by the most prevalent retailers. Consequently, for the current study, we visited stores in a neighboring state where statewide residential upstream lighting programs do not operate.

Cadmus selected the nonparticipating (Non-Program State) store sample to provide a set of neutral data for comparison with data collected at participating stores in the Program State. We matched the stores on several social and economic characteristics to improve comparability of Program State and Non-Program State samples. In both states, we visited stores from the same retailers, which allowed direct price comparisons for like samples of lamps. This removed the need to control for variations in pricing and stocking strategies between different participating and nonparticipating retailers.

Cadmus developed two samples, each of 12 stores, across the Program and Non-Program states. For the Program State sample, we used utility-provided program lamp sales data to identify the five retailers selling the greatest number of program lamps. Cumulatively, these retailers accounted for at least $92 \%$ of all program lamp sales from June 1, 2013, through May 31, 2014. Table 1 shows the distribution of program lamp sales among the chosen retailers.

Table 1. Distribution of Program Lamp Sales Among Retailers

| Store | Distribution Channel | Number of Program <br> Lamps Sold* | Percent of Total <br> Program Lamp <br> Sales |
| :--- | :--- | :---: | :---: |
| Retailer 1 | Home Improvement | $2,713,512$ | $40 \%$ |
| Retailer 2 | Warehouse | $1,432,934$ | $21 \%$ |
| Retailer 3 | Warehouse | 592,383 | $9 \%$ |
| Retailer 4 | Mass Merchandising | $1,154,581$ | $17 \%$ |
| Retailer 5 | Home Improvement | 338,117 | $5 \%$ |
| Other/Unknown Retailers | N/A | 546,525 | $8 \%$ |
| Total | N/A | $\mathbf{6 , 7 7 8 , 0 5 2}$ | $\mathbf{1 0 0 \%}$ |
| *These data reflect invoiced sales of program lamps from June 1, 2013, through May 31,2014. |  |  |  |

Cadmus visited two or three stores from each retailer in each state. We stratified the Program State store sample design by population density and then selected stores randomly. The Program State is served by several investor-owned utilities (IOUs), and while we sought to represent all of these IOUs with at least one store, we did not stratify the sample by utility to improve randomization of the sample. Based on prior conversations with the program implementer, we expected prices to be set at the corporate retail level and not to vary significantly between stores from the same retailer. Table 2 shows the distribution of the store sample in the Program and Non-Program states.

Table 2. Retailer Distribution of Store Samples

| Retailer | Distribution Channel | Program State <br> Sample | Non-Program State <br> Sample |
| :--- | :--- | :---: | :---: |
| Retailer 1 | Home Improvement | 2 | 2 |
| Retailer 2 | Warehouse | 2 | 2 |
| Retailer 3 | Warehouse | 2 | 2 |
| Retailer 4 | Mass Merchandising | 3 | 3 |
| Retailer 5 | Home Improvement | 3 | 3 |
| Total |  | $\mathbf{1 2}$ | $\mathbf{1 2}$ |

We determined Program State population densities for all counties using 2010 U.S. Census figures and assigned each county to one of three categories: rural, suburban/exurban, or urban. Natural breaks in the Program State county-level population density data, with a similar number of counties in each section, provided cutoff points for each of these categories. Using this approach, we classified the categories using the following definitions:

- Rural: All areas with fewer than 250 people per square mile, on average.
- Suburbun/Exurban: Areas with fewer than 1,000 people per square mile, on average.
- Urban: Areas with equal to or greater than 1,000 people per square mile, on average.

The initial Non-Program State store population included all stores in the five retailers presented in Table 1. We excluded stores in counties immediately bordering the Program State (to prevent nonparticipant spillover from affecting the results), as well as stores in the most distant counties (to avoid prohibitive travel times for field staff).

As previously mentioned, we sought to design a Non-Program store sample directly comparable to that selected for the Program State. We aligned the two store samples by matching the following characteristics:

- Population density within a 10 -mile radius ${ }^{2}$
- Median household incomes within a 10 -mile radius ${ }^{3}$
- 2012 presidential voting records at the county level ${ }^{4}$
- Estimated store sizes, based on satellite views (where notable variations occurred in store sizes)

We mapped the Non-Program State store sample to the Program State sample using a form of nearest-neighbor matching to improve the comparability of participating and nonparticipating samples. For each store, we calculated z-scores ${ }^{5}$ for each characteristic named above, which normalized the values for these parameters. We selected a Non-Program State store to match each Program State store by minimizing the Euclidian distance ${ }^{6}$ between the z-score for each Program State store and the z-scores for all NonProgram State stores from that retailer.

Seven of the 12 stores in the original Non-Program State store sample (including at least one store from each of the five retailers) turned away our field staff. In large part, this was because of managers' concerns about corporate policy and approval. ${ }^{7}$ Consequently, we adjusted this sample, which produced a

[^0]final Non-Program State store sample that-while still mapped to the Program State sample-did not correspond as closely to the Program State stores as the original sample.

## Data Collection and Glossary

Cadmus investigated four types of residential lighting technologies: CFLs, LEDs, A-series halogen lamps, and A-series standard incandescent lamps between 40 watts and 100 watts. For all lamps observed within these four categories, field staff collected detailed price and lamp characteristics including shape, base type, wattage, lumen output, color, lifetime, and a number of other attributes.

In discussing the study methodology and analysis, we define key terms as follows:

- SKU: Package of lamps with a unique SKU and/or model number at a given store.
- Lamp Pack: Individual package or set of lamps.
- Lamp: Individual lamp with a unique SKU/model number and store.
- Program Lamp, Lamp Pack, or SKU: Lamp, lamp pack, or SKU offered in a participating Program State store and listed on the appropriate utility-retailer contract specifying program buydowns.
- Program-Equivalent Lamp, Lamp Pack, or SKU: Lamp, lamp pack, or SKU offered in a NonProgram State store and listed on a Program State utility-retailer contract for the appropriate retailer.


## Lighting Sample Summary

Cadmus field staff recorded 2,620 lamp SKUs for all lighting products. Figure 1 illustrates the distribution of the dataset across technology types.


Figure 1. Key Characteristics of Data Collected in the Study
We sought to characterize systematic pricing differences among lamps at Program State and Non-Program State stores and, specifically, among lamps discounted through the program and their equivalents at non-program stores in the comparison state. To control for potential store-to-store differences in lamp availability, and to supply directly matching samples of lamps in both states, we restricted our analysis to lamp SKUs offered by the same retailers in both sets of stores. Table 3 lists the reduced sample, which includes approximately $82 \%$ of all SKUs observed in the Program State and approximately $92 \%$ of all SKUs observed in the Non-Program State.

Table 3. Matched Sample Summary*

| Characteristic | Program State SKUs | Non-Program State SKUs |
| :--- | ---: | ---: |
| Program or Program-Equivalent SKUs, Matched Between Store Sets |  |  |
| Lamp SKUs Recorded | 330 | 393 |
| Incandescent | 0 | 0 |
| Halogen | 0 | 0 |
| CFL | 255 | 289 |
| LED | 75 | 104 |
| Non-Program and Non-Program-Equivalent SKUs, Matched Between Store Sets |  |  |
| Lamp SKUs Recorded | 782 |  |
| Incandescent | 45 | 759 |
| Halogen | 121 | 56 |
| CFL | 370 | 134 |
| LED | 246 | 352 |

* Variation within the numbers of matching SKUs offered at stores in the Program and Non-Program state is expected since the field staff visited multiple stores per retailer in both states. As a result, SKUs may not have been offered at the same number of a given retailer's stores in both states, which led to more matched SKUs in one state than in the other.


## Data Analysis and Results

## Program State Implied Original Pack Price Compared to Base Contract Price

In comparing prices between the Program and Non-Program states, Cadmus defined the IOPP as the observed shelf price of Program State lamp packs eligible under the upstream lighting program, with the amount of the buydown value added to infer the original, undiscounted price. To verify program implementation, Cadmus compared this IOPP to the base price provided on each utility-retailer contract. ${ }^{8}$ Through this comparison, we sought to determine if inconsistencies in program implementation were present (that is, packs being undiscounted or under-discounted in stores) or if packs were discounted against a higher base price than that contractually specified. ${ }^{9}$

As shown in Table 4, retailers discounted $67 \%$ to $97 \%$ of program SKUs by the exact amount of the incentive when compared to the base price provided in the utility-retailer contracts. Less than $10 \%$ of lamps showed evidence of buydown implementation not aligning with the utility-retailer contracts, where the listed shelf price of these SKUs exceeded that recommended on the contracts. In fact, program lamp prices averaged lower than recommended discount prices for all retailers.

[^1]Table 4. Comparison of Program State Implied Original Pack Prices and Contract-Specified Base Prices

|  | Program SKUs in the Program State* |  |  |  | Average <br> Retailer |
| :--- | ---: | ---: | ---: | ---: | ---: |
|  | Count | IOPP Matches <br> Contract Base- <br> Price | IOPP Higher <br> than Contract <br> Base-Price | IOPP Lower than <br> Contract Base- <br> Price | Difference from <br> Contract Base <br> Pack Price** |
| Retailer 1 | 106 | $82(77 \%)$ | $10(9 \%)$ | $14(13 \%)$ | $\$(0.08)$ |
| Retailer 2 | 15 | $12(80 \%)$ | $1(7 \%)$ | $2(13 \%)$ | $\$(0.15)$ |
| Retailer 3 | 9 | $6(67 \%)$ | $0(0 \%)$ | $3(33 \%)$ | $\$(0.68)$ |
| Retailer 4 | 169 | $112(66 \%)$ | $11(7 \%)$ | $46(27 \%)$ | $\$(0.44)$ |
| Retailer 5 | 31 | $30(97 \%)$ | $0(0 \%)$ | $1(3 \%)$ | $<\$(0.01)$ |

*Excludes SKUs without a price labeled on the shelf. Restricted to SKUs present in both states.
**Includes price differences of zero in the averaging process.

## Price Comparisons of Lamps in Program and Non-Program States

To analyze program performance relative to a neutral reference group, Cadmus compared prices for program and non-program lamp SKUs in the Program State with their counterparts in the Non-Program State. For program SKUs (that is, lamp packs for which retailers, in agreement with utilities, applied a buydown to reduce the price), we referred to the utility-retailer contract supplied by each participating utility to determine the monetary value of the SKU's buydown. We added this buydown amount to the observed shelf price to arrive at the IOPP. We then compared this value with the price of matching SKUs in the NonProgram State. For non-program SKUs in the Program State, where the program does not apply a buydown, we directly compared shelf prices with the respective SKUs in the Non-Program State.

For each Program State SKU, Cadmus classified the results of the comparisons into the following categories:

- Price Equality: After inferring the original pack price by adding program buydowns to observed pack prices, Program State prices equaled the prices of identical packs in the Non-Program State.
- Higher IOPP/Price: After inferring the original pack price by adding program buydowns to observed pack prices, Program State prices were greater than the prices of identical packs in the Non-Program State.
- Lower IOPP/Price: After inferring the original pack price by adding program buydowns to observed pack prices, Program State prices were less than the prices of identical packs in the Non-Program State.
When compared to its Non-Program State equivalent SKU or SKUs, each Program State SKU was characterized by the proportion of matching SKUs showing evidence of each of the three price relationships (price equality, higher Program State price, or lower Program State price). ${ }^{10,{ }^{11}}$ We aggregated the SKU count showing evidence of each price effect to reflect the prevalence of that pricing trend in the sample.

Retailer Price Comparisons. Cadmus compared the frequency of equal, higher, and lower Program State IOPPs between the program and non-program SKU datasets, as shown in Figure 2Error! Reference

[^2]source not found.. The Program State SKUs consistently had higher pack prices among program lamps than among non-program lamps, which suggests a program-related effect.


Figure 2. Comparison of Program State IOPPs and Prices with Non-Program State Prices, Program and Non-Program Lamps - Retailers

Table 5 summarizes the results of Cadmus' investigation into price differences between program lamps offered at Program State and Non-Program State stores. ${ }^{12}$

Table 5. Price Comparison of Program Lamp SKUs by Retailer*

| Retailer | Program State <br> SKUs with <br> Non-Program <br> State <br> Match(es) | Equal IOPPs | Higher <br> Program State IOPP | Lower Program State IOPP | Average <br> Pack Price <br> Difference <br> Where <br> Higher | Average Pack Price Difference Where Lower |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Retailer 1 | 106 | 33.5 (32\%) | 60.5 (57\%) | 12 (11\%) | \$1.10 | \$(1.93) |
| Retailer 2 | 15 | 10.5 (70\%) | 4.5 (30\%) | 0 (0\%) | \$1.52 | N/A |
| Retailer 3 | 9 | 2 (22\%) | 5 (56\%) | 2 (22\%) | \$1.00 | \$(1.70) |
| Retailer 4 | 169 | 32.3 (19\%) | 129.4 (77\%) | 7.3 (4\%) | \$0.76 | \$(3.00) |
| Retailer 5 | 31 | 20.2 (65\%) | 8.6 (28\%) | 2.3 (7\%) | \$3.95 | \$(4.34) |

*As discussed in footnote [11], partial SKU counts may occur where a SKU is matched at multiple stores in the Non-Program State at different price points.

We observed substantial variations in the distribution of price relationships (that is, price equality, higher Program State prices, and lower Program State prices) across all five retailers. Nevertheless, each retailer indicated a relatively high percentage of SKUs ( 28 to 77\%) that were found to have a higher IOPP in

[^3]the Program State than the price observed in the Non-Program State. For four of the five retailers sampled, a percentage of SKUs exhibited lower IOPPs in the Program State than in the Non-Program State, demonstrating a reduction in Program State prices beyond that expected from the utility contracts. This effect, however, occurred less commonly than price equality or higher Program State IOPPs, indicating program participation did not result in widespread reductions of pack prices beyond the buydown level.

The observations shown in Table 5 contrast with the corresponding results for non-program SKUs sold in the Program State and their equivalents in the Non-Program State, shown in Table 6. A larger percentage of matched SKUs among non-program lamps showed price equality.

Table 6. Price Comparison of Non-Program Lamp SKUs*

|  | Program <br> State SKUs <br> with Non- <br> Program <br> State <br> Match(es) |  | Equal Prices |  | Higher <br> Program <br> State Price | Lower <br> Program <br> State <br> Price |
| :--- | :---: | ---: | ---: | ---: | ---: | ---: |
| Retailer | 169 | Average <br> Pack Price <br> Difference <br> Where <br> Higher | Average <br> Pack Price <br> Difference <br> Where <br> Lower |  |  |  |
| Retailer 1 | 2 | $2(100 \%)$ | $0.7(77 \%)$ | $22.5(13.3 \%)$ | $15.8(9 \%)$ | $\$ 1.33$ |
| Retailer 2 | 6 | $4(67 \%)$ | $1(17 \%)$ | $0(0 \%)$ | N/A | $\$(2.87)$ |
| Retailer 3 | 237 | $218.2(92 \%)$ | $11.7(5 \%)$ | $7.2(3 \%)$ | $\$ 1.00$ | $\$(6.00)$ |
| Retailer 4 | 368 | $332.2(90 \%)$ | $18.2(5 \%)$ | $17.5(5 \%)$ | $\$ 2.28$ | $\$(1.28)$ |
| Retailer 5 |  |  |  | $\$ 1.88$ | $\$(2.04)$ |  |

*As discussed in footnote [11], partial SKU counts may occur where a SKU is matched at multiple stores in the Non-Program State at different price points.

These lamps consistently had high percentages of SKUs with equivalent prices ( $67 \%$ to $100 \%$ ), which indicated a large proportion of non-program SKUs priced identically in both states. Those with nonmatching prices did not show a strong tendency toward higher or lower Program State prices with respect to comparable Non-Program State SKUs.

Manufacturer Price Comparisons. As the utility-retailer contracts are specific to manufacturer, we compared Program State IOPPs with Non-Program State base prices for the five manufacturers whose products were most frequently observed (Figure 3). We observed wide variations between manufacturers in the percentage of Program State SKUs demonstrating higher, lower, or equal IOPPs when compared with the Non-Program State retail baseline. Several manufacturers demonstrated consistency in pricing of program and non-program lamps; however, for the two most common manufacturers (Manufacturer $1^{13}$ and Manufacturer 2), we observed Program State IOPPs exceeding their counterparts in the Non-Program State for the majority of program SKUs recorded. As these two manufacturers account for $82 \%$ of program lamp SKUs and $81 \%$ of non-program lamp SKUs in the Program State, they drive the results detailed above.

[^4]

Figure 3. Comparison of Program State IOPPs and Prices with Non-Program State Prices, Program and Non-Program Lamps - Manufacturers

## Net Price Effects

To summarize the differences between Program State and Non-Program State lamp prices, Cadmus calculated a net price difference between comparable lamp samples at retailers in each state. This net price effect (shown in Equation 1) reflects the weighted average of the price differences, whether higher or lower, in the prices of like SKUs. (Note: this is a SKU-weighted net effect, not a sales-weighted net effect.)

Equation 1. Net Price Effect on Program State SKUs Relative to Matched Non-Program State SKUs
Net Price Effect
$=(\%$ Higher Program State IOPP $\times$ Average Price Difference where Higher $)$

+ (\% Lower Program State IOPP $\times$ Average Price Difference where Lower)
A negative price difference indicates a lower Program State price, while a positive price difference indicates a higher Program State price.

As shown in Table 7, we observed a positive net price effect for program lamps sold by all retailers; this implies that, on average, pack prices of program lamps at participating Program State stores did not account for the full value of the buydown amount relative to the neutral matching sample in the Non-Program State.

By contrast, net price effects observed for non-program lamps varied noticeably between retailers, and were not uniformly positive or negative. Net price effects were, however, relatively low:
for four of the five retailers, the net price effect was less than 10 cents in magnitude, with the remaining retailer strongly influenced by a small sample of matching SKUs.

Table 7. Net Price Effects on Lamp SKUs

|  | Program Lamp SKUs |  | Non-Program Lamp SKUs |  |
| :--- | ---: | ---: | ---: | ---: |
| Retailer | Program State SKUs <br> with Non-Program <br> State Match(es) | Net Pack Price <br> Effect | Program State SKUs <br> with Non-Program <br> State Match(es) | Net Pack Price <br> Effect |
| Retailer 1 | 106 | $\$ 0.41$ | 169 | $\$(0.09)$ |
| Retailer 2 | 15 | $\$ 0.46$ | 2 | $\$ 0.00$ |
| Retailer 3 | 9 | $\$ 0.18$ | 6 | $\$(0.83)$ |
| Retailer 4 | 169 | $\$ 0.46$ | 237 | $\$ 0.07$ |
| Retailer 5 | 31 | $\$ 0.78$ | 368 | $<\$(0.01)$ |

The disparity between price effects observed for program and non-program lamps provides further support for our investigation into program-related factors that might underlie such differences.

## Appropriate Baseline Price: Retail and Contract Baselines

In addition to comparing Program State IOPPs with the base pack prices listed on the retailerutility contracts, Cadmus compared the prices of Non-Program State program-equivalent lamps (that is, Non-Program State lamps with SKUs appearing on the appropriate Program State utility contracts) with the original pack prices listed in these contracts. From the verification analysis shown in Table 9, we determined that the rate at which Program State prices were higher than Non-Program State prices could not be explained by unexpected or inconsistent application of program buydowns.

Therefore, we sought to determine the extent to which higher Program State prices might be caused by disparities between the baseline in the utility-retailer contracts and the retail baseline defined by the Non-Program State sample. Similar to the comparison shown in Table 4 between observed program lamp IOPPs and the corresponding contract base-prices, we compared pack prices observed in Non-Program State stores with the program contract base-price for the same SKU.

To determine the contract base price for program-equivalent SKUs observed in the Non-Program State, we averaged the base price listed on all utility contracts for a given SKU sold by a given retailer. Where the Non-Program State pack price matched one but not all utility contracts, we assumed the contract base price equaled the Non-Program State pack price. This assumption avoided penalizing or rewarding Non-Program State retailers based on differences between utility-retailer contracts in the Program State. ${ }^{14}$

Figure 4 presents these analysis results, which indicate a Non-Program State retail baseline consistently and substantially below the baseline defined by the Program State utility-retailer contracts. Each of the five retailers in the Non-Program State priced more than one-quarter of program-equivalent SKUs below the base price cited in the contracts with the Program State IOUs, with the magnitude of this price difference ranging from a $\$ 0.47$ to $\$ 0.96$ reduction per SKU .

[^5]2015 International Energy Program Evaluation Conference, Long Beach


Figure 4. Comparison of Non-Program State Pack Prices and Contract-Specified Base Prices for Equivalent SKUs

## Discussion of Findings

The null hypothesis of this research-that is, the expected result in the case where there is no relationship between program participation and the base, undiscounted price of a lamp-is that, on average, the observed shelf price of a program lamp sold by a particular retailer in the Program State, plus the value of the program incentive (that is, the implied original pack price), would equal the observed shelf price of the same lamp sold by the same retailer in the Non-Program State. In other words, the difference in shelf prices between the states would be the amount of the program incentive. In this scenario, any variation in prices (for example, due to price modulations over time) would not be expected to bias results toward systematically higher or lower prices of lamps in either state. The differences between the implied pack prices in the Program State and the observed prices in the Non-Program State would therefore be expected to be equally distributed around zero (that is, equal IOPPs), with similar numbers of lamp packs in the NonProgram State more or less expensive than the implied Program State price.

Approaching the current study, Cadmus' alternative hypothesis was that IOPPs in the Program State would be lower than the observed prices in the Non-Program State. Previous research using a nonparticipating sample of alternate retailers in the Program State had supported a conjecture that the upstream program was having an effect on prices greater than the amount of the incentive. What we found in the current research was the opposite, however. As previously discussed, the IOPPs in the Program State tended to be higher than the observed prices in the Non-Program State. A review of lamps that were not discounted through the program did not reveal a corresponding price disparity.

Our findings did not appear to stem from implementation challenges or other problems with the discounted shelf prices in the Program State. Based on a comparison of the Program State IOPPs and the contract baseline prices (Table 4), we found program implementation generally adhered to prices set by the contracts, ${ }^{15}$ with a preponderance of relevant program SKUs priced at or below the contract-specified prices. We expected that observed retail prices in the Non-Program State would also align with the base prices cited in the utility contracts; however, we found that, on average, the observed base prices were notably lower than those listed on the contracts.

In some cases, it appears that the base, undiscounted prices identified in the utility contracts in the Program State exceed the observed retail baseline prices for the same lamps. The result is that the difference between the program-discounted pack prices and the retail baseline-what we expect the lamp packs would

[^6]have been sold for absent the program-is less than the incentive amount. There are several possible explanations for this finding, which singly or in combination may have contributed to differences between program contract prices and the Program State IOPPs and the observed Non-Program State prices.

- Short-term in-store promotions or discounts could have artificially reduced the observed shelf prices of SKUs in the Non-Program State. During store visits in both states, field staff noted that several SKUs received discounts through store-specific, non-program-related promotions. Since short-term promotions were observed at stores in both states, and could be a component of a broader retailer pricing strategy, we would not expect them to create the systematic discrepancies observed. The relatively small store sample size, however, could exaggerate the effects of chance differences in the timing of promotions between the states. Moreover, it is possible that retailers may not have offered promotions available at stores in the Non-Program State at like participating stores in the Program State to avoid doubly discounting program lamps. This would result in reduced Non-Program State lamp prices relative to the contract base price without providing a corresponding decrease in program lamp prices.
- The upstream lighting program may have induced retailers in the Non-Program State to reduce their prices in order to compete with lighting prices in the Program State or to provide regional comparability in pricing. Reduced prices on efficient lighting products, spurred by this and other upstream lighting programs across the country, could have led retailers to reduce their prices in the Non-Program State to more closely match prices in the neighboring Program State. Such market-driven price reductions would reflect broader market effects from this program and similar programs-a kind of spillover between the states. However, to lessen the likelihood that leakage might influence results, we excluded stores in counties bordering the Program State from the sample.
- Base prices specified in the program contracts between participating utilities and retailers could have been outdated or otherwise overstated. In this rapidly changing market it is possible that the prices of lamps are shifting faster than the contracts are updated, resulting in contract prices that exceed in-store retail prices in nonparticipating states. The current contract base prices may allow participating retailers to adopt a less intensive pricing strategy for efficient lighting products, with the program making up the difference. Without a program, retailers might have reduced their prices to match levels observed in the Non-Program State. We note that in a comparison of April 2014 and April 2013 memoranda of understanding between the utilities and retailers, among the 55\% of SKUs that are found in both years, nearly two-thirds ( $63 \%$ ) had the same base price in both years.
Whether driven by disparate promotional campaigns, regional spillover, or out-of-date estimates of the retail price in the absence of the program, the results of Cadmus' study indicate that further research is critical to determine a more robust estimate of these undiscounted prices. Data collection in a neutral nonparticipating state allows for an impartial assessment of the undiscounted retail prices for which program lamps would have been sold-a critical piece of information in determining the effectiveness of an upstream program. Further studies of this topic in other jurisdictions may provide additional insight into whether these observations are more broadly applicable and what the resulting impact is on prices discounted through upstream programs.

Although Cadmus' findings focus on a single state's upstream lighting program, the involvement of national retail and manufacturing chains suggest that the need to improve estimations of undiscounted retail prices absent the program will apply to other upstream programs as well. While rigorously establishing these prices presents its own set of challenges, doing so will ensure that each dollar of incentive offered on efficient measures through an upstream program will go further in promoting sales of these products, increasing program impacts and cost-effectiveness.


[^0]:    ${ }^{2}$ American FactFinder. "GCT-PH1: Population, Housing Units, Area, and Density: 2010-Congressional District-County by State; and for Puerto Rico." United States Census Bureau. Accessed April 2014.
    ${ }^{3}$ American FactFinder. "DP03: Selected Economic Characteristics: 2012 American Community Survey 5-Year Estimates." United States Census Bureau. Accessed April 2014.
    ${ }^{4}$ References not provided to preserve anonymity.
    ${ }^{5} \mathrm{~A}$ z-score is defined as $z=\frac{\overline{x-\bar{x}}}{\sigma}$, where $x$ is the current parameter value, $\bar{x}$ is the average value for that parameter, and $\sigma$ is the standard deviation for that parameter.
    ${ }^{6}$ The Euclidian distance between two points $x$ and $x$ ' in $n$-dimensional space is defined as $\sqrt{\sum_{i=1}^{n}\left(x_{i}-x_{i}{ }^{\prime}\right)^{2}}$.
    ${ }^{7}$ Field staff had not been ejected from participating or nonparticipating stores during previous studies in the Program State. 2015 International Energy Program Evaluation Conference, Long Beach

[^1]:    ${ }^{8}$ Cadmus only performed this verification for Program State lamp SKUs when field staff observed corresponding SKUs in the Non-Program State. A similar analysis of the full dataset would have produced different results.
    ${ }^{9}$ Market forces may have led retailers to alter their undiscounted (base) pack prices to values other than those specified in the utility-retailer contracts.
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[^2]:    ${ }^{10}$ More than $80 \%$ of Program State SKUs had more than one matching SKU in the Non-Program State. While a vast majority of these SKUs could be uniformly characterized as showing price equality, a higher Program State IOPP, or a lower Program State IOPP for all Non-Program State SKU matches; $10 \%$ matched to multiple SKUs with differing price relationships.
    ${ }^{11}$ For example, consider a non-program SKU sold for $\$ 2.00$ at a Retailer 1 store in the Program State but sold for $\$ 2.75$ and $\$ 1.80$ at two different Retailer 1 stores in the Non-Program State; this example would count as 0.5 with the Program State price higher and 0.5 with the Program State price lower. Thus, we could fairly account for Program State SKUs with multiple matches.
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[^3]:    ${ }^{12}$ Without appropriate sales data to weight the results for each SKU at each retailer, we could not aggregate results to the statewide level.

[^4]:    ${ }^{13}$ Manufacturer 1 bulbs include three in-house brands at participating retailers (Retailers 1, 4, and 5).
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[^5]:    ${ }^{14}$ For example, if a lamp SKU sold for $\$ 2.00$ per pack in the Non-Program State, with a listed base-price on one utility contract of $\$ 2.00$ and on another contract of $\$ 1.50$, we would consider the Non-Program State SKU matched to the contract base price. If, however, the same SKU sold in the Non-Program State for $\$ 1.80$, we would compare it against the average contract base price: \$1.75.

[^6]:    ${ }^{15}$ Among the sample of SKUs that were observed in stores in both states.

