Measuring progress in appliance market transformation programs: weaknesses of traditional sales / shipment methods and innovative proxy metrics – The "NEEPP" tracking approach

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Abstract

Measuring progress in energy efficiency programs usually includes estimating the proportion of sales for energy efficient models out of total sales for the equipment. However, getting information on sales is extremely difficult. State programs in the US usually use data from one (or more) of the following main sources:

- Dealer / manufacturer sales data or industry / association sales data;
- Shipments data;
- In-store clipboard surveys of models for sale;
- Required reporting by "participating" vendors;
- Household surveys;
- On-site inspections / audits; or
- Warranty cards; or other sources.

This paper summarizes recent work examining the pros and cons of these methods of measuring "market progress" in market share, and reports quantitative results (with comparisons and differences) using these methods for key household appliances. We found profound disagreements in market share computations using these different data sources.

The paper then proposes a new, cost-effective proxy measurement approach to indicate market transformation progress, and the paper provides results and comparisons to traditional metrics. This approach uses price rather than quantity (sales) to track market progress – and uses statistical methods to identify the portion of the apparent price difference for a variety of appliances that are attributable to efficiency labels or energy efficiency features for market transformation programs. This metric is robust, low cost to compute, and provides several advantages over traditional metrics:

- Tracks market progress and supports comparisons;
- Indicates appropriate rebate levels; and
- Identifies mature markets ready for exit strategies.

The work illustrates a promising approach for three important applications in program planning and evaluation. Results for several appliances and regions of the country are provided to illustrate both traditional and proposed tracking methods.

Introduction

Analysis of market transformation (MT) has emerged as a critical area of DSM research over the past ten years,. In the US, MT was a particualar focus of program evolution in California, Wisconsin, and the Northwest.[1] In the 1990s, the California Board for Energy Efficiency (CBEE) worked to develop market transformation programs, and they remain important in program portfolios across North America.[2] Although MT

1. This is witnessed by hundreds of reports on the "Calmac" website at www.calmac.org/search.

2. As an example, MT was a keyword for 38 papers in the 2004 American Council for an Energy Efficient Economy (ACEEE) Summer Study on Buildings. The complexities of measuring MT programs can be reviewed in Sebold et.al. 2001.

programs lead to important, positive broad market impacts, the shift from direct install programs made the task of evaluating program impacts sustantially more complicated. Instead of just counting "widgets" directly rebated by the program (a simplified verison of the basics of a direct install evaluation), assessment of attributable program impacts requires measuring the growth in saturation of energy efficient equipment and practices in a market wide context.

Sales or market share tracking is one of the most critical market progress indicators for many energy efficiency programs; however, tracking market shares for efficient equipment is expensive, onerous, and, based on our research for several programs, prone to potentially unacceptable swings in values from alternative measurement methods and data sources. Even more problematic, direct sales (and even reliable shipment) data are,difficult to obtain from wholesalers and retailers, who lack incentives to provide information they consider business sensitive. Skumatz Economic Research Associates (SERA) researchers decided to explore the potential of alternative, parallel, and less expensive methods of indicating market progress that might monitor interim progress. If the metric was successful, it could reduce overall tracking expenses. Even if market sales data remained an indicator, sales data could be used less often, with the less expensive method used to track progress in the in-between years.

After examining a variety of potential metrics, our proposed indicator was based on a simple concept from basic economics – equilibria are reflected in sales and price. We proposed that, ideally, both of these should be tracked to give a comprehensive picture of market transformation. Because sales information is difficult to gather, then, we believed we could use a variant of price differentials as an alternative or additional tracking mechanism. We called the method "Normalized Energy Efficiency Price Premium" tracking method (NEEPP). Figure 1 illustrates that greater sales are tracked in a move from C to D, while price reductions are tracked in a move from A to B. Our proposed measurement method is based on the fact that, in our experience, price changes are easier to track.[3]

In-house and project work over a period of eight years indicates this progress indicator shows strong promise. This is not only because the data are far easier and less expensive to obtain than traditional measures, but because the analysis provides information different from, and in some ways provided information beyond that derived from sales tracking methods alone.

Problems with Traditional Tracking Methods

For projects across the country, we had employed a variety of tracking methods to reflect market progress. Based on our experience with the data and the computed results – and the expense – we found significant problems associated with each. These are illustrated in the Table below.

Our research for clients computed results from each of these methods in various combinations, and the unpleasant results were that the market penetration results were different for each method – and not at all similar in some cases. This left us, as evaluators, in the extremely uncomfortable position of having to "select" the market progress value for our client (with clients naturally leaning toward ones that showed greatest progress). "Checking" the results using multiple methods in some ways raises more questions than it answers, and based on our experience, few projects are in a position to be able to afford results from more than one of these measurement methods.

Finally, the expense – and the fact that the expense of collecting these market data will likely continue unabated – led us to investigate whether there wasn't a less expensive method of providing a reliable indicator reflecting the same market progress we were after. We were interested in developing proxy indicators that could reflect market performance, and although they may not be the direct indicator, could provide useful indicators of performance. We looked for something more easily gathered that could provide useful information on the market progress. Bottom line – why continue to pay a lot for numbers that, if you examined and compared them closely, varied more than a little bit anyway? Or can market progress be reflected periodically using the expensive metric, but use that method less frequently, and monitor interim progress using a less expensive method?

Approach for the NEEPP Analysis

In a nutshell, the **NEEPP** method gathers data from both energy efficient and non-energy efficient equipment in retail or wholesale outlets, and examines the size of the price difference that is associated with "high" vs. "low" energy efficiency. Comparing the raw data on prices for efficient vs. non-efficient models is not a valid indicator, as the prices for the two groups of equipment vary because of differences in features, samples, and other factors. However, there are valid statistical techniques that can be adapted for "pulling out" the effects of differences in the wide array of features for the equipment – including the energy efficiency indicators (u-values, Energy Star logos, etc.). Data on price plus the array of aesthetic, performance, energy, and other features of the equipment are collected and used in the analysis. Over the years, we have used these methods to investigate the market progress of more than two dozen types of equipment – mostly residential to date – and have found the results to be extremely informative.

Instead of comparing market shares for efficient (or program-sponsored) equipment and inefficient equipment, we compute and use that share of the price differential between efficient and inefficient equipment that is attributable to the energy features (or in the case of Energy Star equipment, the logo). The price differentials associated with all other non-energy features are excluded from the analysis – and are pulled out of the normalized price premium. Comparison of the normalized price premium attributable to the energy features provides a reflection of increases in the market share for efficient models (per Figure 1). For a refrigerator you might have an equation like the following where the subscripts are suppressed: eg. Refrigerator price = a + b*capacity +c*ice maker + d*side by side +e*Energy Star qualifying + … + error term, so then the coefficient "e" tells us something about the price differential due to Energy Star.

This approach relates back to the goal in evaluating market transformation programs, which is to monitor market progress – usually market share of sales of the efficient equipment, which

3. And of course, if the price elasticity were known, the change in quantity could even be computed directly; however that enhancement is not necessary to the principle of this paper.

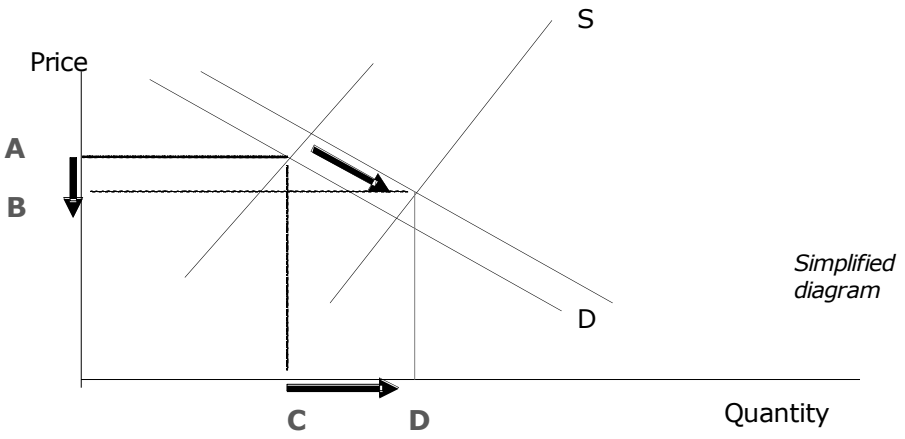

Figure 1: Reflecting Progress in the Market – Quantity differentials (C-D) can be reflected in "Controlled" Price differentials (A-B)

Table 1: Pros & Cons of Traditional Market Share-Related Progress Indicators

Method	Assessment	Cost
Periodic sales data from dealers, manufactures	Suppliers are balky / have little incentive to provide information (considered business sensitive); labor intensive to collect / reliance on "good will"; representativeness issues, data consistency issues when suppliers "drop out" in some time periods.	Very High
Shipments	Somewhat inconsistent data source, problems with reselling across state boundaries, available for some commodities.	Medium
In-store models counting / tracking, relative shelf space measures	Inaccurate for quantities, although shelf space provides some proxy indicator of relative sales; not very practical for commercial sector	Medium
Dedicated or saturation surveys, purchases	Lack of knowledge by respondents, lack of incentive to respond (or respond fully), sample size problems for commercial sector.	High
On-site inspections / audits	Inspectors have good knowledge of equipment, but sample sizes are a problem; finding a sample of recent purchases difficult	High
Industry / association sales data	Some sales data are available for limited equipment types, but much equipment is not available	Medium
Warranty cards / rebate	Shows promise for some products, but "Control" sales are missing	Medium

(Source: Skumatz Economic Research Associates – SERA, 2005)

are intended to increase. In our variation, we look to monitor the normalized price premium associated with efficient equipment compared to standard equipment – and potentially track these changes (hopefully, according to logic, declining) over time. However, the incremental cost metric is always confounded by the fact that the "feature bundle" on appliances and lighting is not consistent (i.e., many efficient products are loaded up with other, high-end features). Based on exploratory work conducted by the authors in 1999 on windows and appliances, we adapted statistical modeling approaches to decompose the price differentials for a wide range of efficient and standard appliances, lighting equipment, shell measures, and other equipment.

Over time, the authors have gathered data on many hundreds of models of equipment, including prices and features, for sets of efficient and standard equipment. These data have been collected over time and between market areas for tracking and comparison purposes. We first examine apparent (raw) price differentials between efficient and standard models. Then, using adapted statistical techniques to control for differences in features on the measures, the **NEEPP** differences attributable to various features – and in particular to energy efficient features and logos – were estimated.

We believe the **NEEPP** also provides a reflection of the decision-making made by shoppers. Price differences faced by shoppers are a key component of their purchasing decision; however, shoppers implicitly conduct a price comparison that accounts for and trades off a variety of factors making up the product bundle. While one item might be more expensive, it might be larger, or have more settings or other features that the potential buyer would find attractive. The challenge is to conduct a similar comparison incorporating features and price differences to gain a more complete understanding of whether the price premium we are most interested in – the premium associated with the Energy Star® label – is decreasing (perhaps due to economies of scale). We believe the statistical analysis method we used mimics the types of comparisons and decision-making by consumers. As such, it reflects a key element driving the purchase of efficient vs. inefficient equipment, and provides a quality indicator of progress in the consideration of this equipment by shoppers.

Table 2. Examples from Energy Star Appliance NEEPP Price Difference Analyses

	Gross price difference	Gross price difference (%)	NEEPP "Controlled" efficiency price premium	NEEPP "Controlled" efficiency price premium (%)
Refrigerators	$ 650	109 %	$ 251	42 %
Dishwashers	$ 96	27 %	$ 0-12	0-3 %
Clothes Washers	$ 313	64 %	$ 71	15 %

(Source: Skumatz Economic Research Associates – SERA 2006)

NEEPP Applied: The Example of Several Energy Star® Appliances

As noted above, reliable information on sales (or related) data supporting computation of market shares of or market progress for Energy Star® appliances sold over time are difficult to obtain. However, it should be possible to infer developments in the market share of such merchandise by:

- identifying whether there is a price premium evident for efficiency features or the Energy Star® label, and
- tracking "controlled" **NEEPP** price premium changes over time.

Using the logic above, reductions in the premium may provide proxy indicators of market (and market share) progress. In the real world, this approach gives rise to its own set of challenges. Energy Star® labeled appliances are generally more expensive then their unlabeled counterparts. Not all of the price difference, however, can be attributed to the Energy Star® label. Because manufacturers invest in substantial research and development in order to design and produce merchandise sufficiently energy-efficient to earn the Energy Star® label, they often attempt to recoup the costs of their investments by bundling their products with additional features that allow them to be sold at higher prices. Measuring the changes in gross price differentials between Energy Star® and non-Energy Star® merchandise will not produce an accurate estimate of the direction and intensity of the trends in Energy Star® market progress.

To use change in price as a proxy for market progress, then, requires the measurement of only those components of the changes in gross price that can be attributed to the Energy Star® label. We use adapted statistical approaches to compute this incremental price premium.

As mentioned, Energy Star® appliances generally come at a premium. Table 2 below summarizes the price information from a sample of three categories of residential appliances – refrigerators, dishwashers, and clothes washers. The first two columns of Table 2 present the raw price comparisons for the sample of appliances examined.

In each case, the Energy Star® appliances were more expensive on average. As discussed above, the gross price of Energy Star® equipment is not the best indicator of market progress. The price of such equipment is a function of a vector of characteristics, and changes in any characteristic can affect the overall price. Statistical work was conducted to sort out the energy-associated normalized premium, and these figures are presented as the "NEEPP" premium.

In developing these estimates, we identified a number of equipment features beyond the Energy Star logo that were significant in affecting the price of the appliance. For refrigerators, these included changeable color panel, stainless steel finish, water filter, ice maker and other features. For air conditioners, important features affecting price included height, EER, room size features, multi-functions and other features. For dish washers, price-affecting features included stainless outside finish, number of wash levels, electronic tap controls, number of cycles and other features. For clothes washers, examples of important features affecting price included capacity, electronic controls and other features. In each case, we needed to control for these feature bundles to identify the price premium specifically associated with just the Energy Star logo – the purchases of interest to the Energy Star programs evaluations.

Discussion and Implications of NEEPP Results

The results for these appliances were selected for the examples for this paper because they illustrate different outcomes. A significant gross price differential exists for of the set of large appliances we examined. However, simple comparisons hide the effects of other differences in the equipment – for example, differences in size, features/options, or other factors. A variety of Energy Star® programs are designed to affect the purchase decision,[4] which is made on a whole product basis. While consumers look at the entire price premium, they also consider tradeoffs in the array of features associated with those higher priced models and make decisions based on this joint assessment. Our analysis approach is well-suited to decomposing these effects and isolating the effect attributable to Energy Star®. This statistical analysis helps sort out the portion of the price premium that is due to the Energy Star® feature – a Figure that the price shoppers may estimate in an *ad hoc* way as they shop and make purchasing decisions. The research demonstrates that our statistical approach is successful at separating out the impacts of factors beyond Energy Star® that may influence differences in Energy Star® vs. non-Energy Star® prices for energy efficient appliances or other equipment.

The results of this analysis are the "controlled" price premiums shown in Table 2. The results show the simple gross price comparisons and the price premiums that could be associated with the Energy Star® label, controlling for other differences. Findings – and associated implications – evident from this Table include:

- **Refrigerators**: A simple comparison of the refrigerators included in the sample was almost $ 600, or 109 % more than standard models; however, after controlling for key features,

4. Through a variety of interventions, including broad advertising, point of purchase advertising, rebates, and other methods.

the remaining **NEEPP** price premium that appears to be attributable to Energy Star® is about $ 251 or a 42 % price premium.

- **Implications:** The Energy Star® premium for refrigerators before accounting for other factors was 109 % of the price of non-Energy Star® refrigerators. After controlling for other features, the **NEEPP** price premium for Energy Star® fell to 42 %. Manufacturers appear to be bundling additional features on Energy Star® models, causing their apparent prices to be higher than they would need to be if "comparable" models that were Energy Star® and non-Energy Star® were available (or obvious) to shoppers. However, the results still show a fairly substantial premium for Energy Star®, and program incentives may still be needed in the marketplace to generate or maintain increased sales of the efficient products.

- **Washing Machines**: The results showed that the Energy Star® variable, after eliminating the effects of other factors, was responsible for a **NEEPP** price difference of $ 71, a significant decrease from the gross price differential of $ 313. The percentage premium for the Energy Star® label decreased from 64 % to 15 % attributable to the Energy Star® label.

  - **Implications**: The results for clothes washers showed a decrease from a 64 % premium to a 15 % **NEEPP** premium for the Energy Star® logo, after controlling for feature bundles. This is an important finding, because the apparent price difference for these clothes washers has been a considerable concern to program managers. The NEEPP work shows that a good share of that price difference is due not the Energy Star® logo per se, but is due to manufacturers "loading up" other premium features on these machines to help recoup development costs, reap consumer surplus, and maximize profits on these models that currently have cachet. Again, the results show a fairly substantial **NEEPP** premium for Energy Star®, and program incentives may still be needed in the marketplace to generate or maintain increased sales of the efficient products.

- **Dishwashers**: Table 2 shows that the gross price difference between the dishwashers in our sample that are Energy Star® qualified and those that are not is $ 96. After accounting for other features, the **NEEPP** price premium associated with the Energy Star® variable is small and statistically insignificant, and the estimated price premium falls from $ 96 to $ 12 (or less), and from 27 % to about 3 % or less. The price premium associated with the Energy Star® label for dishwashers appears to be nearly zero.

  - **Implications:** The results for dishwashers are particularly noteworthy. The research shows that the NEEPP price premium for the Energy Star® logo has become negligible. This may indicate that the market has become reasonably mature, and that interventions may no longer be needed to encourage selection of Energy Star® models. This indicator might be adopted as a trigger for invoking an "exit strategy" for program interventions.

The results from these example show high gross differences for refrigerators and clothes washers and low differences for air conditioners. However, when looking at the "controlled" **NEEPP** differences, we see the smallest energy efficiency price premiums are associated with dishwashers, and the highest are associated with refrigerators. Simply put, the information shows that in the market, abstracting from the components of price differentials associated with non-energy features, consumers see almost identical prices between Energy Star and non-Energy Star models for dishwashers. The question might be asked – is the market mature, and is a program needed to further induce the purchase of energy efficient dishwashers? The opposite may be true for refrigerators and some of the other equipment.

This analytical method provides additional insights into current and future program needs. For example, tracking product market shares doesn't provide insight on the level of rebate that might be effective at increasing purchases of energy efficient equipment (without *over*-incentivizing the purchase). We have applied these methods to tracking differentials over periods as long as 5 years with interesting results.

Summary and Applications of the NEEPP Approach

This paper summarizes work using statistical methods to examine the portions of the apparent price differences for a variety of appliances that are attributable to efficiency labels or components of efficient measures. The work stems from research examining methods of measuring progress in market transformation. The goal was to monitor market progress in the premium associated with efficient equipment compared to standard equipment – and potentially track these changes over time. However, the simple incremental cost metric is always confounded by the fact that the "feature bundle" on appliances and lighting is not consistent (i.e., many efficient products are loaded up with other, high-end features). Based on work conducted by the authors some years ago, we adapted statistical models to decompose the price differentials for efficient and standard refrigerators, clothes washers, and dish washers. The authors used site visits and web searches to gather data on appliance prices and features for a set of efficient and standard models. The authors first examined apparent (raw) price differentials between efficient and standard models. Then, using statistical techniques to control for differences in features on the measures, the differences attributable to various features – and in particular to energy efficient features and logos (**NEEPP** premiums) – were estimated.

The results showed that while the apparent (gross) price differences for efficient measures are high, the percentage and dollar differences decrease dramatically when the price differences statistically attributable to other features of the measure are accounted for. Results differed by appliance, and the varying results have different implications for the underlying programs and measures.

This work has several applications. Tracking price differentials over time is an important application of this work – and this indicator may be used instead of, or in addition to (and

more cheaply than), market share.[5] For example, to save funds, it may be cost-effective to decrease the frequency of tracking market shares, and introduce between-period price analysis studies. Results from tracking for one client shows that price premiums associated with both appliances fell between the two years, potentially demonstrating market progress and indicated that the approach shows promise in providing an idea of how mature the market has become.

The values may also be compared between states or areas for evidence of relative market progress of maturity. The authors have conducted empirical price analysis work in states with and without high levels of Energy Star® program activity. In theory, price premiums for high-activity states should be lower than in states where less promotion of the Energy Star® label has taken place.[6]

The values derived by an on-going series of these price decomposition studies can be compared to future studies of a similar nature to look for market effects measured in terms of decreasing price differentials from Energy Star® programs. The authors are monitoring this effect on an on-going basis (and comparing to other locations) and are collecting data on price and appliance/equipment features, in association with the periodic on-site data collection efforts conducted as part of program evaluation. This work has several applications.

- **Tracking market progress toward transformation.** Sales and market share data are very difficult and expensive to obtain (if they can be obtained at all). Using readily available market price data and information of features, a price decomposition analysis can provide an alternate source for information indicating progress in the market. Assuming that this indictor reflects similar market equilibrium conditions as market share, this proxy variable can provide tracking information in a way that is less expensive and complicated to measure than maturity of the market, as reflected in a declining premium. Presumably, the lower the premium the lower the incremental manufacturing costs, the higher the market share (since consumers do not have to pay much extra for this feature), and the more the market resembles the long-run equilibrium, the market has moved forward and become more transformed. The results can possibly address the question of whether additional or continuing interventions are needed in the market, and how quickly the market is progressing toward transformation. In addition to comparisons over time, the work can be used to make comparisons to other states or areas to assess relative market progress between areas and possibly identify more and less successful intervention approaches.
- **Assessing need for new or continuing program interventions.** A high or continuing price premium may be an indicator that the market is not maturing on its own, or that additional interventions may be needed to assist in achieving market transformation – information that is fairly reliable and inexpensive to obtain through this method, and can augment information from process evaluations or assessments of barriers and logic. The price premium may implicitly reflect this "market state," though it may not address "why" and additional research may be needed.
- **Estimating appropriate incentive or rebate levels.** The "controlled" price premiums estimated through this approach provide guidance for identifying appropriate levels for appliance rebates to encourage purchase of efficient models. This is useful to program planners, and may be more reliable than rebate estimates derived form other methods. The information on the premium is useful as a reflection of the amount of a price rebate that might be needed to encourage consumers to purchase Energy Star® labeled appliances (or reflect the maximum threshold at which they would be indifferent). If consumers conduct similar tradeoffs of features vs. price as the statistical work assumes, a dollar amount equal to the premium associated with Energy Star® should reflect the maximum rebate needed to make consumers indifferent between the two models. This estimate makes several simplifying assumptions. The first is that the consumer assigns zero value to the stream of energy savings that they will receive in the future. If they assign a value to this stream, then the rebate could presumably be lower than the estimated associated price increment. Second, if they associate with the logo higher quality appliances, the rebate may be able to be set lower than the estimate. Third, if they assign differences in maintenance, the rebate may be lower than the price premium indicates.
- **Identifying market maturation.** A low or zero attributed price premium may prove a useful "trigger point" for helping to identify the point at which markets may have matures, and program exit strategies may be justified.

The authors are applying this approach to additional measures, and are tracking pricing and sales results for a number of appliances to allow comparison of the results to identify whether the method provides a parallel (and less expensive) tracking method. Finally, we are applying the work to commercial measures to explore applications in that sector.

This method provides intriguing implications for program analysis. For clients around the country, the following types of information have been analyzed using the **NEEPP** method:

- Tracking market progress in equipment over time using a less expensive metric (**NEEPP** normalized efficiency price premiums.
- Identifying the need for continued market interventions by programs.
- Demonstrating the need for and level of possible rebates to continue market progress.
- Indicating the timing for possible market exit for programs, and indicating the level of market maturity – and in particular, if price differentials are low, indicating the need to increase the efficiency levels of the equipment covered by the program.

5. For one client, the authors have conducted work to track price premiums over the last two years, focused on just two appliances. The research indicated that price premiums associated with both those appliances fell between the two years, potentially demonstrating market progress and indicating that the approach shows promise in providing an idea of how mature the market has become.

6. Our in-house exploratory research has found some indicative evidence of this effect, comparing non-Energy Star® state results (Colorado) to Energy Star® states (New York) for several appliances.

- Tracking market progress within and between states or service territories, using a proxy variable that is less expensive and complicated to measure than direct indicators of sales or market share.

This **NEEPP** tracking method uses more readily available data and reduces the need for very expensive sales tracking – tracking that is unlikely to get less expensive over time. You might consider it the next time you identify a series of market progress indicators in your program evaluation's "researchable questions" and indicators list.

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