Who Pays for Energy Efficiency Standards?

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Abstract
Policies to promote energy efficiency in household appliances have different impacts, depending on the structure of market supply. If provision is perfectly competitive, markets will offer the variety of energy efficiency levels that consumers demand. However, if producers can price discriminate, using energy intensity to help segment consumer demand, consumers of low-end appliances are offered too little energy efficiency so that high-end consumers can be charged more for efficient appliances. Minimum energy efficiency standards can then improve welfare. We also consider average intensity standards, energy prices, and innovation and identify important differences in their effects on energy intensity, welfare, and consumers, depending on market structures. To evaluate the role for policy, one must know not only how consumers value energy efficiency in their decisionmaking, but also how producers respond to those values.

Key Words: energy efficiency, appliance, standards, price discrimination

JEL Classification Numbers: Q40, Q55, Q58, O3
1. Introduction

The U.S. Department of Energy (DOE) mandates minimum energy efficiency standards for household appliances. Under the 1975 Energy Policy and Conservation Act, DOE is required to set energy standards for major appliances at the highest level that is technologically feasible and economically justified. In a recent report, DOE analysts estimate that new, more stringent standards would save consumers $150 billion through 2050 (Meyers et al., 2003). Challenging the discount rates used in that cost-benefit analysis as being too low, a Cato Institute report by Sutherland (2003) estimates that the new standards would impose significant net costs, borne disproportionately by the poor. Low-income households have higher internal discount rates, and they prefer appliances with lower up-front costs and higher operating costs. Raising minimum standards removes this choice and raises their initial costs, while it does not affect the choice set of rich consumers.

In well-functioning markets, one would certainly expect a variety of choices in the combination of price and energy intensity of appliances. Households may have different preferences, depending on how long they expect to own the appliance or how often they intend to use it; for example, climate differences affect needs for heating and cooling. Indeed, some form of “market failure” must be present to justify regulations. Hausman and Joskow (1982) identify potential imperfections in the demand for energy efficiency in household appliances: energy prices may be “too low” from a social standpoint, consumers may underestimate energy costs, or they may discount them at “too high” a rate. Still, they note, “Even if a convincing case could be made that information market and capital market failures lead consumers to make ‘incorrect’ decisions, it is not likely that we can make consumers better off, in any meaningful sense, by restricting their choice set.”

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1 For a survey of implicit discount rates for appliances at that time, see Train (1985).

2 p. 222.
However, all of these studies assume that suppliers in appliance markets are perfectly competitive. While differences in initial and operating costs may arise out of consumer demand for these variations, firms may also exploit them in order to price discriminate.

The literature on industrial organization has long been interested in the effects of imperfect competition on quality choice, particularly for consumer durables like household appliances (see, e.g., Mussa and Rosen, 1978; Donnenfeld and White, 1988). Chiang and Spatt (1982) focused in particular on variations in discount rates as a basis for price discrimination. Several studies have analyzed the effects of regulations on quality provision in markets with price discrimination (e.g., Besanko et al. 1988; Srinagesh and Bradburd, 1989). These issues have drawn somewhat less attention in the energy and environment literature, at least with respect to energy efficiency regulation. An important exception is Plourde and Bardis (1999), who examine the effects of Corporate Average Fuel Economy (CAFE) standards on vehicle weight, a quality favored by consumers. Producers must meet the fleetwide standard by reducing the weight of two vehicle types, small cars and large cars, which are purchased by two different types of consumers. What results is equivalent to a standard for the (harmonic) average quality. Plourde and Bardis find that when firms are unable to perfectly price discriminate, they shift more effort to improving the fuel economy of small cars rather than the more profitable large cars. However, they assume that consumers demand weight over fuel economy, and therefore have a preference for higher fuel intensity. This relationship is unlikely to apply to most appliances, as power use is less often so directly correlated with other qualities. For example, room air conditioners or refrigerators of the same capacity can range widely in energy use.

Continuing in the tradition of these studies, we evaluate the effect of policies like minimum energy efficiency standards for appliances under different structures of market competition. With perfect competition, producers will offer efficient combinations of product and operating costs, and discrepancies in energy efficiency arise from differences in consumer preferences. However, at the other extreme, a monopolist producer will use energy intensity to separate consumers and extract as much rent as possible. Consequently, the monopolist will not offer consumers of low-end appliances all of the energy efficiency for which they would be willing to pay, in order to be able to charge more for the high-end appliances. Minimum energy efficiency standards can then both improve the economic efficiency of energy intensity choices for low-end consumers and limit the monopolist’s ability to extract rents from high-end consumers. This result contradicts that of the perfectly competitive model, in which minimum standards inefficiently restrict choices of low-end appliance consumers. With this framework, we also revisit the question of average efficiency standards like CAFE, and we compare the
effects of increases in energy prices and innovation. An important focus for this study is the assessment of the distributional effects of energy policies, as well as their impact on efficiency.

2. Model

A consumer’s demand for appliances is typically characterized as a unit demand—the consumer buys either zero or one unit of the good. We employ this characterization, following Mussa and Rosen (1978), Donnenfeld and White (1988) and Plourde and Bardis (1999), with some notational differences. Consider two types of consumers, high-end and low-end. Both derive the same enjoyment from using an air conditioner, but the low-end consumer discounts the stream of that utility flow at a higher rate. For example, the low-end consumer may have to pay a high interest rate to finance the appliance purchase, while the high-end consumer can buy it outright.

Let the utility of consumer $i$ be defined as $u_i = x_i + \beta_i v_i$, where $x_i$ represents all other goods, $v_i$ is the value of the utility flow of using the air conditioner, $\beta_i = \sum_{t=0}^{T-1} \frac{f_i}{1 + r_i}$ is the cumulative discount factor for that utility flow over the lifetime of the appliance, and $f_i$ is the frequency with which the consumer uses the appliance. For some items, like refrigerators, the appliance may be in use 100% of the time; for others, like air conditioners or heating systems, consumers may only run the appliance as desired according to weather conditions.\(^3\) The operating costs are a function of the price of energy, $g$, the frequency of use, and the energy intensity of the appliance, $\phi_j$. The initial price of the good is $p$. Consumer surplus of consumer $i$ for good $j$ is $CS_{ij} = \beta_i (v_i - g\phi_i) - p_j$. Recognizing the frequency with which he or she would use each appliance and value the net benefits, the consumer purchases appliance type 1, 2, or none, whichever provides the most surplus.

We allow our consumer types to differ in two ways. Type 1 (“high-end”) consumers have a higher willingness to pay for appliance services than Type 2 (“low-end”) consumers, or

\(^3\) We recognize that consumers have a choice as to frequency of use and may change their responses according to changes in energy intensity or energy prices. One could easily endogenize that decision, making net utility flows $v_i (f_i - g\phi_i)$. However, while consumer reactions may affect equilibrium levels somewhat, they do not affect marginal incentives with respect to price or energy intensity: according to the Envelope Theorem, small changes in the frequency of use have no effect on consumer surplus, since consumers always optimize with respect to frequency. Therefore, we choose to simplify by incorporating frequency into the discount factor.
v_1 > v_2. Low-end consumers may be poorer and credit constrained, meaning they have higher internal rates of discount and of valuing future flows, since r_1 < r_2. Low-end consumers may also use the appliance less frequently f_1 ≥ f_2. Both of these factors imply β_1 > β_2. Let there be n_1, high-end consumers, and n_2, low-end ones.

The unit cost of producing an appliance is a decreasing function of the energy intensity, c(φ), where c(φ) ≥ 0, c'(φ) ≤ 0 and c''(φ) > 0. There may be some natural rate above which costs do not fall further.

### 2.1 Optimal Energy Intensity

A social planner would choose energy intensities of each appliance type to maximize total surplus, \( TS = n_1(\beta_1(v_1 - g\phi_1) - c(\phi_1)) + n_2(\beta_2(v_2 - g\phi_2) - c(\phi_2)) \). The corresponding first-order conditions are

\[
-c'(\phi_i^*) = \beta_i g
\]

for \( i = \{1, 2\} \). In other words, the planner would reduce emissions intensity until the marginal cost equals the discounted savings to that consumer. The optimal unit price reflects the costs:

\[
p_i^* = c(\phi_i^*)
\]

Low-end consumers value future savings less and may further reduce that cost burden by using the appliance less frequently (\( \beta_1 > \beta_2 \)). Thus, the social planner would offer them an appliance with a lower price and higher energy intensity than that preferred by the high-end consumers.

### 2.2 Monopoly Provision

Now assume that the appliance producer is a monopolist who is aware of the distribution of consumer types but cannot identify a particular consumer’s type. The producer chooses the pairs of prices and energy intensities to maximize profits, subject to two sets of constraints. First, consumers must be willing to buy a unit (\( CS_{ii} > 0 \)). Second, in the case of imperfect price discrimination, they must also be willing to self-select according to type (\( CS'_{ii} > CS'_{ij} \)), since the monopolist cannot distinguish between them and discriminate accordingly. The Lagrangian is

\[
L(p_1, \phi_1, p_2, \phi_2) = n_1(p_1 - c(\phi_1)) + n_2(p_2 - c(\phi_2)) + \lambda_1(CS_{11}) + \lambda_2(CS_{22}) - \lambda_3(CS'_{12}) - \lambda_4(CS'_{21} - CS'_{22})
\]
The first two inequality constraints are those of market participation, while the third and fourth are self-selection constraints. From the earlier definitions, \( \partial CS_j / \partial p_j = -1 \) and \( \partial CS_j / \partial \phi_j = -\beta_j g \). The first-order conditions are then

\[
\begin{align*}
  n_1 &= \lambda_1 + \lambda_3 - \lambda_4 \quad (4) \\
  n_2 &= \lambda_2 + \lambda_4 - \lambda_3 \\
  -c'(\phi_i)n_1 &= (\lambda_1 + \lambda_3)\beta_i g - \lambda_4\beta_2 g \\
  -c'(\phi_2)n_2 &= (\lambda_2 + \lambda_4)\beta_2 g - \lambda_3\beta_2 g
\end{align*}
\]

Under perfect price discrimination, the monopolist can select appliances for the consumers so only the first two constraints apply, and both bind. Then, \( \lambda_1 = n_1, \lambda_2 = n_2, \lambda_3 = \lambda_4 = 0 \), and the monopolist offers the same emissions intensities as the planner. However, the monopolist extracts all of the consumer surplus through the price, so \( p_i^* = \beta_i (v_i - g\phi_i^*) \).

With imperfect price discrimination, the second and third constraints bind. Thus, we have \( \lambda_3 = n_1, \lambda_2 = n_1 + n_2, \) and

\[
\begin{align*}
p_2 &= \beta_2 (v_2 - g\phi_2) \\
p_1 &= \beta_i (v_i - g\phi_i) - \beta_1 (v_1 - g\phi_1) + \beta_2 (v_2 - g\phi_2) \\
&= p_2 + \beta_i g (\phi_2 - \phi_1)
\end{align*}
\]

In other words, the rent the monopolist can extract from the high-end consumer is reduced by the extent to which that consumer is willing to pay more for the low-end appliance than the type 2 consumer. Then,

\[
\begin{align*}
  -c'(\phi_i) &= \beta_i g; \\
  -c'(\phi_2) &= \beta_2 g - \frac{n_1}{n_2} (\beta_1 g - \beta_2 g)
\end{align*}
\]

Thus, the monopolist offers the efficient energy intensity to the high-end consumer, but does not offer all the energy efficiency for which the low-end consumer is willing to pay. That allows the monopolist to charge a higher price to the high-end consumer, since \( dp_1 / d\phi_2 = (\beta_1 - \beta_2) g > 0 \). Market structure does not then change the fact that a variety of price-quality combinations will be offered. The major differences regard the provision of energy.

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4 Since we are primarily concerned with imperfect price discrimination, we will forego the superscript notation for this default scenario.
efficiency in low-end appliances and the distribution of the benefits and costs of regulation or energy price changes.

3. Policy Options

Next, we consider how market structure affects the assessment of two types of regulation: minimum standards and average standards for energy efficiency.

3.1 Minimum Efficiency Standards

Let’s suppose that regulators mandate a minimum level of energy efficiency equal to the socially optimal level for low-end consumers. Monopolists are then constrained from the energy intensity they prefer to provide. As a result, both types of consumers will receive the optimal energy intensities. Low-end consumers will pay a higher price, but one that just outweighs the gains from a more efficient appliance, so they are as well off as (or no worse off than) before. Meanwhile, high-end consumers are made strictly better off, since the price of their high-end appliance must fall to keep them indifferent to the less inefficient lower-cost appliance. Producer profits are strictly lower; the price increase for type 1 appliances will cover the cost increase (since it represents a welfare improvement), but more revenues are lost on type 2 appliances. Since the former is a gain and the latter is a transfer from the producer to consumers, overall welfare is improved by the minimum standard.6

3.2 Average Intensity Standards

Plourde and Bardis (1999) evaluated average intensity standards, but under quite different presumptions. In their analysis, consumers valued weight over fuel savings, so quality improved with energy intensity. Thus, the fuel economy standard behaved like a maximum average quality standard. In our case, quality is negatively correlated with energy intensity, since consumers dislike energy costs. It is thus worthwhile to revisit their problem in the current framework, both to understand how the results depend on consumers’ valuation of quality changes and to evaluate the distributional impacts of regulation.

5 Formally, an additional constraint is placed on $\phi$, the shadow value of which only affects that first-order condition, and is equal to $(\beta_1 - \beta_2)g_n / n_1$.

6 Besanko et al. (1988) note that minimum quality standards can also be achieved with minimum price standards.
Mandating average intensity standards adds a fifth inequality constraint to the Lagrangian, namely \( n_1 \phi_1 + n_2 \phi_2 \leq (n_1 + n_2) \bar{\phi} \). Since quantities are invariant, this makes the energy intensity of the low-end appliance a function of that of the high-end appliance. The modified first-order conditions with respect to price remain the same. However, those with respect to energy intensity include the shadow cost of energy intensity, \( \lambda_5 \): 

\[
-c'(\phi_1) = \beta_1 g + \lambda_5 \\
-c'(\phi_2) = \beta_2 g - \frac{n_1}{n_2} (\beta_1 g - \beta_2 g) + \lambda_5
\]  

(10)

In other words, the marginal cost of lowering the energy intensity of each good is raised by the shadow value of the constraint. Suppose the standard is set such that 

\( n_1 \phi_1 + n_2 \phi_2 = (n_1 + n_2) \bar{\phi} \).

To meet the standard, rather than raising the energy efficiency of the low-end appliances up to optimal levels, the monopolist will make both types more efficient, in order to preserve the ability to price discriminate. As before, low-end consumers will be no better or worse off. High-end consumers see their prices rise, but their appliances also become more efficient, improving their welfare. Using 

\( \phi_1 = ((n_1 + n_2) \bar{\phi} - n_2 \phi_2) / n_1 \), we note that a change in the standard raises consumer surplus:

\[
\frac{dCS}{d\phi} = \frac{d\phi}{d\phi} (\beta_1 g - \beta_2 g) > 0
\]  

(11)

The effects on net welfare, however, are ambiguous, depending on the extent and distribution of the rise in unit costs:

\[
\frac{dW}{d\phi} = n_1 \frac{d\phi}{d\phi} (\beta_1 g - \beta_2 g) - (n_1 + n_2) \lambda_5
\]  

(12)

In relation to the automobile fuel economy case, the critical issue is how consumers value energy efficiency and how energy efficiency relates to other quality attributes (like weight). In our case, \( \beta_1 > \beta_2 > 0 \), so type 2 consumers are offered too little energy efficiency and, correspondingly, too much weight. With the Plourde and Bardis assumptions, in effect the utility weights on the energy costs are \( \beta_1 < \beta_2 < 0 \), so type 2 consumers would get too little weight and too much energy efficiency. In both cases, low-end consumers are offered less of the quality they like. However, within this framework, if consumers have opposing tastes, low-end consumers may be offered too much of the quality they like. Consider the effect of one consumer type preferring weight, while the other prefers fuel economy: \( \beta_1 < 0 < \beta_2 \).

Meanwhile, in discounted terms, consumer 1 is still willing to pay more for a car than fuel-cost-conscious consumer 2 ( \( \beta_1 v_1 > \beta_2 v_2 > 0 \)). In that case, consumer 2 gets much more fuel economy.
than is efficient, since it makes the low-end product more attractive to them, and more importantly, less attractive to type 1 consumers.\textsuperscript{7} These incentives are then exacerbated when an average fuel economy standard is imposed, resulting in small cars becoming smaller and more fuel efficient, while large cars are only slightly downweighted.

4. Energy Prices and Induced Innovation

Market structure also has important effects on how we evaluate the impact of changes in energy prices and in product costs. In particular, we show that while consumers bear the costs and reap the rewards under perfect competition, producers shoulder most of the impacts with price discrimination. Imperfect competition also weakens the signal from an energy price rise or production cost innovation to the producer to increase the energy efficiency of low-end appliances.

4.1 Energy Pricing

The effect of an increase in energy prices is twofold. First, both types of consumers reduce their frequency of use. Second, energy intensity falls for both types of appliances. However, it falls more for the high-end appliance, since low-end consumers value the reduction less and use the appliance less. In the optimal case, $d\phi_i / dg = -\beta_i / c''(\phi_i)$. However, with price discrimination, higher energy prices increase the discrepancy in the marginal valuation of energy intensity between consumers, which facilitates price discrimination, resulting in less incentive to improve the energy efficiency of the low-end appliance:

$$\frac{d\phi_2}{dg} = -\left(\beta_2 - (\beta_1 - \beta_2)n_1 / n_2\right)/ c''(\phi).$$

In the optimal case, since the choice of energy intensity is always optimized, the change in consumer surplus (and welfare, since profits are zero) reflects the direct operating cost increase: $d\CS_i / dg = -\beta_i \phi_i$. However, in our monopoly case, the surplus for the high-end consumers changes according to the effects of the energy price change on the monopolist’s ability to price discriminate. Using the implied decrease in energy intensity for the low-end appliance, we can derive the change in 1’s surplus as:

\textsuperscript{7} Srinagesh and Bradburd (1989) analyzed the difference between total utility and marginal utility of quality among consumer types in determining the effect of price discrimination on quality.
While still negative, this impact is likely to be less than with perfect competition, since it is determined by the differential in operating costs, rather than the direct costs, albeit in proportion to the higher emissions intensity of the type 2 appliance. The impact on consumers of the low-end appliance is by definition smaller, since their surplus is constant (at zero) under monopoly provision.

4.2 Induced Innovation

A driving force for improvements in energy efficiency is technological change. A major empirical question has been the extent to which this change is autonomous or induced. Induced innovation is driven by market forces, the primary incentives for which are cost reductions. In this model, with fixed quantities, they are also the only incentives.

Let us redefine our production costs as a function of innovation, so that \( c(\phi_i) = (1 - \alpha)c_0(\phi_i) \), where \( \alpha \) is a technology shift parameter (the percentage reduction in costs), and \( c_0(.) \) is the current cost function. Since the relevant objective function (profits or surplus) is always maximized with respect to energy intensity, changes in energy intensity that arise from cost reductions do not affect profits on the margin. Similarly, the monopolist always reoptimizes with respect to the prices. Thus, it is the direct cost savings that drive the return to innovation:

\[
\frac{\partial \pi}{\partial \alpha} = n_1c_0(\phi_i) + n_2c_0(\phi_2)
\]  

(14)

To assess the differences in innovation incentives with respect to market structure, we then need only evaluate the differences in costs. If new technologies only affect the costs of high-end appliances, the difference should be negligible. However, if innovation reduces the cost of producing any given level of energy intensity in an appliance, the fact that the price-discriminating monopolist underprovides energy efficiency means that the lower initial costs for the low-end appliances reduces the overall incentives for innovation. Minimum energy efficiency standards then have the added effect of increasing innovation incentives.

These issues also have relevance for estimating induced technological change. Newell et al. (1999) studied innovation in appliance energy efficiency and found it to be driven in significant part by demand, and indirectly by energy prices, as well as by regulation and autonomous progress, although the shares differ by appliance. Since they use price as a proxy
for cost, they prominently acknowledge the importance of their assumption that markup ratios be constant across models and over time. We explore how market structure affects this assumption and find that, while it holds for perfect competition, it is violated under price discrimination as the price response to innovation is completely different.

We can express our markup ratio as \( \mu_i = p_i / ((1 - \alpha)c_i(\phi_i)) \). To maintain a constant markup ratio, it must hold that the percentage change in price equals the percentage change in costs:

\[
\frac{dp_i}{p_i} \mid _{\alpha \to 0} = \frac{c'(\phi_i) d\phi_i}{c(\phi_i) d\alpha} - \frac{1}{1 - \alpha} < 0 \tag{15}
\]

With perfect competition, \( \mu_i = 1 \) and this assumption holds. However, with price discrimination, prices are not directly related to costs but rather determined by demand, and this assumption breaks down. With perfect price discrimination, only the changes in energy costs are passed along in the price:

\[
\frac{dp_i^p}{p_i^p} = \frac{g}{v_i - g\phi_i} \frac{-d\phi_i}{d\alpha}.
\]

Since those are actually energy savings, one should actually predict a price increase with technological progress! With imperfect price discrimination, the effect of innovation on low-end appliance prices is as above, while the markup for high-end appliances is more complicated. Not only is the price of the high-end appliance unrelated (directly) to its cost, but it is also tied to the energy intensity of the low-end appliance. Consequently, the price response to a reduction in costs is

\[
\frac{dp_i}{p_i} = \frac{g}{p_i} \left( \beta_1 \frac{-d\phi_i}{d\alpha} - (\beta_1 - \beta_2) \frac{-d\phi_i}{d\alpha} \right) \tag{16}
\]

Totally differentiating the first-order conditions with respect to energy intensity, we see how it responds to innovation:

\[
\frac{-d\phi_i}{d\alpha} = \frac{-c'_0(\phi_i)}{(1 - \alpha)c'_0(\phi_i)} \tag{17}
\]

Since the high-end market has higher marginal costs to begin with, innovation has a bigger impact on their costs. Consequently, they are likely to experience a larger energy efficiency improvement than the low-end market, although this result still depends on the exact form of the cost function. From (16), one would then also expect innovation to raise prices of the high-end appliance.

Newell et al. do find a decreasing trend in real prices for appliances in their study (from –0.9% for water heaters to –2.2% for room air conditioners). Assuming that consumers’
willingness to pay for these appliances did not fall, this result indicates that some significant degree of competition is limiting the kind of price discrimination characterized here, which would require perfect collusion. On the other hand, it does not necessarily suggest that perfect competition is the rule. To the extent that some price discrimination by producers does occur, such price changes are a weaker proxy for cost changes, and the resulting estimates of induced innovation will admittedly be biased. In essence, while we do expect somewhat less cost-reducing innovation with price discrimination than with perfect competition, our estimates of the innovation that did occur will tend to be too low.

5. Conclusion

Policies to promote energy efficiency have different impacts, depending on the structure of the market for appliances. To illustrate this point, this paper has evaluated various policies under extreme conditions: perfect competition, perfect price discrimination, and imperfect price discrimination by a monopoly. If provision is perfectly competitive, markets will offer the energy efficiency that consumers demand, at least in the absence of other market failures, such as spillovers in technology, incomplete information, or the underpricing of energy. Price changes follow the changes in unit costs induced by the policy, and consumer welfare reflects overall welfare. In the case of minimum standards, if the energy efficiency of low-end appliances is raised too high, the welfare of low-income consumers will indeed fall, as in Sutherland (2003).

However, if producers are not perfectly competitive, the effects are quite different. We presented a model of a producer that uses energy intensity to help segment consumer demand and maximize prices. In this case, since low-income consumers always have lower willingness to pay, the monopolist’s strategy is to charge a purchase price that extracts their entire surplus. Meanwhile, the monopolist offers them inefficiently high levels of energy intensity, in order to be able to charge high-income consumers more for the higher quality appliances. To that same end, the monopolist offers the consumers of the high-end products an efficient level of energy intensity—that is, all the energy efficiency for which they are willing to pay.

In this situation, policies cannot change the net surplus of the low-income consumers, since the monopolist always raises their price according to what they will pay for energy savings. However, minimum energy efficiency standards, by making the low-end appliances more efficient, restrict the monopolist’s ability to discriminate among consumers, resulting in lower prices and higher welfare for high-income consumers. Overall welfare is also improved, since the energy efficiency of the low-end appliance was too low without the policy.
Other policies, like average intensity standards, do not address the price discrimination problem as directly as minimum standards. While average intensity standards improve the energy efficiency of the low-end appliances, they also inefficiently improve the high-end appliances as well, as the monopolist endeavors to keep prices high and markets segmented. A caveat is that energy costs not be directly correlated with other, more important indicators of appliance quality, which can reverse the analysis. The essence of price discrimination is that low-end consumers get less of a quality that both they and high-end consumers value. For many appliances, that quality is likely to be energy efficiency.

Market responses to changes in energy prices also differ depending on market structure. Under perfect competition, consumers bear all the impact of a rise in energy prices, including the increased cost of the more efficient appliances that they subsequently demand. In the price-discrimination model, the monopolist bears the cost increase to low-income consumers. Furthermore, the monopolist can only pass on to high-income consumers the difference in their valuation of the costs of operating the low-end appliance compared to the valuation by low-income consumers. While appliance efficiency increases in response to the energy price increase, it remains inefficiently low for low-end appliances.

Most empirical studies of appliance markets have focused on the demand side, not the structure of the supply side. However, there is reason to believe that appliance markets are not perfectly competitive. For example, Sears, a major retailer, carries only one brand of room air conditioner (Kenmore, its own). While differences in taste, use, and discount rates do create legitimate demand for a variety of cost and energy efficiency options, imperfectly competitive markets will not necessarily provide the right ones. An important question is then, how competitive—or uncompetitive—are appliance producers? To the extent that marginal cost pricing is not the rule and market segmentation through price and quality discrimination occurs, our traditional analysis of appliance efficiency standards and innovation is biased. Price trends will underrepresent cost trends, and energy price changes will tend to induce less innovation. Finally, the welfare and distributional analysis of energy efficiency regulation is quite different. In particular for segmented markets, minimum efficiency standards can play a useful role both in improving the choice of energy intensity and in reducing the distortions from price discrimination. To understand the role for policy, then, we must understand not only how consumers value energy efficiency in their decisionmaking, but also how producers respond to those values.
References


