Conveyance, envy, and home-owners adoption of energy-efficient appliances

**Joachim Schleich[a,b], Corinne Faure[a],
Marie-Charlotte Guetlein[a], Gengyang Tu[c]**

[a] **Grenoble Ecole de Management, Grenoble, France**
[b] **Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany**
[c] **European Centre for Environment and Human Health, University of Exeter, UK**

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Background

Energy efficiency paradox – multiple explanations for empirical findings (e.g. Gerarden, Newell and Stavins 2015)

- **Market imperfections**
  - e.g. asymmetric information / split incentives / principal-agent / incomplete contracts
    - **landlord-tenant** problem
      - » empirical support (e.g. appliances): Davis (2011), Krishnamurthy and Kriström (2015), Mills and Schleich (2010)
    - **conveyance** (i.e. appliance stays with dwelling, when moving):
      - » "suggestive evidence" (appliances): Sandler (2018)
- **Behavioural phenomena**
  - e.g. present bias, myopia, loss aversion and reference dependencies, bounded rationality, rational inattention
- **Measurement errors**
  - e.g. adopter heterogeneity due to preference heterogeneity (time and risk preferences, environmental preferences)

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Objectives

Explore effects of conveyance on appliance characteristics, in particular energy performance (market imperfection)

Explore the effects of envy on appliance characteristics, in particular energy performance, when appliances convey (preference heterogeneity in social context)

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A simple theoretical model of appliance choice

Indirect utility function reflecting consumer i's preferences for product j

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

$\boldsymbol{q}_j$ is a vector of product characteristics (e.g. price, size, warranty)

z_i is a vector of consumer characteristics and attitudes (e.g. envy)

b_i is a vector of "barriers" (institutional factors – e.g. conveyance laws)

θ is a vector of parameters

<u>Hypotheses:</u>

(1) $\frac{\mathrm{d}q_k}{\mathrm{d}b_c} < 0$ (conveyance negatively affects premium product features)

(2) $\frac{\mathrm{d}^2 q_k}{\mathrm{d}b_c \mathrm{d}z_e} < 0$ (this effect is larger for more envious consumers)

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Empirical methodology

- **Survey of homeowner households**
    - **US:** High mobility (~12 times during life), conveyance is common
    - **CAWI** in June 2018 using existing panel from Prolific Academic, demographically representative wrt gender, regional distribution; self-reported conveyance rate: ~60%
    - **Discrete Choice Experiment (DCE**): Participants were asked to imagine that their refrigerator had broken down and thus needed to be replaced.

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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,

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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

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    - Incentivized **Envy Game**

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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 <u>or</u> 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)

Distribution of amounts chosen in the envy game
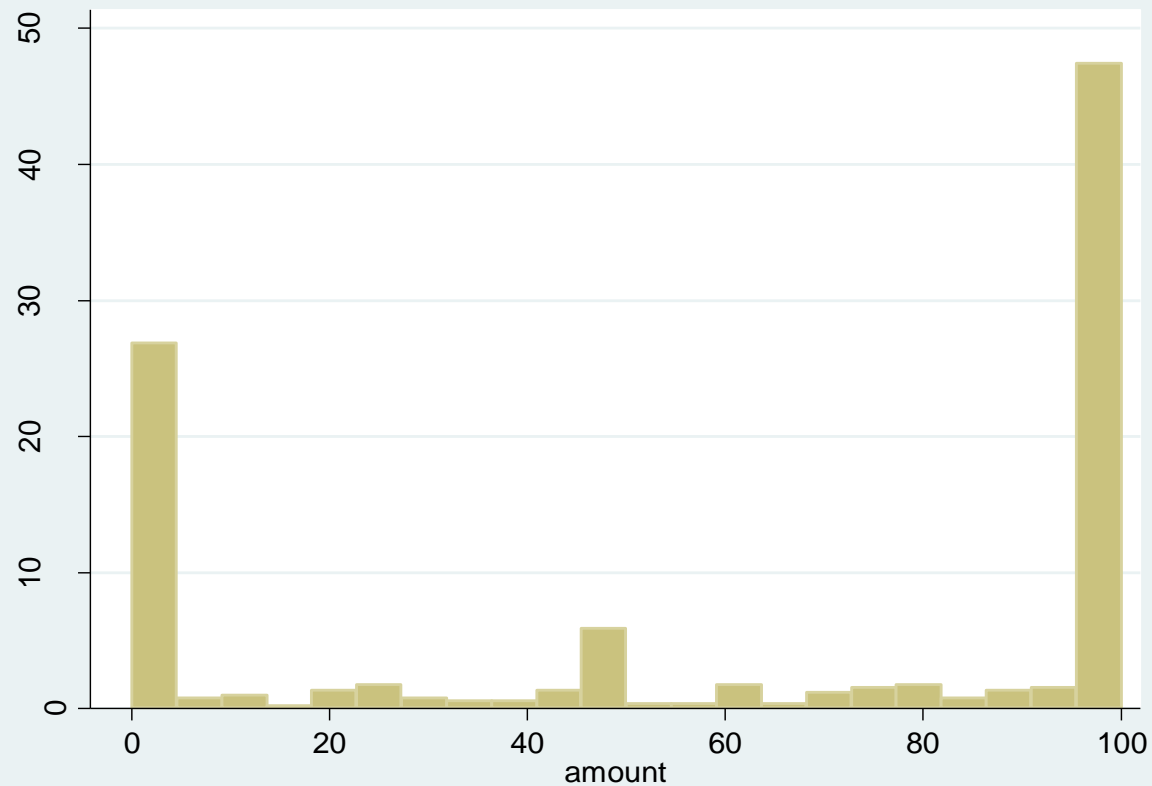
Median amount: 86 $

Empirical methodology

- **Survey of homeowner households (N~500)**
  - **US:** High mobility (~12 times during life), conveyance is common
  - **CAWI** in June 2018 using existing panel from Prolific Academic, demographically representative wrt gender, regional distribution; self-reported conveyance rate: ~60%
  - **Discrete Choice Experiment (DCE**): Participants were asked to imagine that their refrigerator had broken down and thus needed to be replaced.
  - Incentivized **Envy Game**
  - **Mixed Logit analysis (here: estimated in WTP space)**
    - Does not rely on IIA
    - Allows for unobserved heterogeneity across participants

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Empirical methodology – 3 types of models

1) **Base Model**
   - includes attributes only

2) **Conveyance Models**
   - effect of conveyance on attributes is captured via an interaction dummy:
     - *convey-5*: if expect to convey and to move within next 5 years
     - *convey-2*: if expect to convey and to move within next 2 years

3) **Envy Model**
   - effect of envy on attributes is captured via an *interaction dummy*
     - *highenvy:* give at most median amount in envy game ($86)
   - split sample in conveyers and non-conveyers and test for differences in interaction terms (use plan to convey only, not moving plans)

Results: Conveyance models (mixed logit model in WTP space)

	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***
	(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)
N	8048	8048	8048

Conveyence associated with lower WTP for
- capacity
- brand
- customer ratings

No evidene that conveyance affects WTP for energy costs or warranty

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Results: Envy models (MLM - WTP space)

	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)
Highenvy-x energy cost	-0.3140	1.7145
	(1.818)	(2.513)
Highenvy x capacity	-18.7624**	-17.8916
	(9.184)	(12.346)
Highenvy x warranty	-1.1124	44.6146**
	(15.726)	(22.758)
Highenvy x brand	-43.2113	127.0667*
	(54.190)	(68.045)
Highenvy x star4.5	-168.1813***	86.5391
	(63.495)	(84.728)
N	4960	3088

Find lower WTP for envious conveyors
- capacity
- warranty
- brand
- 4.5 star consumer rating

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Conclusions

- **Conveyance**
    - negatively effects size, brand and customer ratings of chosen refrigerator
    - effects are more pronounced when conveyers expect to move in the shorter run
    - but no evidence that energy performance is related to conveyance for average homeowner in the sample
    - *Energy efficiency paradox*: no evidence that conveyance regulation per se works as a market imperfection for average homeowner in our sample

- **Envy**

    - reinforces effects of conveyance on performance/quality characteristics: envious conveyors exhibit tendencies to purchase a smaller refrigerator, with lower customer ratings, from a less well-known brand

Thank you!

Fraunhofer Institute Systems-
& Innovation Research
Breslauer Straße 48
76139 Karlsruhe
Germany
joachim.schleich@isi.fraunhofer.de

Grenoble Ecole de Management
12 Pierre Sémard
38000 Grenoble
France
joachim.schleich@grenoble-em.com