MARKET TRANSFORMATION: MEASURING THE IMMEASURABLE

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Introduction

The focus of utility-sponsored energy efficiency activities throughout the United States has begun to shift increasingly toward market transformation programs. Unlike resource acquisition, which focuses on direct control (management) of demand at the end-use level, market transformation initiatives aim to modify the behavior of market participants and stimulate the demand for and supply of energy-efficient products and services. Market "transformation" programs are ambitious undertakings. Their targets are large, complex, dynamic and, arguably, illusive. Their effects, therefore, tend to be hard to identify, small and gradual--and hence, very difficult to measure.

A sound and reliable methodology for evaluation of the effects of market intervention programs must be able to address four distinct, yet interrelated issues: identification of market effects, attribution, timing (a subset of attribution, i.e., detection of outcomes related to interventions in a particular period), and permanence of the effects.

This paper presents the results of applying a hybrid qualitative-quantitative approach, the Analytic Hierarchy Process, to evaluate the market effects of two similar residential new construction program in California offered by two utilities (hereafter Company A and Company B). These programs, aimed at promoting construction practices that exceed local energy codes by offering information and incentives to builders for six measures including higher efficiency HVAC equipment, improving duct work, insulation, efficient windows, efficient lighting, and planting shade trees.

Design of the Study

Depending on the type and importance of specific barrier(s), that impede the market process, intervention policies and programmatic initiatives may be directed at demand (end user), supply (manufacturer, distributor, retailer, builder, etc.) or both. Since barriers in the residential new construction market appear to lie mostly on the supply-side, both programs studied here targeted primarily builders and contractors. The evaluation effort, therefore, concentrated on the same market actors. Although it can be argued that purchase behavior may more appropriately reflect the actual change in the market, in the short-run, supplier behavior might serve as a good proxy for market transformation.

For the purposes of this study, we assumed that a market effect is likely to be present if there is a measurable change in the behavior of market participants that can be attributed to the programs. We further assumed that a change in behavior can be inferred from the change in the importance that market participants attach to energy efficiency in marketability of the house. Four groups of market players--builders, realtors, builder sales agents, and local code consultants--were surveyed using in-depth interviews. Two sets of information were collected through either direct elicitation or in AHP format from market actors: 1) qualitative indicators of market barriers and their changes; and 2) quantitative measures of the perceived importance of energy efficiency.

Market players were asked to rate the importance of energy efficiency vis-a-vis five other major attributes of the house, namely, cost, location, style, floor plan, and size. The analysis included both participating and non-participating market actors. To establish the relationship between the program and the observed changes in ratings, both groups were asked to repeat the rankings as they would have before the programs became active. The research, thus, sought to replicate a quasi-experimental design. The main objectives and components of the study are summarized in Table 1. In this paper we will focus on the AHP and its results.

Table 1. SUMMARY OF APPROACH

Objective	Data Collection/Analysis Method
Determine the existence of the identified market effects.	Direct Elicitation
Determine the magnitude of these effects.	Direct Elicitation and AHP
Estimate a hypothetical baseline to assess attribution.	Direct Elicitation and AHP
Specify whether the market barriers have been reduced, eliminated, or bypassed.	Direct Elicitation, AHP
Assess the permanence of the observed changes.	Direct Elicitation

Analytic Hierarchy Process (AHP)

AHP is a useful and flexible method for analyzing complex decision situations involving multiple players, different sets of decision criteria and often several alternatives. AHP has been applied to similar research questions in numerous industry applications within the electric utility industry. The applications have included forecasting, T&D planning, and rate setting. AHP involves three basic elements:

1) Describe a complex, multi-criteria problem with objective or subjective elements as a hierarchy;
2) Estimate the relative importance weights for various criteria (or subcriteria) on each level of the hierarchy; and
3) Integrate the relative weights to evaluate the hierarchy with respect to the overall objectives.

AHP uses ratios as a measure for comparative judgments. Specifically, pairwise comparisons are used to estimate the relative importance of individual criteria within each level of the hierarchy. A commercially available software program (Expert Choice™) performs all necessary computations and provides detailed reports for the generated weights of the criteria and alternatives (Figure 1). Steps in application of the AHP in our analysis were:

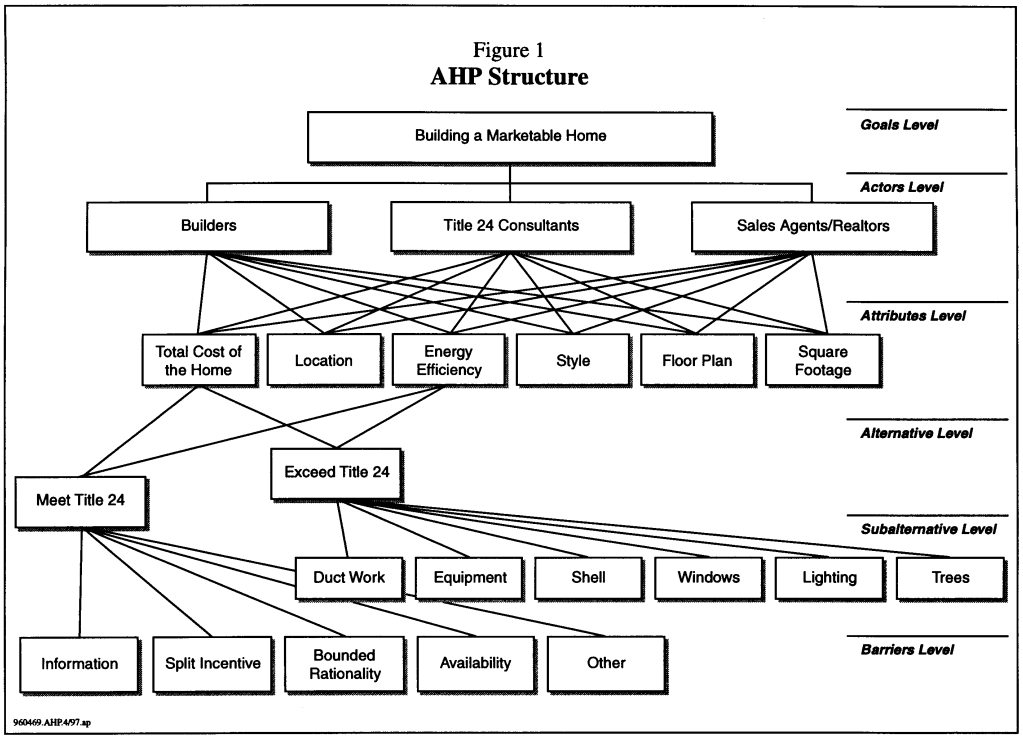
(1) Build an overall AHP structure. The decision situation is first structured as a hierarchy, comprised of an overall goal, a set of actors, a set of decision criteria, a set of decision alternatives, subalternatives (specific measures/end uses), and barriers for installing energy efficiency measures.

(2) Estimate the importance weights for each attributes. Starting with an overall goal, each market actor is asked to assess the importance of various attributes. This evaluation is performed based on pairwise comparisons using a 1–9 ratio scale, where 1 means equal importance and 9 indicates extreme importance of one item over another.

(3) Estimate the preference weights for each alternative. For certain attributes (energy efficiency, cost) actors are asked to conduct pairwise comparisons between meeting or exceeding local energy efficiency standards.

(4) Estimate the weights for barriers associated with each alternative. When exceeding standards is the preferred alternative, actors are asked to state the preference weights (via pairwise comparisons) between different methods (alternative measures or their combinations) for exceeding existing local codes. When choosing not to exceed codes, actors are asked to rate the impact of expected market barriers.

Figure 1
AHP Structure



AHP also provides a means of assessing the consistency of a respondent's judgments with respect to his or her evaluations. For example, if respondents believed A was more important than B and B was more important than C, then they must have felt A was more important than C. AHP's consistency analysis quantifies this concept, and provides a means of assessing the overall consistency of the process. This leads to the calculation of a measure called the "inconsistency ratio." It has been empirically shown that if an inconsistency ratio is more than .10, the overall consistency is unacceptable. In this case, Expert Choice identified the most inconsistent judgments and eliminated them to achieve an acceptable consistency level. In summary, the main results produced by the AHP included three sets of weights based on responses by each key actor:

(1) Importance weights for the overall attributes;
(2) Preference weights for meeting or exceeding standards; and
(3) Preference and importance weights for methods of exceeding standards (e.g., windows, HVAC, lighting, insulation, etc.), and barriers for not exceeding standards (e.g., lack of information, split incentives, and availability of measures).

Establishing the Baseline

Since the main objective of the study was to determine change in the market players' behaviors and attitudes, it was necessary to first establish an appropriate baseline. Two comparisons were made to establish a hypothetical baseline:

(1) Participating actors were compared to nonparticipating actors; and
(2) Actors were asked to reconsider the AHP questions in "retrospect". For participants, the "past" is the period prior to participating in the program. For nonparticipants, the "past" is the date corresponding with the period before the programs were introduced.

The difference between the energy efficiency "importance weights" of the past and the present is used as an indicator of changes in attitudes for specific players.

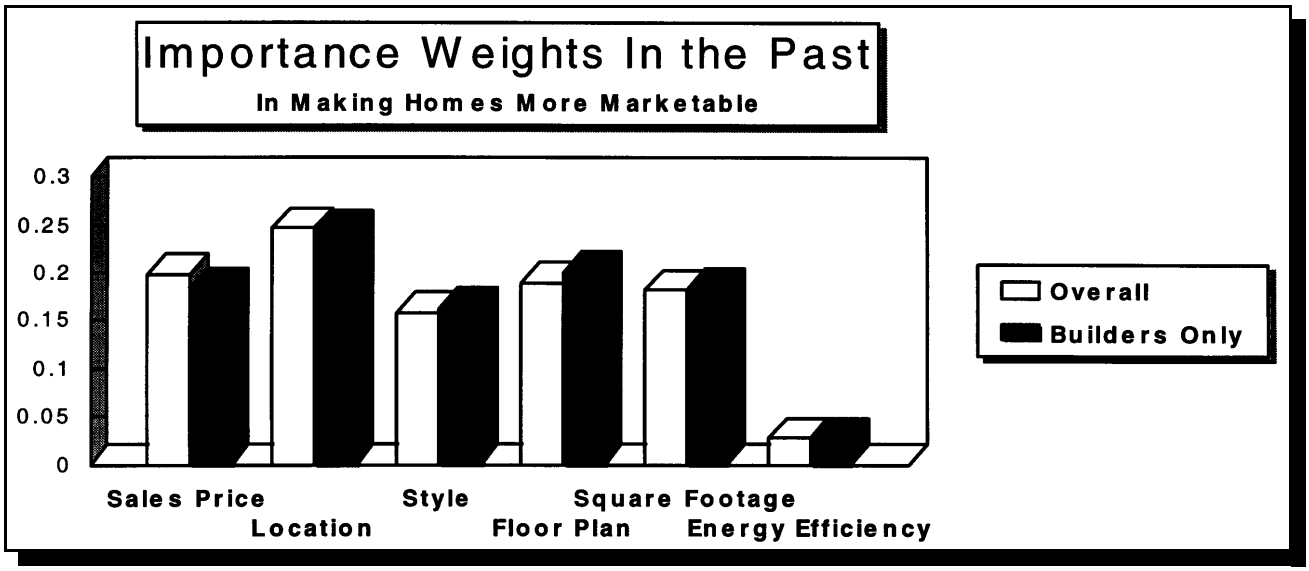
Relative Importance of Energy Efficiency

Expert Choice was used to generate AHP importance weights by different "market actors," "service territory," and (in the case of "builders") by "program participation status." The magnitude of the AHP-generated importance weight for "energy efficiency" relative to other home marketability criteria such as "price," "location," "style" (e.g., ranch versus Tudor), "floor plan" (e.g., number of bedrooms), and "square footage," is relatively small.[1]

Examining overall importance weights across all market actors reveals the most important home attribute (in making a home more marketable) is location, with an importance weight of 0.246, followed by price, with an importance weight of 0.198. Energy efficiency received the lowest importance weight, only 0.027.

As a group, builders perceived location to be the most important criterion (0.243), followed by floor plan (0.2), sales price (0.184), square footage (0.183), style (0.163), and, finally, energy efficiency (0.027). However, looking at the builders' responses by service territory and participation status reveals that the participating builders generally placed higher importance on energy efficiency than did the nonparticipating builders.

[1]AHP does not estimate variance, hence no statistical statements can be made in absolute terms regarding the significance of the findings. However, we feel small differences (i.e., less than 5% in absolute terms) should be treated with caution. Differences more than 5% are probably significant.



The respondents were asked to make the same set of trade-offs in the present. The overall perception of the importance of sales price has increased over time, while the other criteria have not changed as profoundly. The importance of floor plan has increased, and energy efficiency have gained somewhat. On the other hand, style, location, and square footage have lost ground slightly.

Comparison of change in relative importance of the attributes from before to after the introduction of the program showed that overall, sales price seems to have become considerably more important over time (increasing by 7% overall and 23% for builders). All other attributes changed only modestly during the analysis period.

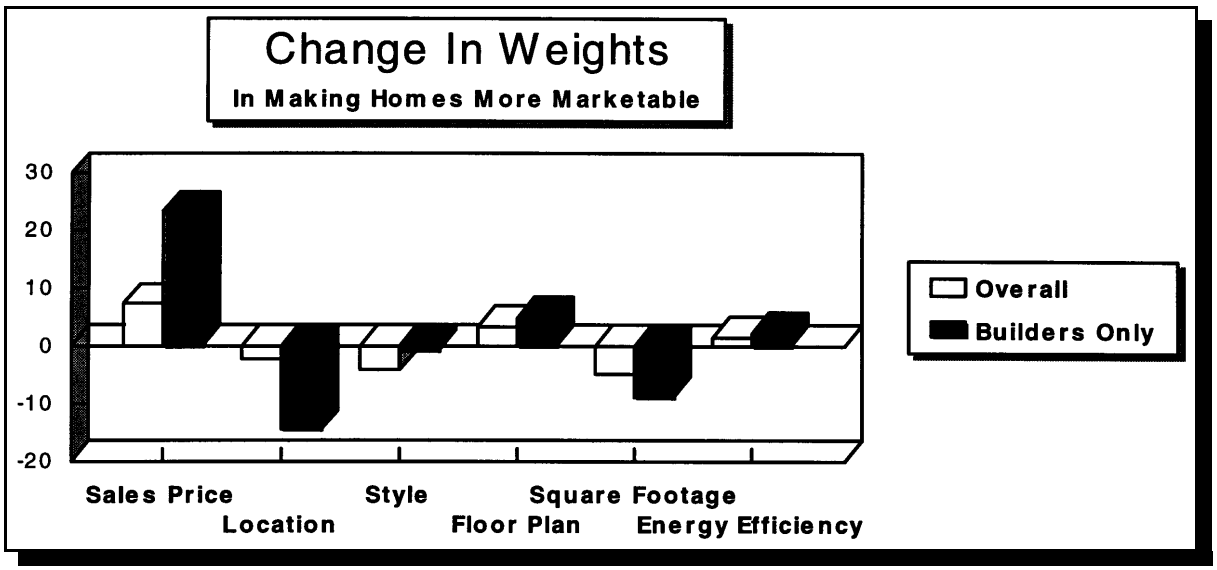


Table 2 focuses on the perceived importance of energy efficiency. It summarizes the average AHP-generated importance weights for energy efficiency as perceived in the past and present, as well as the percentage change in the importance weights. A detailed review of this table reveals the following:

- Most respondents in various market actor and service territory categories perceived energy efficiency to be more important now than before the programs were introduced.
- Participating and nonparticipating builders showed different degrees of change in the perceived importance of energy efficiency.

In both Company A's and Company B's service territories, participating builders showed an increase in the perceived importance of energy efficiency over other marketability factors. Nonparticipants showed change in the opposite direction. The differences between the two percentage changes were approximately 15% in Company A's service territory and about 9% in Company B's service territory. In the absence of other explanations for these differences, the apparent impacts of the programs appear significant. Local code consultants also reported a noticeable increase (5%) in their perception of the importance of energy efficiency.

Table 2
CHANGE IN ENERGY EFFICIENCY IMPORTANCE WEIGHTS

Market Actor	Region	Program Status	Average Importance of Energy Efficiency			
			Past	Present	% Change	n
Builders	Company A	Participants	2.81	3.03	7.83	4
		Nonparticipants	2.60	2.41	-7.31	1
		Overall	**2.77**	**2.90**	**4.69**	**5**
	Company B	Participants	2.76	2.86	3.26	3
		Nonparticipants	2.53	2.45	-3.16	4
		Overall	**2.63**	**2.62**	**0.00**	**7**
	Overall Builders		**2.68**	**2.74**	**2.24**	**12**
	PROGRAM IMPACT ACROSS TWO COMPANIES				**9.86**	**12**
Code standards Consultants	Company A		2.75	2.94	6.91	2
	Company B		2.77	2.88	3.61	2
	Overall Code standards Consultants		**2.76**	**2.91**	**5.43**	**4**
Sales Agents	Company A		2.85	2.72	-4.56	3
	Company B		2.46	2.47	0.41	4
	Overall Sales Agents		**2.63**	**2.58**	**-1.90**	**7**
Realtors	Company A		2.78	2.62	-5.76	4
	Company B		2.98	3.19	7.05	4
	Overall Realtors		**2.88**	**2.90**	**1.04**	**8**
Overall Across All Market Actors			***2.73***	***2.77***	***1.97***	***31***

Preferences for meeting of exceeding local codes

In addition to the importance ratings, the AHP analysis also produced estimates of the market actors' preference ratings for exceeding local codes. Builders and local code consultants were the only market actors included in this preference rating. They were asked to rate the importance of exceeding local codes with respect to cost and the ability to save energy. Table 3 presents the relevant results and shows the breakdown of preference ratings by area and, in the case of builders, by participation status.

Overall, the results show that neither the builders nor the local code consultants believed that exceeding the local code was preferable with respect to either cost[2] or energy savings. In other words, the results indicate that when considering the cost of construction *or* energy efficiency, exceeding the code was not a desirable option. This was true for code consultants, participating and non-participating builders in both areas. These suggest that one reason builders did not participate in the programs, or chose not to exceed local codes because they believed it would cost more and did not provide sufficient benefits in terms of increases in the marketability of the home. The code standards consultants seemed to be even less convinced of the benefits of exceeding local codes.

Table 3
PREFERENCE FOR MEETING OR EXCEEDING Code standards

Market Actor	Service Territory	Program Status	Cost			Energy Savings		
			Meet Code standards	Exceed Code standards	n*	Meet Code standards	Exceed Code standards	n*
Builders	Company A	Participants	0.7833	0.2167	4	0.6611	0.3389	6
		Nonparticipants	0.7917	0.2084	2	0.7500	0.2500	1
		Overall	**0.7861**	**0.2139**	**6**	**0.6738**	**0.3262**	**7**
	Company B	Participants	0.7648	0.2352	5	0.7981	0.2019	5
		Nonparticipants	0.8143	0.1857	4	0.8000	0.2000	4
		Overall	**0.7868**	**0.2132**	**9**	**0.7989**	**0.2011**	**9**
	Overall Builders—Both Companies		**0.7865**	**0.2135**	**15**	**0.7442**	**0.2558**	**16**
Code standards Consultants	Company A		0.7917	0.2084	2	0.8375	0.1625	2
	Company B		0.7917	0.2084	2	0.7333	0.2667	2
	Overall Code standards Consultants		**0.7917**	**0.2084**	**4**	**0.7854**	**0.2146**	**4**
Overall Across All Market Actors			*0.7876*	*0.2124*	*19*	*0.7524*	*0.2475*	*20*

** Missing cases were deleted on a question-by-question basis.*

[2]We did not expect any respondents to say exceeding Title 24 would be "preferable" to meeting it in terms of cost. Rather, we sought an estimate of how much additional cost the respondent believed was required to exceed code.

Assessment of Barriers

Builders and code consultants were asked to make pairwise comparisons among four of the reasons that would explain why builders do not build homes exceeding codes. Table 4 presents the AHP-generated prioritization of these barriers with respect to market transformation.

Table 4
RANKING OF MARKET BARRIERS

Time Period	Split Incentives	Lack of Information	Bounded Rationality	Availability
Past	0.5237	0.1582	0.1789	0.1393
Present	0.5334	0.1791	0.1895	0.0980
% Change	1.9	13.2	5.9	-29.7

The barriers include:

(1) Builders focusing on home marketability rather than energy savings [i.e., not believing the additional cost of building homes to levels exceeding code would be offset by an increase in marketability (split incentives)].
(2) Lack of information regarding energy saving technologies or techniques.
(3) Limited ability to analyze alternatives or lack of an easy approach for analyzing different options for achieving energy efficiency (bounded rationality).
(4) Energy-efficient equipment availability.

When interpreting the results presented in Table 4, it should be remembered that these barriers' importance weights are computed relative to the other barriers. In this case, for example, the fact that split incentives numbers were similar (past and present) would not mean that the barrier had not changed, only that it maintained its relative importance. Therefore, one should view these trends with caution. However, if we had found that the proportion of homes exceeding code standards had significantly increased, we would have concluded that barriers (as whole) have been reduced. Instead, the direct elicitation portion of the study indicated the proportion of homes exceeding code standards witnessed only a slight increase. Therefore, we can conclude that the barriers have not been significantly lowered as a whole and direct across-time comparisons can be made - e.g., the split incentive has not been lowered significantly.

Examination of Table 4, reveals that split incentives were perceived to be the most important barriers to building homes exceeding code standards. As mentioned above, this perception did not change with time (i.e., the market barrier was not lowered). Difficulty in the choice of options was a distant second to split incentives. Lack of information was third. In fact, these two barriers have increased in importance. Finally, respondents indicated that the "lack of availability" importance has actually declined as a barrier, indicating equipment availability no longer is viewed as a problem.

Conclusions

The programs that were studied here were not designed as market transformation programs. They did, however, have several market transformation effects. This study shows evidence of moderate to negligible reduction in the information-related barriers of home buyers, builders sales agents and buyers' realtors, and builders having to do with subcontractor selection and in the HVAC subcontractor barrier of poor ductwork installation practices.

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