

**Behavioural constraints in energy technology uptake:
evidence from real-purchase offers in rural Rwanda and Senegal**

Gunther Bensch^{1*} and Michael Grimm^{2,3}

¹RWI – Leibniz Institute for Economic Research, Essen, Germany, ²University of Passau, Passau, Germany and ³IZA, Bonn, Germany

*Corresponding author: Gunther Bensch; Email: bensch@rwi-essen.de

ONLINE APPENDIX

Appendix A

Table A1. WTP participation, bidding and payment behaviour of households

	Number of households	
	Rwanda	Senegal
Not willing to participate	12	4
WTP below prices drawn	129	52
Purchase withdrawn before contract signing	28	4
Product bought and paid fully	102	93
	<i>Kit 1: 50; Kit 2: 50; Kit 3: 2</i>	<i>another 103 purchases of the second EEBC</i>
Product not paid fully	52	4
Total	323	260

Table A2. Descriptive statistics on main household characteristics used as control variables

	Rwanda		Senegal	
	mean	sd	mean	sd
Household size	4.53	1.73	13.46	9.07
Household head attended at least primary school	0.65		0.33	
Household head is female	0.19		0.14	
Household head's main occupation is farming	0.80		0.87	
Flooring material is cement or tiles	0.20		0.61	
Wall material is stone or brick	0.69		0.34	
Vehicle ownership (incl. bicycles)	0.26		0.36	
Monthly household expenditures (excl. expenditures on energy), in US\$	53.29	61.40	228.06	171.17
Absolute age difference between enumerator and respondent	15.17	13.44	17.26	12.72
Number of observations	323		260	

Notes: sd refers to the standard deviation. The number of missings per variable does not exceed one in Rwanda and six in Senegal after a few control variable values were imputed econometrically or otherwise based on other survey information (*Household size* and *Household head attended at least primary school* (each 2 in Senegal); *Absolute age difference* (27 in Senegal); *Monthly household expenditures* (12 in Rwanda)).

Appendix B. Measurement of variables

Risk aversion and consumer resistance. To avoid the ambiguity introduced by relative riskiness of old and new technologies (cf. Section 2), we concentrate on eliciting the perceived riskiness of the new technology. Specifically, we measure risk aversion in three ways. First, following Giné and Yang (2009), we asked respondents to self-report on a Likert scale to what degree they are ready to take risks in purchasing new products. The scale ranged from 1 to 7 in Rwanda and from 1 to 5 in Senegal. Second, we played an investment game in which each respondent is put in a hypothetical situation of winning about US\$100 that can be invested into a business or not.¹ The invested amount would either double or halve, both with the same ex-ante probability. Given this payout pattern, respondents had to decide how much to invest of the US\$100. Third, in an income gamble adapted from Barsky *et al.* (1997), the participant was asked to imagine s/he had approximately US\$15 and is then invited up to three times to either keep the money or to gamble. The odds to win the gamble as well as the winning amount are held constant across all three attempts at 0.5 and roughly US\$30, respectively. Yet, the loss s/he incurs in case of losing decreases approximately from US\$7.5 US\$ to US\$5 to US\$3. The earlier the participant accepts the gamble, the more s/he is accepting risks.

To capture consumer resistance, we follow Levine *et al.* (2018) and construct an early-technology adopter measure for which respondents are asked to list the three most recent technologies that others in the community had bought and whether they adopted any of these technologies, which gives us an ordinal measure from zero to three. Improved cooking stoves or solar technologies could only be mentioned in the country where they were not the technology introduced in the WTP experiment, as their adoption would otherwise fall under the *experience* dimension. To approximate the physical, economic, functional and social risk that people associate with new technologies, we adjust Ram's (1989) *Measures of Innovation Resistance*. We asked respondents to rate their accordance with four statements on a scale from 1 to 5 (where 1= totally agree, 3= no opinion, 5=totally disagree). Perceived social risk or habit are captured by the statement "*In my village we have always lived well without this technology*", functional risk by "*For me and my family, it would be difficult to get used to solar kits/ improved stoves*", perceived physical risk by "*Solar kits/ improved stoves can be dangerous*", and economic risk by "*There will soon be a technology available that is better than this type of solar kits/ improved stoves, for instance the national grid*".

¹ US\$100 are equivalent to about one (three) month of average wage for casual agricultural work in the Senegalese (Rwandan) study area (Bensch and Peters, 2020; Jones *et al.*, 2022). Similarly, the amount is about half (twice) the average household expenditure in our Senegalese (Rwandan) sample (see Table A2).

Time preference. We concentrate on the measurement of discount factors, abstracting from hyperbolic preferences, which are far from trivial to identify (Mahajan *et al.*, 2026). The literature typically uses intertemporal choice questions to approximate discount rates. We included three questions in our survey where each requires making a choice between getting a present from a trusted person of about US\$5 today and about US\$15 alternatively in two weeks, one month, in three months or in one year (see Levine *et al.*, 2018). A respondent with a strong preference for today's consumption and thus a high discount rate would choose receiving the gift today even in the case of a two-week delay.² We define a bidder as having a low discount rate if the bidder chooses US\$15 in each situation.

Experience and beliefs. To test the role of product experience, we asked households whether they ever had or still have a comparable device. Moreover, we asked households whether they had used or seen such a device in someone else's household, or whether they have heard about it. Two questions measured the respondents' expectations about the benefits associated with the new technologies. First, whether they think the device will reduce their energy expenditures, second, which lifetime people think the device will have (the latter was only asked to interviewees in Senegal). The belief indicator on whether households expect the device to reduce energy expenditures is not shown in the results section because virtually all interviewees responded with 'yes'.

Additional references

Barsky RB, Juster FT, Kimball MS, and Shapiro MD (1997) Preference parameters and behavioral heterogeneity: an experimental approach in the health and retirement study. *Quarterly Journal of Economics* **112**, 537-579.

Giné X and Yang D (2009) Insurance, credit, and technology adoption: Field experimental evidence from Malawi. *Journal of Development Economics* **89**, 1-11.

Jones M, Kondylis F, Loeser J and Magruder J (2022) Factor market failures and the adoption of irrigation in Rwanda. *American Economic Review* **112**, 2316-2352.

² The amounts are chosen such that differences between them exceed local lending interest rates, which households could earn by taking the earlier payout. Taking the earlier payout hence reflects not only the time value of money but also time preference.