### *Conveyance, envy, and home-owners adoption*

### *of energy-efficient appliances*

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#### **Overview**

The energy efficiency paradox postulates that individuals and organizations refrain from adopting energy-efficient technologies, even though these technologies appear profitable based on net present value calculations (e.g., Jaffe and Stavins, 1994). Following Gerarden et al. (2015), the factors explaining this paradox may be classified in three categories: (i) market failures such as incomplete contracts stemming from asymmetric information, split incentives, and agency issues; (ii) behavioral anomalies such as present bias, myopia and loss aversion; and (iii) measurement errors stemming among others from adopter preference heterogeneity. This paper addresses two of these categories, market failures and measurement errors, thereby investigating two novel facets for each: as market failure, we focus on conveyance (i.e., leaving one’s appliance for the next homeowner in the dwelling when moving out) as an example of incomplete contracts, and as measurement error, we focus on heterogeneity in envy, a relatively unstudied social preference.

While the literature has long recognized the existence of the landlord-tenant and other agency problems (e.g. Davis, 2012; Olsthoorn et al. 2017), Sandler (2018) recently brought to the fore another type of in-complete contract for homeowners: conveyance. Specifically, Sandler (2018) suggests that the fact that appliances convey may lead homeowners to purchase less energy-efficient products, because conveyance shortens the expected length of ownership. The discounted present value of an appliance purchase may therefore be lower than what it would be if the appliance had been kept for its entire useful lifetime - unless the value of the investment is fully capitalized into the real estate sales price. Capitalization may be incomplete because preferences of original and new owners may differ and rounding off (housing prices are typically rounded off to the nearest thousand dollars, yet differences in costs of energy-efficient versus non energy-efficient appliances are a few hundred dollars, at most). Sandler (2018) further finds “suggestive evidence” that in federal states in which conveyance dominates, consumers tend to purchase refrigerators with lower energy performance.

In the context of conveyance, the fact that the appliance adopted will be used by the future house buyer adds a concrete social dimension; as a consequence, socially-centered preferences, especially envy, may affect the characteristics of the chosen appliance. Since the value of individual appliances is not fully capitalized into housing prices, envious potential house sellers might resent the fact that house buyers get high quality appliances at little to no extra cost.

In this paper we investigate the impact of expected conveyance on homeowners’ willingness-to-pay (WTP) for attributes of new refrigerators (including energy efficiency) and also analyze the moderating role of envy on willingness-to-pay for these attributes. To do so, we conducted a survey among homeowners in the U.S., which included a discrete choice experiment and an incentivized envy game. We chose to focus on the U.S. market because mobility in the U.S. is rather high and conveyance of major appliances is quite common.

#### **Methods**

We implemented an online survey in June 2018 via computer-assisted web interviews among 504 homeowners in the U.S. using an existing panel from Prolific Academic. Participants were selected via quota sampling to be roughly representative in terms of gender and regional population dispersion; only participants who reported being involved in their household’s investment decisions were qualified for the survey. The survey included a stated preference discrete choice experiment. Participants were asked to imagine that their refrigerator had broken down and thus needed to be replaced. Respondents were then asked to make a series of choices between different refrigerator purchase options differing by energy consumption, capacity, length of warranty, brand, customer review ratings, and purchase price (see Table 1). The attributes energy consumption, capacity, brand, and purchase price have already been used in choice experiments on refrigerator purchase (Ward et al. 2011). We added to this list two quality attributes: length of warranty and customer review ratings. To increase the efficiency of design, we applied a Bayesian efficient design. The priors used for the design were obtained from a pilot study with 50 U.S. homeowners. Our choice experiment consisted of 24 scenarios divided into three blocks. Each respondent was randomly assigned to one of the blocks and faced eight scenarios.

Table 1: Levels of different attributes considered in the choice experiment

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| Attribute | Levels |
| Energy cost | $54; $66; $78; $90 |
| Capacity | 18 cu. ft.; 20 cu. ft.; 22 cu. ft.; 24 cu. ft.; 26 cu. ft.; 28 cu. ft. |
| Warranty | 1 year; 3 years; 5 years |
| Brand | Well-known quality brand; lesser-known brand |
| Customer review | 2.5/5 stars; 3.5/5 stars; 4.5/5 stars |
| Price | $799; $999; $1,199; $1,399; $1,599; $1,799, |

Following the choice experiment, respondents took part in an incentivized envy game inspired by Fehr, Bernhard and Rockenbach’s (2008) envy game and by Güth’s (2010) generosity game. In our game, respondents were informed that one out of every 100 respondents would be selected at random to receive an amount between zero and 100 U.S. dollars in addition to the participation fee. The exact amount would be determined by another randomly selected respondent. Respondents were then asked to indicate how much another participant should receive in case they were selected to determine this amount. We further informed respondents that they could be selected either as a receiver or as a giver, but not both, thus excluding any form of reciprocity from the game.

We estimated several mixed logit models in WTP space. We first estimated a base model which includes the attributes only. Then we ran a model exploring the impact of conveyance on willingness-to-pay for attributes of refrigerators, especially for likely conveyors. We therefore created a dummy variable to distinguish conveyors from non-conveyors. Conveyors are defined as respondents who stated they would leave their refrigerator with the home when they sold their current home and that they planned to move within the next 5 years. To test for the effects of envy on refrigerator characteristics, we included interaction terms for each attribute with a dummy which takes on the value of one, if respondents give at most the median amount of $86 in the envy game. To assess the effects of envy in the context of conveyance, we split the sample into conveyors and non-conveyors.

#### **Results**

The findings suggest that conveyors are more likely to purchase a smaller refrigerator, from a less well-known brand, and with lower customer ratings. In contrast, conveyance was not found to affect respondents’ willingness-to-pay for energy costs. Envy generally reinforces these effects of conveyance.

#### **Conclusions**

Conveyance negatively affects product quality characteristics and size, but does not appear to be related with energy performance. Hence, Sandler’s (2018) conclusion that conveyance leads to the adoption of less efficient refrigerators may therefore have been an indirect effect. Homeowners may incidentally purchase less energy-efficient appliances (even without paying attention to energy consumption) through the purchase of lower quality appliances. However, this effect on energy consumption may be compensated by conveyors’ choice of smaller refrigerators, which typically consume less energy than larger ones. Our results further suggest that envy preferences may play a large role in explaining preferences for certain attributes when appliances convey, thus contributing to explaining the energy efficiency paradox.

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