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Conveyance and the moderating effect of envy on homeowners' choice of appliances

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Abstract

Conveyance, i.e., the fact that an appliance purchased will be left in the dwelling when moving out, may lead homeowners to purchase appliances of lower quality or performance, because the extra costs are not entirely capitalized into the house sales price. Employing a discrete choice experiment with homeowners in the United States, this paper explores the effects of conveyance on homeowners' willingness-to-pay for various attributes of refrigerators. To account for the social nature of purchases when conveyance is likely to occur, it also tests the moderating role of envy (elicited through an incentivized game). 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 homeowners' choices when it comes to energy cost. In addition, envy was found to generally reinforce the negative effects of conveyance on homeowners' willingness-to-pay for quality and performance attributes. While conveyance and its interaction with envy help explain homeowners' choice of quality/performance attributes of appliances, these factors do not appear to explain the energy efficiency paradox.

Key words: energy efficiency paradox, conveyance, envy, choice experiment.

Highlights:

- Conveyance negatively affects quality/performance attributes of refrigerators.
- Conveyance is not found to affect energy performance.
- Envy reinforces the effects of conveyance on quality/performance attributes.
- Interaction of conveyance and envy does not explain the energy efficiency paradox.

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1 Introduction

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., Gerarden et al., 2015; Gillingham and Palmer, 2014; Jaffe and Stavins, 1994; Sorrell et al., 2004). Following Gerarden et al. (2015), the factors explaining this paradox may be classified in three categories: (i) market imperfections 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 imperfections and measurement errors, thereby investigating two novel facets for each: as for market imperfection, 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.

A prominent example for incomplete contracts is the so-called landlord-tenant (or user-investor) problem. Because of information asymmetry and transaction costs (e.g. for working out contractual arrangements, for verifying the benefits from the investment accruing to the landlord and tenant – such as an increase in property value and lower energy expenditures, respectively), landlords and tenants cannot enter into a contract that ensures that landlords can recover investments in, say, insulation measures, which would benefit tenants through lower heating expenses. Technically speaking, the terms of the contract fail to specify the obligations of the contract partners (here a landlord and a tenant) under every possible set of contingent facts (Grossman and Hart, 1986). If landlords cannot pass on these costs to their tenants (e.g. via higher rents), they have no financial incentive to invest in such measures.

While the literature has long recognized the existence of the landlord-tenant and other agency problems (Davis, 2012; Gillingham et al., 2012; Krishnamurthy and Kriström, 2015; Olsthoorn et al. 2017; Schleich, 2009), Sandler (2018) recently brought to the fore another type of incomplete contract for homeowners: conveyance. Specifically, Sandler (2018) suggests that the fact that appliances convey (i.e., are left in the dwelling for the next homeowner when the dwelling is sold) may lead homeowners to purchase less energy-efficient products, because conveyance shortens the expected length of ownership. The net 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. Similar to the landlord-tenant problem, asymmetric information (about appliance performance and quality) and transaction costs may prevent the seller and buyer of a dwelling from agreeing to a contract that ensures that the seller can fully recover her investments in energy-efficient appliances. Relying on sales data of houses in the U.S. real estate market (where conveyance is the default in many U.S. federal states), Sandler (2018) concludes that the value of appliances (refrigerators and clothes washers) is not fully capitalized into housing prices when a homeowner moves and appliances convey. As a consequence, conveyance causes these households to buy less expensive appliances. Possible reasons for incomplete capitalization include the fact that preferences of the original and new owners may differ[1], 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 States in which conveyance dominates, consumers tend to purchase refrigerators with lower energy performance (but he finds no such effects for clothes washers).

Because of data availability, Sandler (2018) could not disentangle energy performance from other possibly correlated features which may lead to a spurious association between low price and low energy efficiency. The lower price of refrigerators in the states where conveyance is the default may for instance be explained by smaller size or lower quality rather than lower energy efficiency. Likewise, if quality or brand are positively correlated with energy performance, buyers valuing quality (or brand) may incidentally purchase more energy-efficient appliances. Existing studies therefore do not allow testing for such effects or for clearly identifying the effect of conveyance on the adoption of energy-efficient appliances. In the present research, the use of a discrete choice experiment allows for the disentangling of the effects of price, size, brand, quality, and energy consumption.

1 Houde (2016) finds substantial heterogeneity in consumer valuation of energy efficiency in appliances.

Gerarden et al. (2015) identify heterogeneity in preferences as a main source of measurement errors when studying energy-efficient technology adoption. Previous research has investigated the link between the adoption of energy-efficient technologies and heterogeneity in time and risk preferences (e.g., Bradford et al., 2017; Qiu et al., 2014; Schleich et al., 2019), in environmental attitudes (e.g., Di Maria et al.; 2010; Ramos et al., 2015), and in social preferences, especially social norms (e.g., Allcott, 2011). In a recent working paper, Fischbacher et al. (2018) study the impact of a novel type of social preference, envy, on energy-efficient technology adoption[2]. They find that envious homeowners are more likely to invest in energy-efficient measures such as home insulation and reason that investments in energy efficiency might be partially driven by envious homeowners' dislike for being behind. However, as Fischbacher et al. (2018) do not consider a concrete social interaction such as conveyance, the social dimension is rather indirect in their study.

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, in addition to individually-centered preferences, socially-centered preferences, especially envy, may affect the characteristics of the chosen appliance. Because the value of individual appliances may not be 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. This reasoning is anchored within a large body of empirical literature revealing that envious individuals react negatively when others are better off or receive undeserved payments (see for example Zizzo and Oswald, 2001; Beckman et al., 2002; Casal et al., 2012).

To sum up, in this paper we investigate the impact of expected conveyance on homeowners' willingness-to-pay 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 (DCE) and an incentivized envy game.

2 To be precise, Fischbacher et al. (2018) study envy and fairness preferences. Envy also differs from inequity aversion. An envious person dislikes inequity if she is worse off compared to others (but not if she is better off compared to others). The fact that the buyer of the house gets high quality appliances at little to no extra cost might be considered inequitable by the seller of the house. In contrast to an envious person, an inequity averse person always dislikes inequity – whether she is better off or worse off compared to others.

Our paper adds to the extant literature in two ways. First, we provide empirical evidence on whether conveyance (i.e., incomplete contracts) leads homeowners to purchase appliances of lower quality or performance such as energy efficiency, thus complementing the work by Sandler (2018). Second, we investigate the moderating role of a novel type of social preference, envy, which we expect to play a strong role in situations that involve multiple actors (here current and future homeowners). Our findings offer novel insights into the factors explaining the energy efficiency paradox and provide guidance for policy (i.e., for regulation on conveyance).

The remainder of the paper is organized as follows. Section 2 presents a brief formal conceptual model linking appliance choice with conveyance and envy. Section 3 presents the empirical methodology, including the survey with the stated preference discrete choice experiment, an incentivized game to elicit respondents' envy, and the econometric model. Section 4 reports the findings. The final Section 5 summarizes and discusses the main findings.

2 Conceptual model of appliance choice

Following Berry and Pakes (2007), our model assumes that each consumer buys one product from a set of products with different characteristics (in this case, a homeowner buying one refrigerator from a set of refrigerators). Consumer *i*'s preferences for product *j* may be captured by the following indirect utility function

$$V_{ij} = V(\boldsymbol{q}_j; z_i; b_i; \theta) \tag{1}$$

where $\boldsymbol{q}_j$ is a vector of product characteristics (i.e., including also the price, quality, size or energy performance of product j), z_i is a vector of consumer characteristics (including also social preferences such as notably envy), b_i is a vector of "barriers" (e.g., market imperfections such as regulation on conveyance), and θ is a vector of parameters.

We hypothesize that some "barriers" affect product characteristic q_k. In particular, we posit that regulation on conveyance b_c negatively affects product quality or performance, i.e.,

$$\frac{dq_k}{db_c} < 0 \tag{2}$$

We further hypothesize that this effect is larger for more envious consumers. That is, we posit

$$\frac{d^2 q_k}{db_c dz_e} < 0 \quad (3)$$

where z_e reflects envy levels. For the subsequent empirical analysis, we assume that the indirect utility function in (1) is additively separable in a deterministic function *f* and an error term ε_{ij}.

$$V_{ij} = f(\boldsymbol{q}_j; z_i; b_i; \theta) + \varepsilon_{ij} \quad (4)$$

Equation (4) gives rise to the random utility framework (McFadden, 1974) commonly used to model product choices.

3 Material and methods

To test the model presented in Section 2, we employ a stated preference DCE with homeowner households in the United States. As postulated in the familiar goods-characteristics approach (Lancaster, 1966) and the random utility framework (McFadden, 1974), in a DCE a consumer derives utility from the characteristics of products and chooses the preferred option available to her. A DCE simulates market transactions by constructing hypothetical choice scenarios where alternatives are described by a range of attributes, and where respondents are expected to make trade-offs between these attributes and select their most preferred alternative. This allows simultaneously estimating the values for multiple attributes of a product and their trade-offs.

We chose to focus on the U.S. market because mobility in the U.S. is rather high and conveyance of major appliances quite common. According to the latest U.S. census data, the average American citizen moves 11.7 times during their life. Likewise, between 2016 and 2017, about 11% of the U.S. population and 6% of homeowners changed homes[3]. Further, about 60% of the appliances included in the sample used by Sandler (2018) convey. We chose to focus on refrigerators because refrigerators often (but not always) convey in the U.S. market. In the sample used by Sandler (2018), 48% of the refrigerators in the U.S. convey, while 100% of dishwashers and water heaters convey, but only 26% of clothes washers.

Several studies have previously carried out choice experiments with refrigerators. Revelt and Train (1998) analyze a series of hypothetical choices between

3 See CPS Historical Migration/Geographic Mobility Tables, Table A-4 in https://www.census.gov/data/tables/time-series/demo/geographic-mobility/historic.html.

refrigerators differing in their price, energy efficiency and savings, and available financing (loans at different interest rates and rebates). Similarly, Ward et al. (2011) ask respondents to make hypothetical choices over different refrigerator purchase options and an outside option. In their choice experiment, refrigerators are characterized by the attributes price, configuration (e.g., French door), brand, external ice and water dispenser, capacity, and Energy Star label. Li et al. (2016) analyze data from the same choice experiment as Ward et al. (2011) but include an additional treatment group in which respondents are told that Energy Star-certified refrigerators qualify for a mail-in rebate. Comparing the two treatment groups, the authors look at the effect of mail-in rebates for Energy Star-certified refrigerators on stated choices. We used these studies as guidance for the design of the DCE.

In the following section we describe the survey (including the stated preferences DCE) and the statistical model used to estimate the parameters. Our empirical methodology relies on an online survey among U.S. homeowners. The survey includes a questionnaire on housing and household characteristics, an incentivized game to elicit envy preferences and a DCE for refrigerator purchases. We further collected household-level information on moving plans and intentions to convey, thus allowing us to directly test whether households that are planning to move and convey their appliances in the near future purchase less energy-efficient refrigerators.

3.1 Survey

We implemented an online survey via computer-assisted web interviews (CAWI) among 504 homeowners in the U.S. using an existing panel from Prolific Academic. Prolific Academic is a crowdsourcing platform that permits recruitment of participants for academic research studies; the platform has been tested and validated by academic researchers (Peer et al. 2017). The survey was fielded in June 2018. 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.

3.1.1 Description of choice experiment

The main part of the survey consisted of a stated preference DCE. Participants were asked to imagine that their refrigerator had broken down and thus needed to be replaced. The following framing was used to introduce the choice experiment:

"*Imagine that your refrigerator has broken down and you need to buy a new one. (In case you have several refrigerators, please imagine that the one you use most has broken down.) On the following pages, we will show you different refrigerator purchase options. We would like to know which refrigerator you would choose, if these were your only options. Please assume that all refrigerator options fit properly in your kitchen and are currently available in color and finish of your choice.*"[4]

Respondents were then asked to make a series of choices between different refrigerator purchase options. These options differed by energy consumption, capacity, length of warranty, brand, customer review ratings, and purchase price (attributes and levels are summarized in Table 1). Attributes were chosen to represent relevant information for customers choosing a refrigerator and to be independent of one another. 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.

Overall, the attributes were chosen to cover the majority of the refrigerator market in the U.S., therefore including the most common range of sizes and prices available at the time of the study. Extreme values (for instance mini-refrigerators) were left out so that the choices proposed could be realistic and comparable and that the majority of consumers could seriously consider each option proposed. Information on energy consumption was provided as the estimated yearly cost to run the refrigerator; the values proposed (ranging between \$54 and \$90 a year) were calculated based on average electricity use and national electricity prices. We expected consumers who intend to move and to leave their refrigerator in the house when moving (hereafter called conveyors for simplification) to choose less energy efficient appliances. Size or capacity has been shown to be a particularly important attribute for refrigerator choice in the U.S. (see for instance Ward et al. 2011), with consumers preferring larger refrigerators; we included six different sizes in the design, with increases of two cubic feet at a time (equivalent to an extra drawer); here again, we expected conveyors to choose smaller fridges compared to non-conveyors. We included

4 Adapted from similar framing in Ward et al. (2011) and Li et al. (2016).

three quality indicators. Length of warranty was chosen to vary from 1 to 5 years. We expected this attribute to be of lesser importance for conveyors because they would move too early to benefit from a longer warranty. To avoid biases due to diverging previous experience and preferences with specific brand names, the attribute brand was kept general and included two levels, either a well-known brand, or a less well-known brand. Customer ratings, which have been shown to have a great impact on purchase decisions (Chevalier and Mayzlin, 2006; Moe and Trusov, 2011), were also included with the typical visual five-star representation used in many online shops; we included three levels, ranging from 2.5 stars to 4.5 stars. We generally expected conveyors to give less importance to these quality attributes than non-conveyors because conveyance shortens the length of ownership and prevents the costs associated with a better brand, longer warranty, or a higher customer rating to be recouped, because they are not capitalized in higher housing prices. In the subsequent econometric analysis, we chose the 3.5-star level as the reference level because it reflects a moderate view (Mudambi and Schuff, 2010).

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

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

To reduce the large numbers of treatment combinations and increase the efficiency of design, we applied a Bayesian efficient design (Sándor and Wedel, 2001) using the NGENE software (ChoiceMetrics, 2014). 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. Appendix A depicts an example of a scenario shown to respondents.

3.1.2 Elicitation of envy preferences

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[5]. 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. Lastly, respondents were reminded that their answers were binding and anonymous. Appendix B provides the exact wording of the envy game as used in the survey.

We anticipated that envious respondents who allocate low amounts or nothing to another player also dislike leaving high quality / high performance appliances when selling their house. In our choice experiment, we thus expect to observe a lower willingness-to-pay for quality/performance-related attributes for envious respondents compared to non-envious respondents if the refrigerator is likely to convey.

3.1.3 Questionnaire

Additional survey questions addressed dwelling and appliance characteristics, moving plans, as well as respondents' intention to leave their refrigerator when selling their home and their perception of conveyance regulation. Socio-demographic information was gathered both at the beginning of the questionnaire (to ensure that quota requirements were met), and at the end of the questionnaire.

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5 Under the minimum allocation, receivers and givers both only get the participation fee. The most envious allocation thus corresponds with the equity allocation (as in Fehr, Bernhard and Rockenbach's (2008) envy game). In this case, envy and inequity aversion lead to identical allocations and cannot be distinguished. Moreover, we cannot exclude that envious allocations result from participants being indifferent about others' payoffs and randomizing their answers.

3.2 Econometric model

Our econometric analyses employ mixed logit model, because it relaxes the Independence of Irrelevant Alternatives assumption (IIA) and also accounts for unobserved heterogeneity of individual preferences (Revelt and Train, 1998).

3.2.1 Standard mixed logit model

In a given sample N respondents face T choice tasks. Each choice task involves J alternatives. The utility for respondent n choosing alternative j in the choice set t is then:

$$U_{njt} = \beta_n X_{njt} + \varepsilon_{njt}, \ n = 1, \dots, N, \quad j = 1,2, \dots J \quad t = 1, \dots, T \tag{5}$$

where X_{njt} is a vector of refrigerator attributes in our choice experiments, β_n is a vector of normally distributed random parameters, and θ is a vector of parameters of this distribution. The unobserved error term ε_{njt} is assumed to be Gumbel-distributed.

Conditional on knowing β_n, the probability of respondent n choosing alternative j in the choice set t is expressed as:

$$\mathrm{P}_{jt}(\beta_n) = \frac{\exp(\beta_n X_{njt})}{\sum_{j=1}^{J} \exp(\beta_n X_{njt})} \tag{6}$$

Knowing β_n, the conditional probability of the observed sequence of choices is given by:

$$\Gamma_n(\beta_n) = \prod_{t=1}^{T} P_{njt}(\beta_n) \tag{7}$$

Because β_n is unknown, the unconditional probability of the observed sequence of choices of respondent n is the conditional probability integrated over the distribution of β:

$$\Lambda_n(\theta) = \int \Gamma_n(\beta_n) f(\beta|\theta) d\beta, \tag{8}$$

where $f(\beta|\theta)$ denotes the density of the random parameters (Train, 2003). The log likelihood is computed as below:

$$LL(\theta) = \sum_{n=1}^{N} \ln \Lambda_n(\theta) \tag{9}$$

As no closed form solution for LL exists, it is approximated through simulation (Train, 2003). The simulated log likelihood is given by:

$$SLL(\theta) = \sum_{n=1}^{N} \ln\left\{\frac{1}{H}\sum_{1}^{H} \Gamma_n(\beta^h)\right\}, \tag{10}$$

where H is the number of replications and β^h is the hth draw from $f(\beta|\theta)$. We used 250 Halton draws in our simulations.

3.2.2 Mixed logit model in willingness-to-pay space

The previous section presented the mixed logit model in preference space. Applying mixed logit in preference space provides several advantages, but it also raises some issues concerning the WTP estimation. With the common two-step practice, which is also referred to as a model in preference space, the average marginal WTP for an attribute x is calculated as the ratio of the attribute's parameter β_x to the price parameter β_p.

$$WTP_x = -\frac{\beta_x}{\beta_p} \tag{11}$$

The ratio of two randomly distributed parameters will cause the distribution of WTP to be skewed (Meijer and Rouwendal, 2006). Therefore, following Train and Weeks (2005), we apply the mixed logit model in willingness-to-pay (WTP) space. By re-parameterizing the parameters of attributes, the WTP is directly estimated by reformulating the model so that the estimated parameters represent the WTP values, and so that their distribution is directly specified.

In our case, we assume that the utility a respondent n derives from choosing refrigerator j in choice situation t is given as:

$$U_{njt} = \alpha_n p_{njt} + \beta_n X_{njt} + \varepsilon_{njt}, \tag{12}$$

where $p_{njt}$is the price of refrigerator j, and X_{njt} is a vector that includes the attributes of our choice experiment. α_n and β_n are individual random parameters, and ε_{njt} is an error term following an extreme value distribution with variance $Var(\varepsilon_{njt}) = k_n^2(\pi^2/6)$, where k_n is the scale parameter for the nth individual. Dividing equation (12) by k_n does not change the household's behavior and yields a new error term e_{njt} following an extreme value distribution with variance $\pi^2/6$:

$$U_{njt} = \lambda_n p_{njt} + c_n X_{njt} + e_{njt}, \tag{13}$$

where $\lambda_n = \alpha_n/k_n$, $c_n = \beta_n/k_n$. Equation (13) corresponds to the model in preference space. The WTP for a given attribute is obtained through the ratio $\gamma_n = c_n/\lambda_n$.

Dividing both sides of Equation (13) by λ_n, we obtain:

$$\widetilde{U}_{njt} = p_{njt} + \gamma_n X_{njt} + \tilde{e}_{njt}, \tag{14}$$

where $\widetilde{U}_{njt}$ and $\tilde{e}_{njt}$ in equation (14) are just the rescaled expressions of U_{njt} and e_{njt} from equation (13). Reparametrizing our model in this way, the parameters obtained through the mixed logit estimation yield the (marginal) WTP for attributes $\gamma_n = c_n/\lambda_n$ rather than the utility parameters of attributes β_n. As is standard in the literature, we assume that γ_n follows a normal distribution.

3.2.3 Mixed logit model accounting for conveyance and envy

We first estimated a *base model* which includes the attributes only. To test equation (2), we then ran a model exploring the impact of conveyance on willingness-to-pay for quality/performance attributes of refrigerators, especially for likely conveyors. We therefore created a dummy variable, *convey*, to distinguish conveyors from non-conveyors in the empirical analysis. Under *convey-5*, likely 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 five years (*convey* = 1)[6]. In an alternative specification, *convey-2*, we used two years rather than five years. *Convey-5* and *convey-2* both include a vector of interaction terms between *convey* and the five quality/performance-related attributes of our choice experiment. The estimated parameters of the interaction terms are specified as fixed parameters. Table 1 reports the results of this model.

Second, to test for the effects of envy on refrigerator characteristics, as proposed in equation (3), we interacted envy *w*ith each attribute. The dummy variable *highenvy* takes on the value of one, if respondents give at most the median amount of $86 in the envy game (see section 4.2). If they give more than $86, *highenvy* is set to zero. Because envy is expected to moderate the effects of

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6 The survey asked the following questions: (1) "If you sold your current home, would you leave your refrigerator with the home?" [Answer categories: Yes/No/Don't know]; (2) "Which of the following best describes your future moving plans?" [Answer categories: I will likely change my primary residence within the next 2 years/3 to 5 years/6 to 10 years/ I will likely not change my primary residence within the next 10 years].

conveyance on the quality/performance-related attributes, we included a vector of interaction terms between *envy* and these attributes. We ran this model for two sub-samples, i.e. for conveyors and non-conveyors and test whether the WTP for the quality/performance-related attributes differs across sub-samples[7]. To limit potential endogeneity problems, we did not use stated moving plans to define conveyors. That is, we only used information on whether respondents would leave their refrigerator with the home if they sold their house. The findings for this model are displayed in Table 3.

4 Results

Our presentation of the results distinguishes between the summary statistics of the sample, the findings of the envy game, and the econometric results of the mixed logit models.

4.1 Sample summary statistics

The distribution of respondents across U.S. states roughly corresponds to the distribution within the U.S. population. 35% of respondents (compared to 33% of the U.S. population) were from the four most populous states (California, Texas, Florida, New York). Almost half (47%) were female. 8% of respondents were between 18 and 24 years, 65% between 25 and 44 years, 23% between 45 and 64 years and 4% between 64 and 85 years (compared to 14%, 37%, 36%, and 13% of the U.S. population between 18 and 79 years, respectively)[8]. Respondents between 25 and 44 years – arguably the age group that is the most mobile – were thus overrepresented in our survey.

In our sample, 62% of the respondents stated that their appliance would convey, 39% (22%) planned to move within the next 5 years (2 years), and 26% (13%) satisfied both criteria, i.e., they were identified as conveyors.

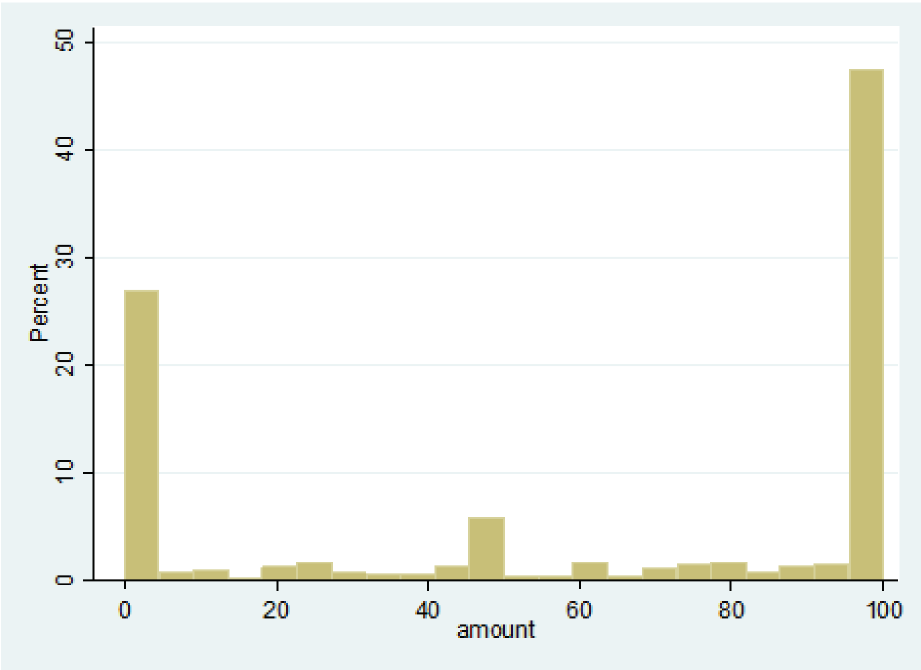
7 We also ran a probit model to test whether belonging to the conveyor group was related with socioeconomic characteristics or with envy (i.e. age, gender, education, income, and household size), but found no statistically significant relation. Thus, the sub-samples do not appear to differ systematically with respect to these variables. Of course, we cannot rule out a potential endogeneity problem, i.e., that unobserved factors affect the model split and the WTP for the attributes. Because regulation on whether appliances convey is made at the level of the federal states and hence not related with (unobserved) individual characteristics, a conveyance-related endogeneity problem should be small.

8 Based on 2010 U.S. Census data.

4.2 Envy game summary statistics

The distribution of the amounts chosen in the envy game is depicted in Figure 1. We observe that 45% of respondents chose the so-called efficient outcome, i.e., $100. At the same time, 26% of respondents opted for an allocation in which the receiver got nothing except the participation fee, thus reflecting strong envy. The remaining 29% of respondents revealed some degree of envy by choosing outcomes between $0 and $100, with a small kink at $50 (6% of respondents).

Figure 1: Distribution of amounts chosen in the envy game



These results are in line with previous findings in the literature. In similar games, Güth et al. (2012) found that more than 50% of participants allocated less than the maximum amount to another player, if their own payoff was fixed at a lower level. Similarly, almost 60% of participants in Fischbacher et al. (2018) chose inefficient allocations.

In this study, respondents had a one in a hundred chance to be selected as winner of the envy game. Out of the 504 participants, five were randomly selected as winners; in total, gains of $307 were distributed (average of $61.4 per winner, ranging from $0 to $100).

4.3 Results of mixed logit models

The bottom part of Table 2 suggests that most standard deviations of the coefficient estimates are statistically significant, suggesting heterogeneity across respondents and thus corroborating using a mixed logit model.

4.3.1 Main effects for attributes for the base model

Turning to the top part of Table 2, we observe that all main effects are statistically significant and exhibit the expected signs. The coefficient associated with price is statistically significant and, as expected, negative. The findings for *energy cost* suggest that, on average, respondents are willing to pay about $8 less if the annual energy costs of the refrigerator increase by $1. This figure appears reasonable, given expected lifetimes of refrigerators of more than ten years and time discounting of future energy cost savings by respondents[9]. Respondents also prefer larger refrigerators. We find that the average respondent is willing to pay about $60 for an extra cubic foot of volume. For an additional year of warranty, the average respondent in our sample would spend $58. Respondents are also willing to pay more for higher quality brands. Compared to a not well-known brand, the average respondent would spend an extra $191 for a well-known quality brand. Finally, compared to a refrigerator with a 3.5-star rating (i.e. the base category), respondents are willing to pay $485 less for a 2.5-star-rated refrigerator, and $191 more for a 4.5-star-rated refrigerator. Clearly, respondents' preferences for customer ratings are not linear in the classification levels and the average respondent displays a strong dislike for refrigerators with a low customer rating.

Table 2: Results for base model and conveyance models from the mixed logit model in WTP space (robust standard errors in parentheses)

	Base model	*Convey-5*	*Convey-2*
Mean			
Price	-5.8651***	-5.8501***	-5.8284***
	(0.094)	(0.105)	(0.129)
Energy cost	-8.0379***	-8.0482***	-7.6512***

9 In our sample, the average self-estimated expected lifetime (usage time) of respondent's refrigerators was slightly below 12 years.

	(0.839)	(0.899)	(0.940)
Capacity	60.5261***	63.8276***	64.4394***
	(3.846)	(4.467)	(4.433)
Warranty	57.9531***	58.8456***	60.0974***
	(6.795)	(7.534)	(7.503)
Brand	191.1568***	220.2321***	209.6854***
	(23.415)	(26.783)	(24.386)
2.5 stars	-485.3052***	-477.1886***	-476.4937***
	(30.945)	(30.373)	(29.838)
4.5 stars	190.9083***	219.8224***	205.4759***
	(30.934)	(34.574)	(32.915)
Convey × energy cost		0.4476	-0.0476
		(1.682)	(2.196)
Convey × capacity		-6.8941	-20.2530*
		(8.357)	(11.097)
Convey × warranty		-2.6930	5.4109
		(14.895)	(20.185)
Convey × brand		-98.2528*	-219.2269***
		(51.973)	(64.903)
Convey × star4.5		-117.5007*	-125.3702*
		(60.271)	(69.911)
SD			
Price	0.8710***	0.8761***	0.9405***
	(0.129)	(0.160)	(0.195)
Energy cost	4.0107***	4.2024***	2.0216
	(1.524)	(1.429)	(2.138)
Capacity	-50.2923***	-48.7236***	-51.9710***
	(4.896)	(3.820)	(4.402)
Warranty	57.5927***	56.6711***	-59.8384***
	(11.052)	(9.624)	(9.121)
Brand	235.9561***	229.9609***	-208.4239***
	(39.594)	(40.076)	(43.128)

2.5 stars	339.4064***	353.0599***	360.3800***
	(38.471)	(35.606)	(46.930)
4.5 stars	-152.0368***	-147.8036***	-113.4142
	(49.456)	(53.650)	(69.014)
LL	-2154.589	-2151.230	-2142.685
N	8048	8048	8048

* p < 0.10, ** p < 0.05, *** p < 0.01

4.3.2 Conveyance and willingness-to-pay for attributes

The findings for *convey-5* suggest that likely conveyors exhibit a lower WTP for a well-known quality brand and for a higher customer rating. Compared to non-conveyance, conveyance lowers the WTP for a higher quality brand by $98 and for a refrigerator with a 4.5-star customer rating (compared to a 3.5-star rating) by $118. For *convey-2*, these discounts are even larger, i.e. $219 for a higher quality brand, and $125 for a refrigerator with a 4.5-star customer rating (yet only the difference for brand is statistically significant at p<0.1). In addition, for *convey-2*, conveyance is found to affect the WTP also for capacity at a statistically significant level. More specifically, conveyance lowers the WTP by about $20 per additional cubic foot of volume. In line with equation (2), these findings generally provide evidence that conveyance affects homeowners' willingness-to-pay for quality/performance-related attributes. As expected, these effects appear to be stronger if homeowners expect to move within the next two rather than the next 5 years. Surprisingly though, the interaction effect for warranty length is not statistically significant: while one could have expected that warranty length could be valued lower because conveyors plan to leave their refrigerator in the house, this is not the case. In addition, and contrary to expectations, we found no evidence that conveyance (in combination with moving plans) affects respondents' WTP for the energy costs of a refrigerator[10].

10 In addition, we ran a model where future stated moving plans were not used to define conveyors. That is, conveyors are classified as homeowners who stated they would leave their refrigerator with the home when they sold their current home. Results are consistent with those presented in Table 2, but, as expected, fewer interaction terms turned out to be statistically significant. In fact, conveyance was found to lower the WTP for brand only.

4.3.3 Envy and willingness-to-pay for attributes

Table 3 presents the findings for the model specification which includes a vector of interaction terms between *highenvy* and the attributes. The difference in these interaction terms across samples reflect whether envy moderates the effects of conveyance on the WTP for attributes as hypothesized in equation (3). Our findings suggest that for envious conveyors, the WTP for capacity, warranty, brand, and a 4.5-star rating (but not for energy cost) is lower than for envious non-conveyors. These findings therefore generally support our hypothesis that envy reinforces the negative effect of conveyance on product quality/performance[11].

Table 3: Results for envy from the mixed logit model in WTP space (robust standard errors in parentheses)

	Conveyors	*Non-conveyors*
Mean		
Price	-5.9373***	-5.7341***
	(0.133)	(0.163)
Energy cost	-7.0292***	-10.2048***
	(1.398)	(1.733)
Capacity	70.9850***	66.1716***
	(7.072)	(8.090)
Warranty	65.6935***	31.2492**
	(11.977)	(14.236)
Brand	164.3077***	158.5637***
	(39.841)	(45.050)
2.5 stars	-493.5470***	-428.7741***
	(36.441)	(46.598)
4.5 stars	264.1617***	166.4629***
	(51.435)	(59.631)

11 As a robustness check, we estimated a model where we use *convey-5* to define conveyors. Results of this model are similar to those reported in Table 3. However, the p-values associated with the parameter estimates for the conveyer group are generally lower, most likely because the number of observations for this group is much lower than in Table 3 (2112 compared to 4960). In addition, this specification may suffer from endogeneity problems as explained in footnote 7.

	Conveyors	*Non-conveyors*
Highenvy-× energy cost	-0.3140	1.7145
	(1.818)	(2.513)
Highenvy × capacity	-18.7624**	-17.8916
	(9.184)	(12.346)
Highenvy × warranty	-1.1124	44.6146**
	(15.726)	(22.758)
Highenvy × brand	-43.2113	127.0667*
	(54.190)	(68.045)
Highenvy × star4.5	-168.1813***	86.5391
	(63.495)	(84.728)
SD		
Energy cost	-0.5230	-4.4496**
	(1.994)	(2.080)
Capacity	55.9295***	-53.6347***
	(5.579)	(7.322)
Warranty	-46.4204***	65.2568***
	(13.668)	(17.639)
Brand	202.9555***	-247.3704***
	(38.951)	(63.112)
2.5 stars	347.9576***	360.6557***
	(36.252)	(54.565)
4.5 stars	123.4659***	-38.1122
	(41.857)	(117.220)
Price	0.9694***	-0.7011***
	(0.200)	(0.271)
LL	-1349.499	-787.544
N	4960	3088

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

Conveyance of appliances may keep homeowners from purchasing appliances with costly attributes such as well-known brand name or high energy efficiency because the extra costs cannot be entirely capitalized into the house sales price. In a recent paper, Sandler (2018) found that conveyance leads U.S. households to purchase less expensive appliances and some suggestive evidence that potential conveyors may purchase less energy-efficient refrigerators.

Using a discrete choice experiment, we tested the effects of conveyance on homeowners' willingness-to-pay for various attributes of refrigerators. Our results suggest that conveyance has a strong impact on appliance attributes: conveyance negatively impacted appliance size, brand, and customer ratings. Conveyors (homeowners planning to move and to leave their refrigerator in the dwelling when moving) appear therefore more likely to purchase a smaller refrigerator, from a less well-known brand, and with lower customer ratings. These effects are more pronounced when conveyors expect to move in the shorter run, thus leaving less time to enjoy the benefits of the high quality/performance appliance attributes.

Interestingly, we find no evidence that conveyance directly affects the choice of energy-efficient appliances: the interaction terms between conveyance and energy costs were not statistically significant. Sandler's (2018) conclusion that conveyance leads to the adoption of less efficient refrigerators may therefore have been an indirect effect, due to conveyors' choice of lower quality/performance appliances. Homeowners may therefore incidentally purchase less energy-efficient appliances (even without paying attention to energy consumption) through the purchase of lower quality/performance appliances. However, this effect on energy consumption may be compensated by conveyors' choice of smaller refrigerators, which typically consume less energy than larger ones. It is therefore not entirely clear how, if at all, conveyance affects adoption of energy-efficient appliances and future research should investigate the effects in more detail.

So far, social preferences such as envy have not received much attention when studying the adoption of energy-efficient technologies. Our results suggest that such preferences may play a large role in explaining preferences for certain attributes when appliances convey (the appliance purchased will be left in the dwelling when moving out). In particular, the effects of conveyance on purchase are generally reinforced by envy: envious conveyors prefer to purchase a smaller refrigerator, from a less well-known brand, and with lower customer ratings than non-envious conveyors. However, our results provide no evidence that conveyance prompts envious homeowners to purchase less energy-efficient appliances.

In sum, our findings suggest that conveyance and its interaction with envy help explain homeowners' choice of quality/performance attributes of appliances. In contrast, our findings provide no evidence that these factors help explain the energy efficiency paradox.

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Appendix A: Typical choice card

Figure A 1: Typical choice card

	Option A	Option B
Energy consumption	Estimated Yearly Energy Cost **$78**	Estimated Yearly Energy Cost **$78** ENERGY STAR
Size	20 cu. ft.	24 cu. ft.
Warranty	1 year	3 years
Brand	Well-known quality brand	Lesser-known brand
Customer review		
Price	$1.199	$1.599

Appendix B: Instructions for envy game

- One out of every 100 survey participants will be selected at random to receive **an additional amount between $0 and $100.** The exact amount will be **determined by another randomly selected participant** who will not receive this additional payment him- or herself.
- In other words, you could be selected to win an additional amount or be selected to determine the amount that another participant will receive.
- **Please indicate how much another participant should receive in case that you are selected to determine this amount.**
- (Please note that your answer to this question is **binding and anonymous.** If you are selected, the amount you chose in this question will automatically be paid to another participant. Your own payment for participation in this study will not be affected by your decision.)

The amount in $ that another participant should receive if you are selected at random to determine this amount. (0–100)

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