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Price transparency in residential electricity: Experiments for regulatory policy

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Abstract
We report two laboratory studies conducted in collaboration with a national energy regulator. The first tested whether consumers have difficulties when confronted with unit prices expressed as discounts from standard rates that vary between suppliers. The results imply that such discounts bias decisions and that percentage discounts reduce consumers' ability to integrate product information. The second study pretested an intervention: a mandatory "Estimated Annual Bill" (EAB) calculated for a customer with average usage. The results indicate that the EAB is likely to help consumers to assess the value of advertised packages, to choose packages with lower unit rates, and to integrate product information accurately. In addition to providing evidence for policy, our findings are consistent with decision-making mechanisms that give increased weight to product information that is easy to process.

JEL Classification: D12; D18

Keywords
price transparency — mandated simplification — consumer protection — energy

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Introduction

Price transparency is an important principle of consumer protection policy, both for reasons of fairness and as a necessary condition of a functioning competitive market. In any given market, whether prices are transparent is an empirical matter. Evidence from behavioral economics and consumer psychology shows that marketing practices that split prices into two or more components can affect consumers' abilities to make good decisions, even if no price component is hidden (Grubb 2015, Greenleaf, Johnson, Morwitz, and Shalev 2016).

The experimental investigations described in this paper were initiated by concerns among policymakers about price transparency in Ireland's electricity market. The island of Ireland has a single regulated wholesale electricity market in which multiple residential suppliers purchase electricity. Following domestic price deregulation in 2011, suppliers are free to set their own residential tariffs; the system relies on competition to hold prices down. The main suppliers all employ a marketing strategy that involves framing unit prices as discounts from standard prices, expressed as percentages or annual cash savings. The apparent enticement of such discounts might prompt consumer activity, but this price frame could also be problematic from the consumer's perspective. Discounts are offered relative to the standard unit rate (SUR) for the specific company. Because SURs vary across companies, discounts are not perfectly correlated with unit prices, which ultimately determine bills. The unit rate is the primary determinant of value, since the large majority of consumers in Ireland do not purchase electricity by fixed quantity, but are instead billed by usage at the end of a time period.

This policy issue prompted the present study in applied behavioral economics. Working closely with Ireland's energy regulator, the Commission for Energy Regulation (CER), we conducted two experimental studies that sought to assess: (1) Whether framing prices as discounts from variable SURs has an impact on consumers' decisions; (2) Whether a mandatory simplification under consideration by the regulator would be likely to assist consumers. The mandate would impose a specific price frame, requiring all marketing of residential energy packages to display an "Estimated Annual Bill" (EAB) calculated for a customer with average usage (set by regulatory standard).

Our findings suggest that the discount price frame is detrimental and, with some qualifications, that the proposed simplification is likely to be beneficial. The studies were motivated by behavior and policy in a specific market and country, yet our findings are relevant wherever discounts are applied to standard prices that vary across firms. The results also have implications for understanding the psychological mechanisms involved in the integration of product information – a recurring issue for consumer protection policy.

Consumer errors when comparing tariffs

While the deregulation of domestic energy markets has delivered some benefits in terms of choice, improved service quality and lower prices in retail markets (Joskow 2008), international evidence points to price dispersion, low switching rates and substantial numbers of consumers who struggle to locate the best value offerings (Giulietti, Price, and Waterson 2005, Brennan 2007, Wilson and Waddams Price 2010). The last of these studies combined survey and billing data to show that the large majority of a sample of British electricity consumers who switched supplier to make savings did not choose the best deal; one quarter switched to a worse one. The authors concluded that many choices "are consistent with genuine decision error or inattention" (p.665). These findings indicate errors in consumers' decision-making, but offer less insight into the causes of errors.

Insight into possible causes comes from work on consumer psychology and human judgement. Energy tariffs typically involve partitioned pricing, meaning that prices are presented in components. At minimum, there is a fixed annual price (in Ireland, the "standing charge") plus a unit price (per kWh). Additional components can include multiple unit rates (e.g. peak and off-peak), promotions and discounts. Evidence shows that separation of prices into components can affect choice (Morwitz, Greenleaf, and Johnson 1998, Office of Fair Trading 2010). A recent review of partitioned pricing research (Greenleaf, Johnson, Morwitz, and Shalev 2016) argued that it may lead consumers to pay insufficient attention to smaller components, to combine components inaccurately, or to alter how price information is combined with other product attributes.

A discount from a variable standard price is a particular kind of partitioned price. We know of no empirical study that has addressed its impact directly, but some studies indicate potential effects on consumer choice. The practice is likely to increase cognitive load, a factor previously linked experimentally to suboptimal choice of energy packages (Sitzia, Zheng, and Zizzo 2015). One possibility is that the information processing required induces uncertainty, causing consumers to give less weight to price information relative to other factors. Such effects have been recorded for the weight given to surcharges (Morwitz, Greenleaf, and Johnson 1998) and this possibility is consistent with laboratory studies in which the ease of mental processing of a cue, or "cue fluency", increases its weight in judgements (Shah and Oppenheimer 2007). How the discount is expressed may matter too. Consumers generally process percentages with distortions (Kruger and Vargas 2008), although there is mixed evidence regarding whether expressing discounts as cash or percentage reductions alters choices (DelVecchio, Krishnan, and Smith 2007, p.160-161).

Given the lack of previous direct evidence, we designed our first study to address two broad questions: (1) Does discounting residential electricity packages from variable SURs alter consumers' choices? (2) Does it affect consumers' ability to integrate product information into decisions? Thus, the first question addresses bias in decisions, while the second addresses the precision of decisions.

Study 1: How do discounts affect consumers' decisions?

Method

Thirty-six consumers were chosen from a list who had responded to an advert looking for participants in experimental research. The sample was broadly representative of the adult (18-70 years) population by gender, age and working status. Participants visited PRICE Lab and undertook the experiment individually. They received a fee of 25€. Experimental sessions lasted approximately one hour (including a refreshment break). Participants undertook two types of computerized task. Full descriptions (including example displays) are available in online appendices.

First was a binary choice task. On each of multiple trials, participants were shown a pair of hypothetical electricity packages, presented as offerings from two of Ireland's four major suppliers. Offers were based on the SURs in the market at the time (Summer 2015). Participants were told throughout that all discounts were relative to standard rates that varied between the companies and that decisions were of the form: if supplier A was offering price X and supplier B was offering price Y, which would you choose? The primary comparison was between price frames. In some experimental runs prices were given as a discount, while in others they were given simply as a per-unit-rate (PUR) in cents per kWh. Participants responded by pressing one of two buttons. Experimental runs were 24 trials long. Packages were designed to resemble online marketing material, with large fonts, bright colors and logos. In this and all other tasks, minor variations in presentational characteristics were uncorrelated with prices and other product attributes, and hence could not contribute systematically to the trade-offs under investigation. There was no time limit for decisions; participants proceeded at their own pace.

We manipulated the information available across multiple stages, summarized in Table 1. Half the participants saw discounts expressed as percentages throughout, while half saw annual Euro discounts; the two types were not mixed. In Stage 1, packages consisted of only the suppliers' name and unit prices (discount or PUR), with no SUR information provided. At this stage, participants had to rely on background knowledge of suppliers and completed one run for each price frame (counterbalanced by order). In Stage 2, participants were initially shown the four SURs, before completing another run under the discount price frame. This simulated a situation where consumers had seen how SURs varied across suppliers but relied on memory to make judgments. Stage 3 involved a further run under the discount frame with SURs always presented directly alongside prices, simulating a situation where consumers had looked up and noted suppliers' SURs. In Stage 4, more attributes were added: the standing charge (correct for the supplier) and whether the package entailed

Stage	Task	Attributes	Price frames	Information
1	choice	brand, price	discount, PUR	none
2	choice	brand, price	discount	SURs initially
3	choice	brand, price	discount	SURs each trial
4	choice	brand, price, standing charge, billing method	discount, PUR	SURs each trial
5	S-ID	brand, price, standing charge, billing method	discount, PUR	SURs each trial

Table 1. Sequential stages undertaken by participants in Study 1.

e-billing (i.e. no paper bill). Participants again undertook one run for each price frame.

Prices (0-20% discount), suppliers and (in Stage 4) other attributes were drawn pseudorandomly. Since some participants were likely to have pre-existing brand preferences, at the start of each stage prices adapted to ensure that each individual participant faced a trade-off between brand and price. Where a participant's early choices favored a given supplier, that supplier was made progressively more expensive as the trials progressed, to ensure that price became a factor in decisions. Note, however, that across price frames trials were precisely matched, so this adaptive procedure could not produce variation in choices under the different price frames – any difference in observed responses implied different decisions when faced with identical offerings described by alternative price frames.

In Stage 5, following a refreshment break, the second type of task was undertaken. A "Surplus Identification" (S-ID) task (Lunn, Bohacek, and McGowan 2016) tests how accurately consumers combine product information. The task again required a binary decision, but the decision was not subjective. The available surplus (the superiority of one of the two offerings) was objectively defined using a "buyer's agent" paradigm, where the preferences of the buyer conformed to a linear combination of product attributes, with pre-set weights. Attributes were as for Stage 4. Participants were told that their job was to choose a package for an elderly relative. They initially received a description of what the buyer was looking for and eight example choices, together with an explanation of why the buyer preferred one package over the other given the trade-offs involved. They then undertook trials in which their task was to select one of two packages for the buyer. Correct answers were rewarded with a friendly "ping" and a picture of a smiling older person; incorrect answers generated a "buzz". The surplus adapted to the participant's performance, reducing following correct responses and increasing following incorrect responses. Participants undertook one experimental run of 60 trials for each price frame (counterbalanced by order).

Although participants might be more accurate when choosing for themselves than when trying to apply someone else's preferences, the key measure was *relative* performance. Superior accuracy under one price frame implies that it is easier to integrate the product information into decisions.

Performance in both tasks was incentivized using a tournament incentive. One in ten participants stood to win a 50€ shopping voucher. For the S-ID task, winners were determined straightforwardly by accuracy. For the choice task, participants were told that their best way of winning a voucher was to choose what they would truly prefer if faced with the two offerings in real life. We explained that we had a statistical method for testing how accurately people responded according to their true preferences and reiterated that this was the best way to win a voucher. No participant queried this. Voucher winners were determined by consistency across price frames. The purpose of this incentive was to motivate participants to concentrate and to be consistent. While it is logically possible that a subset ignored our advice and tried somehow to second-guess the assessment method, given our interaction with participants and the smooth unimodal distribution of our descriptive data, we judge this to be highly unlikely (see online appendix).

Results

Statistical significance was established via multi-level mixed effects models (online appendix). Figure 1 provides results for the choice tasks (Stages 1 to 4). Responses were closely similar for Euro versus percentage discounts, so these data are pooled. In Stage 1, when prices were directly expressed as PURs, participants opted for the lower unit price on over 80% of trials. When prices were framed as discounts, choices were not statistically significantly different from chance (50%). Showing participants suppliers' SURs (Stage 2) resulted in a small increase in choices favoring the lower unit price. Providing SURs on every trial (Stage 3) increased the proportion to just less than 62%, still significantly below the proportion for the PUR price frame ($p<0.01$). In Stage 4, when the standing charge and a billing method were added to offerings, the lower unit price package was chosen 50% of the time under the discount frame, significantly less than the 65% under the PUR price frame ($p<0.01$).

The differences between the price frames were strongly statistically significant and robust to alternative analyses. Employing the lower average annual bill as the key measure produced almost identical results. Individual differences were

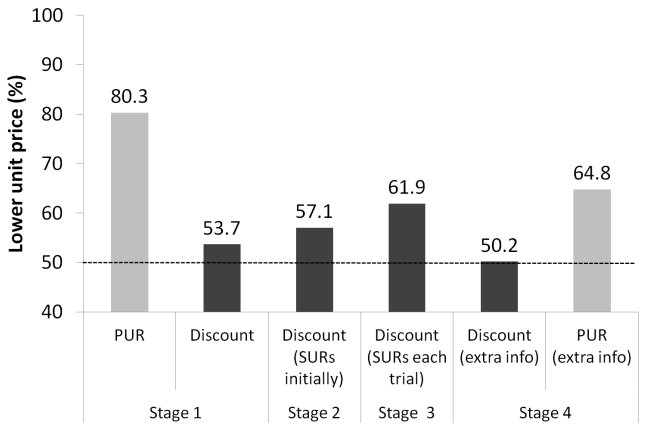

Figure 1. Proportion of choices favoring package with lower unit price in Study 1.

minor: the large majority of participants followed the above pattern.

To analyze the responses to the S-ID task, for each individual we calculated the "just noticeable difference" (JND), which equates to the size of surplus required to identify the better package with 86% accuracy. (This threshold was used because it corresponds to the standard deviation of the logistic distribution fitted to the binary data). Figure 3 displays the median JND by price frame. Under the PUR price frame, participants identified the better product 86% of the time when the difference between the two packages corresponded to 42.06€ on the annual bill (which ranged in the experiment from (697-953€). The JND under the Euro discount price frame was almost identical, but for the percentage discount price frame a significantly higher surplus of 58.11€ was required for participants to identify it reliably (p=0.01).

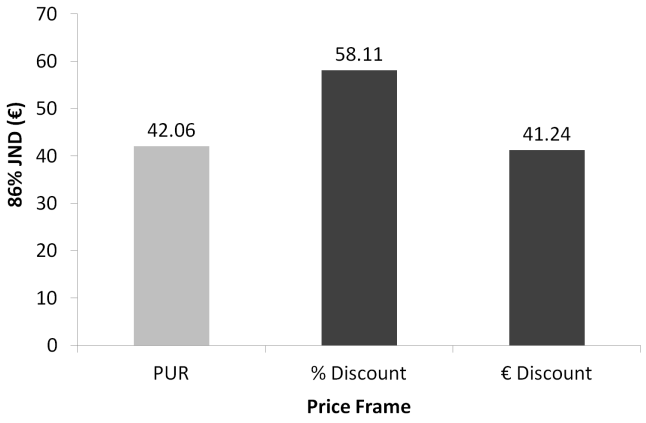

Figure 2. Median "just noticeable difference" (JND) for identifying that one package was superior to another by price frame, Stage 5 of Study 1.

Study 1 can be summarised by the following two results: (1) consumers opted for lower unit price packages when the unit price was expressed as a PUR rather than a discount, despite an incentive to respond consistently; (2) consumers integrated product information less accurately in the percentage discount price frame. The implication is that the discount price frame reduces price transparency.

As with all laboratory experiments, relating the results to everyday consumer decisions requires careful consideration. On the one hand, our results may underestimate the true impact of the discounts, because participants were told that the discount applied to variable standard rates, had opportunities to learn, and were not confronted with both types of discount simultaneously. On the other hand, the experiment tapped only intuitive judgment. Our results would not apply where a consumer uses a calculator or decision-aid, such as a price comparison site. Note, however, that even then consumers must make an initial decision to invest time and effort – a decision that may be influenced by price frames in the market.

Study 2: Pretesting a mandatory estimated annual bill

Study 2 was designed to pretest an intervention under consideration by the regulator (Commission for Energy Regulation 2016) which would mandate marketing material to display an "Estimated Annual Bill" (EAB) calculated for (standardized) average usage. Standardized price frames operate effectively in other domains (e.g. the annual percentage rate, APR, on credit products) and mandatory simplification is increasingly used by regulators (Sunstein 2011).

Study 2 addressed three research questions: (1) Does an EAB prompt consumers to choose packages with lower unit prices? (2) Does an EAB affect the ability to integrate product information? (3) Does any impact depend on specifics of how the EAB is displayed (its prominence and the presence of an explanatory footnote), given that previous research shows that font-size influences how consumers respond to surcharges (Kim and Kramer 2006).

Method

Methods were as for Study 1 with the following modifications. Forty consumers were recruited by a Dublin-based market research company. They received 30€ for participation – higher than Study 1 only because lab participation fees had gone up in the interim. The study had four stages, summarized in Table 2. Stage 1 was an advertisement rating task. Participants rated deals from 1 ("very poor deal") to 7 ("very good deal"). They simply observed the adverts and received no explanation regarding price descriptions. Sixteen adverts were displayed, one for each supplier under four sequential conditions: (1) no EAB information; (2) with "Estimated Annual Bill xxx€" in a smaller font below discount information; (3) with the EAB displayed in the equivalent style and font to the discount; (4) with an additional footnote explaining the EAB. Adverts were designed to resemble billboard or magazine adverts, with photographic backdrops typical of international marketing

Stage	Task	Attributes	Price frames	Information
1	advert rating	brand, price, cash-back	discount, +EAB, +large EAB, +large EAB/footnote	none
2	choice	brand, price standing charge, cash-back, promotion	discount, EAB	none
3	choice	brand, price standing charge, cash-back, promotion	discount, EAB	SUR sheet
4	S-ID	brand, price, standing charge, cash-back, promotion	discount, EAB	SUR sheet

Table 2. Sequential stages undertaken by participants in Study 2.

practice (see online appendices), counterbalanced across suppliers and participants. The attributes of the packages matched the actual offerings of suppliers in June 2016.

Stage 2 involved a choice task. Participants undertook two runs (order counterbalanced), with unit prices indicated via a discount in one and via an EAB in the other. We explained that discounts were relative to different standard prices for each company, but did not provide SURs. Types of discounts were mixed. At the time of Study 2, one supplier promoted cash discounts and three used percentage discounts; this was adopted in the experiment. In the period between studies, suppliers had begun offering promotional inducements (e.g. cash-back, free goods, supermarket points). This raised an issue, because the mandated EAB would include discounts, cash-back and refunds, but not non-monetary promotions. To reflect this, some packages in the choice task included cash-back (0€, 50€, 100€) and/or a free Ireland soccer jersey (a promotion offered at the time of the experiment, which coincided with the European Football Championships). In Stage 3, participants completed the choice task again but were given a laminated sheet with the four SURs to refer to throughout.

Stage 4 consisted of an S-ID task under both price frames. Half the participants chose for an elderly relative with lower than average usage, half for a family with above average usage. Packages varied in standing charge, unit price, billing method, cask-back and whether free supermarket points could be earned. Examples were shown to illustrate the trade-offs involved. Because we had reason to suspect that the effectiveness of the EAB might depend on the surplus, task difficulty did not adapt to performance but instead each trial was "easy", "medium" or "hard" (surpluses of 20%, 12% or 4% of the price range).

Results

Figure 3 presents results from Stage 1. Mean ratings for advertisements by condition and supplier (A, B, C, D) are ordered by SUR (listed in the legend), with differences between successive ratings replotted below. The EAB prompted significantly lower ratings for suppliers with higher SURs and higher ratings for those with lower SURs ($p<0.01$). This effect strengthened when the EAB was displayed as prominently as the discounts ($p<0.05$). The increase between the first and third rounds of ratings for supplier D, which had the lowest SUR, was approximately one standard deviation. The explanatory footnote had minimal additional effect. Across the conditions, 34 of the 40 participants increased their rating for supplier D relative to supplier A. Thus, overall, the EAB had a strong impact on perceptions of good versus bad deals.

Figure 4 shows results for the choice tasks of Stages 2 (no SURs) and 3 (SURs provided). Participants were substantially and significantly more likely to choose the package with the lower unit price when prices were framed as an EAB ($p<0.01$). Statistical modeling confirmed that participants placed greater weight on the price information compared to other product attributes under the EAB price frame ($p<0.01$). The effect was consistent across individuals: 33 of 40 participants became more inclined to opt for the lower unit price under the EAB price frame. There were two smaller but nevertheless statistically significant effects. The likelihood of choosing the lower unit price offering fell between Stages 2 and 3 ($p<0.01$), which may have reflected confusion following the introduction of a third piece of price information (the SURs). The effect of introducing the EAB was also stronger for those who experienced the discount condition first ($p<0.01$), perhaps reflecting different speeds of learning depending on which price frame was encountered first.

Figure 5 shows results from the S-ID task in Stage 4. The probability of deciding that the product on the right was better is plotted as a function of the surplus. Data from the low

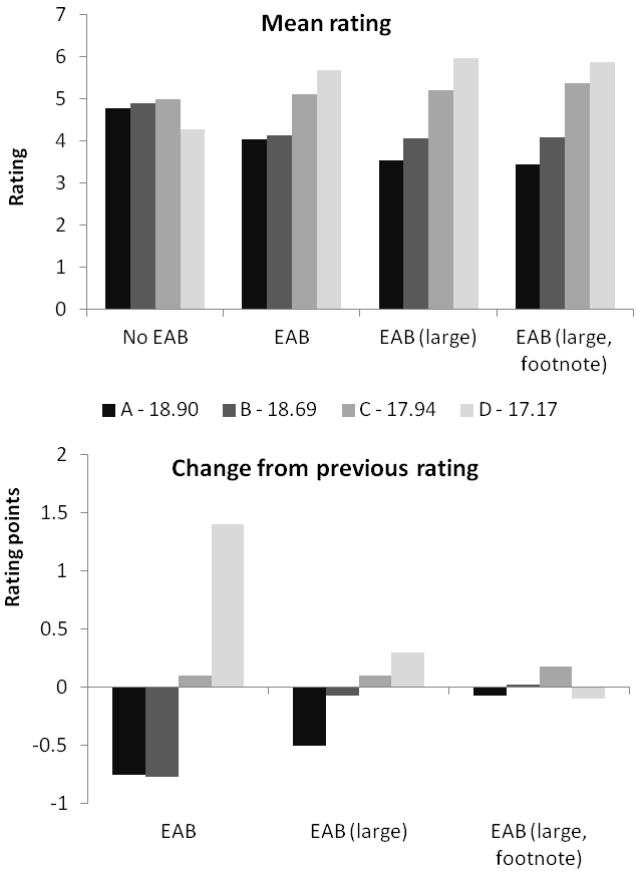

Figure 3. Advertisement ratings by brand in Stage 1 of Study 2.

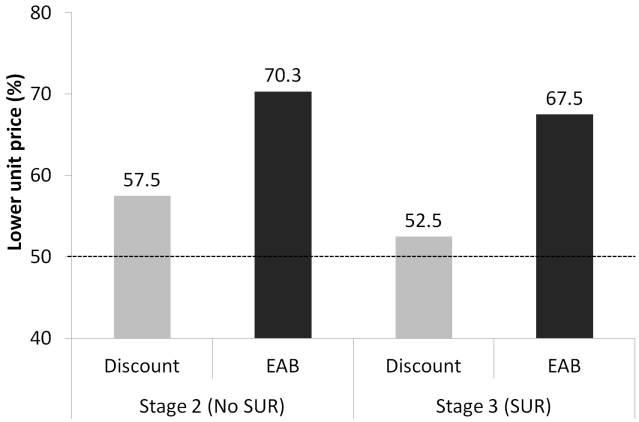

Figure 4. Proportion of choices favoring package with lower unit price by price frame, in Stages 2 and 3 of Study 2.

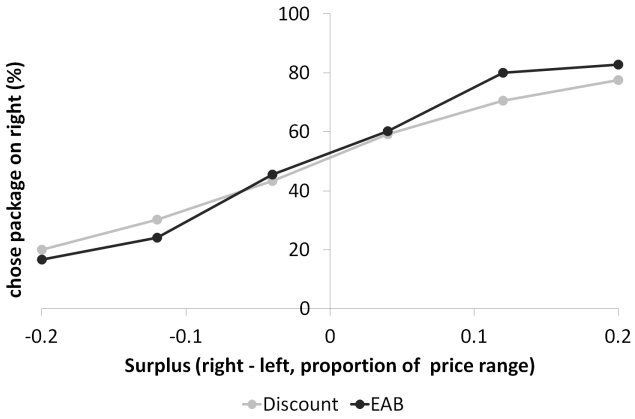

Figure 5. Probability of determining that the package on the right was the better package for the buyer as a function of the surplus, in Stage 4 of Study 2.

usage and high usage conditions are pooled, with surplus expressed as a proportion of the range of annual bills. The EAB price frame significantly increased the precision of participants' judgments for the two larger surpluses (12% and 20%, $p<0.01$) but not the smaller surplus (4%).

To summarise the results of Study 2: (1) consumers' judgments of adverts tallied better with unit prices when EAB information was added, especially when it was prominent; (2) consumers chose lower unit prices more often under the EAB price frame than the discount price frame; (3) the EAB made it easier to integrate product information into decisions, at least for larger surpluses. This overall pattern of results clearly favors the EAB intervention.

The lack of an effect for small surpluses in the S-ID task probably reflected the relative weighting of fixed and unit price components. The more usage differs from average and the greater the variation in fixed components, the less accurately the EAB signals the lowest overall price, especially at low surpluses. The implication is that if variation in cash-back or standing charges between suppliers were to increase relative to variation in unit prices, the usefulness of the EAB would be reduced for consumers with non-average usage.

Conclusions

The two experimental studies provide evidence for two separate but related conclusions. First, Study 1 implies that expressing unit energy prices as discounts from standardized rates that vary by supplier reduces price transparency and is likely to be detrimental to consumer decision-making, relative to more straightforward descriptions of prices. Second, Study 2 suggests that the introduction of a mandated "Estimated Annual Bill" (EAB) is likely to help consumers to locate cheaper electricity packages from among available offerings. The findings of both studies are consistent with a psychological mechanism that gives greater weight in decisions to explicit information that is easier to process.

These laboratory experiments represent an innovative application of behavioral economics to regulatory policy and some caveats are naturally required. Firstly, while our designs aimed to test capabilities and mechanisms likely to affect real-world choices, the environmental validity of laboratory

experiments needs always to be considered carefully. Secondly, we considered only impacts on consumer choice, not how suppliers might alter prices and marketing in response to the introduction of a mandated EAB. Lastly, any costs associated with the intervention need to be weighed against estimated benefits.

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