Erschienen in: Resource and Energy Economics. Elsevier. 2021, 63, 101202
https://doi.org/10.1016/j.reseneeco.2020.101202

Heterogeneous preferences and investments in energy saving measures

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A B S T R A C T

We investigate whether risk, time, environmental, and social preferences affect single-family homeowners' investments in the energy efficiency of their house using established experimental measures and questionnaires. We find that homeowners who report to be more risk taking are more likely to have renovated their house. Pro-environmental and future-oriented renovators, i.e. renovators with lower discount factors, live in homes with higher energy efficiency. Pro-social preferences as measured in a dictator game relates positively to the energy quality of renovated houses. Controlling for the energy efficiency of houses, we further find that energy consumption as measured by heating and electricity costs is lower for future-oriented and pro-environmental individuals.

Keywords:
Risk preferences
Time preferences
Environmental preferences
Social preferences
Energy efficiency
Artefactual field experiment

1. Introduction

The building stock of EU member states accounts for nearly 40 % of EU's final energy consumption (European Commission, 2020). EU's residential energy use represents 63 % of total energy consumption (see Balaras et al., 2007) and, similarly, the US residential sector[1] strongly impacts total energy use and greenhouse gas emissions (Eichholtz et al., 2010; Eichholtz and Quigley, 2012; Royal Institution of Chartered Surveyors, 2005). However, according to several studies, the building sector also offers important possibilities for greenhouse gas abatement (Bardhan et al., 2014; Enkvist et al., 2007; Evans et al., 2011; Intergovernmental Panel on Climate Change, 2007; Levine et al., 2007, 1995; Stern, 2008; Swiss Federal Office of Energy, 2019). Engineering estimates promise large reductions in energy use (see e.g. Gillingham and Palmer, 2014;

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[1] The U.S. Energy Information Administration defines the "residential sector" as an energy-consuming sector that consists of living quarters for private households. Energy use in this sector includes space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters (see http://www.eia.gov/dnav/pet/tbldefs/pet_pri_prop_tbldef2.asp).

Levine et al., 2007; McKinsey and Co, 2009) and potentially high returns on investments. However, there appears to be large heterogeneity in energy investments across homeowners who live in remarkably similar environments. Why do some homeowners invest in energy saving measures while others appear to be reluctant to do so? The aim of this paper is to provide a better understanding of differences in homeowners' investment behavior (and energy consumption) by relating it to the heterogeneity in homeowners' preferences. Identifying the relation between homeowners' investments and their risk, time, environmental and social preferences not only highlights to what extent investment heterogeneity reflects preferences (instead of potential decision errors) but also helps to develop policies which are tailored to specific misalignments between individual and societal costs and benefits from retrofits.

From an economic point of view, homeowners may underinvest in energy efficiency due to investment inefficiencies and externalities (Allcott and Greenstone, 2012; Hausman, 1979; Jaffe and Stavins, 1994).[2] Investment inefficiencies arise, if homeowners do not fully consider the earnings associated to investments in energy saving measures or overestimate costs associated with them, because they are imperfectly informed or present biased (see also Epper et al., 2011). Externalities refer to the fact that homeowners may not internalize benefits of their investments for others, i.e. for human health and the environment (see also Achtnicht, 2011; Gowdy, 2008).

Homeowners are likely to be heterogeneous in the degree of their investment (in)efficiencies (Allcott and Greenstone, 2012) as well as in the internalization of externalities. In addition, homeowners may differ with respect to other important aspects that matter for investments in energy saving measures. First, energy investments generate uncertain benefits. For instance, recent estimates of causal effects of retrofitting programs cast doubt on returns as high as promised by engineering estimates (Fowlie et al., 2018). Second, benefits from investments in energy efficiency occur in the future and costs frequently arise in the present (see also Schleich et al., 2019). If homeowners differ in their risk and time preferences, the differences in individual investments in energy efficiency measures may result from the differences in homeowners' risk attitudes and time preferences. Further, investments in energy savings may be subject to local social norms (Carattini et al., 2019; Gowdy, 2008; Wilson and Dowlatabadi, 2007), highlighting that comparisons to others and social preferences may play an important role for energy conservation.[3] Finally, a pro-environmental world view may also affect energy investments, because investments are associated with limiting global warming.

The aim of this study is to broaden the understanding of homeowners' investments in energy efficiency measures by studying how heterogeneity in homeowners' preferences along several important dimensions (time, risk, social and environmental preferences) drives differences in homeowners' investment behavior. To avoid split-incentive problems (Gillingham et al., 2012), we elicit preferences of single-family homeowners who live in their house. We combine methods from experimental economics with survey questions and relate these measures to homeowners' renovation and energy consumption behavior. Our study design relates a set of directly elicited individual preference measures to homeowners' renovation behavior, the energy efficiency of their house, and their energy consumption.[4] Our set of individual preference measures consists of a measure of risk preferences, which is obtained using the experimentally validated risk questionnaire proposed by Dohmen et al. (2011), homeowners' individual discount factor (elicited using an incentivized individual decision task, in which homeowners decide between a lower payment in the near future and higher payments in the far future), homeowners' social preferences (obtained using incentivized Dictator and Envy games), and homeowners' preferences for the environment (elicited using a set of items based on the New Environmental Paradigm Scale, following Dunlap and Van Liere, 1978). Our approach allows us to study the relative importance of these measures and helps identify which preference dimensions appear most relevant. Thereby providing insights on which policies are potentially needed or most likely effective.

Our results show that risk preferences are particularly important for the decision to renovate. Homeowners who are more likely to take risks in general (or in financial matters) are also more likely to have their house renovated. Time preferences, social, and environmental preferences seem to play a minor role for the decision to renovate itself but relate to the energy efficiency of renovated buildings. Among renovators, we find that homeowners' discount factors and pro-environmental preferences relate positively to the energy efficiency of the house. That is, renovators who value the future particularly strongly or reveal pro-environmental preferences own houses with higher energy quality. Also, renovators with social preferences have houses with higher estimated energy quality. Finally, we find that pro-environmental and more future oriented homeowners consume less energy (controlling for the energy efficiency of their house).

Our study includes a variety of preference dimensions and thus contributes substantially to the understanding of energy efficient renovation behavior of homeowners. Early research has mainly relied on average estimates of utility functions and implicit discount rates (Alberini et al., 2013; Hausman, 1979; Train, 1985). More recent studies have analyzed the direct impact of specific preferences. For instance, Allcott and Taubinsky (2015) and Newell and Siikamäki (2015) evaluate the impact of individual discount rates on energy efficient choices. Further, risks associated with energy saving investments are

[2] There is an ongoing debate between economists and engineers on the size and existence of a potential "energy efficiency gap". Jaffe and Stavins (1994) provide a deeper discussion on the issue and highlight different notions of optimality which may determine the exact size of the gap. Generally, many economists argue that costs of investment in energy saving measures are neglected or underestimated due to individuals' behavioral considerations. Hence, the cost-benefit analysis of these energy-efficient investments may lead to over-estimate the energy-efficiency gap (Allcott and Greenstone, 2012; Gillingham and Palmer, 2014; Hirst and Brown, 1990; Metcalf and Hassett, 1999; Smith and Moore, 2010). Recent empirical investigations show further that such an energy efficiency gap does not need to exist to justify a policy intervention for renovations (Fowlie et al., 2018).

[3] See e.g. Allcott and Rogers (2014), and references therein, for how social comparisons can affect energy use.

[4] Recent independently developed contributions follow a similar approach (see for example Bradford et al., 2017; Heutel, 2019; Schleich et al., 2019).

considered central in renovation decisions (Hassett and Metcalf, 1993; Metcalf and Hassett, 1999). Farsi (2010) and Qiu et al. (2014) empirically study how heterogeneity in risk preferences relates to individuals' decisions to invest in energy efficiency measures. Epper et al. (2011) report that households explicitly state that they are uncertain about future energy costs and suggest that both future earnings or costs are uncertain as compared to present earnings or costs which are certain such that both risk and time preferences must be considered. The conjoint effects of risk and time preferences on energy efficient choices have been investigated in Bradford et al. (2017); Heutel (2019), and Schleich et al. (2019).

We complement this important line of research with three main contributions. First, we measure social and environmental preferences additionally to risk and time preferences. While the role of social norms has been identified as an important factor in energy contexts (Carattini et al., 2019), the impact of social preferences has been disregarded so far. Second, we investigate the energy efficiency of different parts of the house on top of the decision to renovate, whereas most studies in the literature focus on overall efficiency or binary decisions (for instance, choice of LED light bulbs, appliances or retrofit as in Schleich et al., 2019). Thereby our study allows considering both the decision to renovate and the energy quality of the house. Third, we relate preferences also to incurred energy costs. The broad set of preference measures used in our approach allows to study how heterogeneity in different preference dimensions is reflected in heterogeneity in homeowners' investment behavior and energy costs.

Our results provide insights for the design of policy interventions in a complex and uncertain environment. Traditional policies fostering energy efficient renovations have focused on monetary incentives such as tax reductions and subsidies (see e.g. Alberini and Filippini, 2011). In addition to monetary incentives, researchers have recommended to promote the diffusion of information about technologies and economics of energy efficiency renovations as well as the assignment of energy efficiency renovation specialists (Banfi et al., 2010). However, such policies rarely targeted potential misalignments between individual and societal costs and benefits from renovations explicitly. We find that heterogeneity in individuals' risk, time, social, and environmental preferences is reflected in homeowners' investments and energy consumption. Hence, we provide evidence weakening the policy argument for simply subsidizing energy efficient goods (see also Alberini et al., 2014; Allcott et al., 2014) and calling for more targeted policies (see also Allcott and Greenstone, 2012; Golove and Eto, 1996) that take potential misalignments between individual and societal costs and benefits into account.[5] For example, our results highlight that homeowners with low risk tolerance are reluctant to invest in energy efficient retrofits and the quality of renovations relates systematically to homeowners' time preferences. If homeowners are reluctant to renovate because they fear the risk that renovations do not pay due to false or inappropriate renovations, policies may aim at reducing individual risks through specific market instruments. For instance, policies may require providers of renovation services to provide savings guarantees or free maintenance to reduce moral hazard in renovations. Similarly, policies may aim at shifting benefits from retrofits to the present and costs to the future (as discussed in more detail in Section 6).

The remainder of this paper is organized as follows. In Section 2, we present the main hypotheses concerning the relation between individual preferences and energy investment as well as consumption behavior. These hypotheses are based on existing empirical evidence and a simple theoretical framework which was introduced by Allcott and Greenstone (2012, see Appendix A). In Section 3, we explain the data collection procedure. In Section 4, we present the data set we use for the analysis in Section 5. Section 6 concludes.

2. Hypotheses

We focus on homeowners' investment in energy efficiency measures for their house by analyzing the decision to renovate and the level of energy efficiency of the house. Homeowners' investment behavior depends on their preferences and on the costs of renovations. We base our hypotheses on the model of investment in energy efficiency measures developed by Allcott and Greenstone (2012, for details see Appendix A). The basic trade-off homeowners face stems from the fact that energy efficiency investments are associated with present costs and future benefits and uncertainty in the latter. From an economic perspective, the individual chooses to invest only if her expected utility of the investment outweighs the cost of it. Thus, the expected utility of the investment depends on (risky) future energy cost savings obtained by the investment as well as on the extent to which homeowners derive additional utility from investments, e.g. because they care for others and the environment or compare themselves with others. The model suggests that more future-oriented individuals are more likely to invest in energy efficiency, as costs occur in the present, but benefits occur in the future. Hence, we formulate Hypothesis 1 (H1) as follows:

H1. More future-oriented homeowners are more likely to invest in energy efficiency.

Investigating empirical evidence on this hypothesis, the literature has revealed mixed results so far. Allcott and Taubinsky (2015) and Newell and Siikamäki (2015) find that individuals with low discount factors, i.e. people who care less about future utilities, invest less in energy efficiency in their choice of lightbulbs and water heaters respectively. By contrast, Heutel (2019) finds no effect of time preferences on lights, appliances or vehicles. Bradford et al. (2017) and Schleich et al. (2019) find that the effect depends on the type of product that benefits from the energy efficient investment.

[5] See also Bento et al. (2012) who provide evidence from simulation analyses that empirical studies ignoring consumer heterogeneity may overstate the magnitude of under-valuation of energy efficient products.

Future benefits of investments in energy efficiency are risky because the amount of energy saved as well as the savings per unit can vary substantially, e.g. due to uncertain future energy prices (Mills et al., 2006). More risk-tolerant individuals are therefore expected to be more likely to invest in energy efficiency. Building on this idea we formulate Hypothesis 2 (H2):

H2. More risk tolerant homeowners are more likely to invest in energy efficiency.

The literature on the role of risk preferences shows robust evidence that risk aversion decreases the energy efficiency investments (Farsi, 2010; Heutel, 2019; Qiu et al., 2014; Schleich et al., 2019).

A specific benefit of investments in energy efficiency is that it helps limiting global warming. An individual with pro-environmental preferences may thus be more likely to internalize externalities generated by energy use and, consequently, is expected to be more likely to invest in energy efficiency. We formulate Hypothesis 3 (H3) as follows:

H3. More pro-environmental homeowners are more likely to invest in energy efficiency.

Two empirical studies focus on the role of environmental preferences but find mixed evidence. Schleich et al. (2019) find a positive relation between pro-environmental identity and house retrofit whereas Aravena et al. (2016) find no positive relation between environmental benefits of energy efficiency measures and the intention for and adoption of such measures.

As investments in energy efficiency help limiting global warming, they can also be viewed as investments in a public good (Allcott, 2011b). From this consideration, social preferences appear important to consider while the literature has largely neglected those aspects. The analysis of social preferences is complex as such preferences have diverse components depending on how individuals value the situation of others. On the one hand, pro-social preferences like altruism or equity-based fairness can capture that individuals positively value the welfare of others. Hence, pro-social preferences would make investments in energy efficient measures more likely as the latter generates positive externalities. Hypothesis 4 (H4) takes this into account:

H4. More pro-social homeowners are more likely to invest in energy efficiency.

On the other hand, social preferences can also reflect envy, i.e. social preferences can relate to what extent individuals value the welfare of others relatively to their own welfare and thus also to what extent people dislike being behind. Envy may influence energy efficient investment in two different ways: either negatively when people do not want to be behind in a monetary dimension or positively, when people do not want to be behind in terms of having a house with lower efficiency than others. As it is ex-ante unclear to what extent and in which direction envy will affect investments, we refrain from formulating any directional hypothesis. Instead, we let our data inform us on the role of envy for investments. We thus decompose Hypothesis 5 in two parts (H5a and H5b):

H5a. More envious homeowners are less likely to invest in energy efficiency.

H5b. More envious homeowners are more likely to invest in energy efficiency.

Besides renovation behavior, preferences may also relate to energy consumption. As the simple model (see Appendix A) assumes consumption to take place in the future only, and considers consumption utility to be deterministic, the model predicts risk and time preferences not to matter for energy consumption. However, pro-environmental and pro-social homeowners may consume less energy because energy consumption negatively affects the environment and others (because of negative externalities, e.g. in the form of pollution or global warming). We therefore hypothesize that pro-environmental and pro-social homeowners consume less energy, but do not formulate any directional hypotheses in terms of risk and time preferences. The hypothesis concerning consumption (Hypothesis C-1) reads as follows:

H-C1. Pro-environmental and pro-social homeowners consume less energy.

3. Data collection and methodological aspects

Our study focuses on Swiss homeowners who live in their own house, in order to avoid any split-incentive problem (Gillingham et al., 2012). Although Switzerland is one of the most advanced countries with respect to energy efficiency among OECD countries (Evans et al., 2011), engineers estimated an important potential to reduce greenhouse emissions in the Swiss housing market at the time of data collection. For instance, Jakob and Madlener (2004) reported that energy use for space heating may be reduced by 33–50 % in existing buildings and by 80 % or more in new buildings. Although these studies promised high benefits in terms of energy use, Jochem et al. (2003) indicate that only few Swiss homeowners invested in renovating building envelopes at that time, which may contribute substantially to improvements of buildings' energy efficiency.[6] Apart from these optimistic estimates, also the Swiss government was convinced that retrofitting homes will reduce emissions and established several programs to increase energy efficiency in residential buildings, most prominently the Swiss buildings program (www.dasgebaeudeprogramm.ch), which is still running today. While recent evidence

[6] For further information see also Jochem and Jakob (2004), who provide a detailed analysis of energy perspectives on CO_2 reduction potentials in Switzerland up to 2010.

suggests that the size of these savings potentials is quite optimistic (Fowlie et al., 2018), Banfi et al. (2008) provided evidence that the willingness to pay for building efficiency enhancements exceeded the cost of implementing these measures in Switzerland. Nevertheless, homeowners in Switzerland mainly invested in retrofitting their building envelopes end of the building element's lifetime (see Jakob, 2007b).

We collected the data in German-speaking Swiss cantons in 2010 and 2011. First, we contacted 2500 homeowners in the Canton of Zurich with the help of the Canton of Zurich Buildings Insurance (GVZ). This insurance is mandatory for houses in the Canton of Zurich, such that we contacted a representative subset of homeowners in the Canton of Zurich. Second, we contacted 2139 additional households outside the Canton of Zurich but within the German-speaking cantons of Switzerland (to avoid approaching the same homeowners twice). To increase the likelihood of respondents who recently renovated (or recently formed the intention to renovate), we collaborated with a marketing agency who helped us contact homeowners living in houses that were between ten and twenty years old. Consequently, we control in addition for the age of houses in our regression analyses. The age distribution of houses of respondents in the first wave appears similar to the age distribution of single-family homes in the Canton of Zurich, while houses in the second wave are younger on average. In terms of size, homes of respondents are more often larger than homes in both Zurich and other German speaking cantons (see Fig. B1 in Appendix B). (Swiss Household Panel (SHP), 2020).[7]

In total, we received 550 completed questionnaires, 264 in the Canton of Zurich and 286 in other cantons.[8] The response rate was about 12 percent.[9] To minimize barriers for energy investments such as incentive conflicts (split-incentives) between tenants and homeowners (Clinch and Healy, 2000; Gillingham et al., 2012; Golove and Eto, 1996; Levinson and Niemann, 2004),[10] we focus our analysis on homeowners of single-family houses who also live in their house, and thus benefit themselves from investments in energy efficiency measures (489 homeowners in total).

Homeowners were asked to answer questions on the energy quality of their house depending on three factors: window quality, roof quality and façade quality. Also, they indicated their subjective estimation of the energy efficiency of their house. Further, homeowners had to indicate whether they did renovate their house in the past and whether they plan any future renovation. For a subsample of households, we additionally elicited information about energy consumption. Further, we asked for the age and size of their house. To control for the financial situation of homeowners, we included questions from the German SAVE study (see Boersch-Supan and Essig, 2005) in our questionnaire. The questions focus on how much money is available at the end of a month and thereby indirectly and non-intrusively elicit a proxy for homeowners' wealth.[11]

Homeowners' time preferences and social preferences, i.e. pro-social preferences and envy, were elicited using incentivized pen and paper experiments. Homeowners' preferences with respect to risk were elicited using experimentally validated risk questionnaire proposed by Dohmen et al. (2011).[12] Homeowners' preferences for the environment were elicited using a set of items based on the New Environmental Paradigm Scale (Dunlap and Van Liere, 1978). The NEP is one of the most widely used questionnaires to elicit whether individuals hold a pro-environmental worldview (Dunlap, 2008; Ziegler, 2019). To keep our questionnaire as short as possible, we used only three items of the NEP, that clearly capture pro-environmental preferences. While alternative and broader concepts of environmentalism – for example the value-belief-norm theory (Stern, 2000; Stern et al., 1999) – would have allowed us to elicit a more nuanced picture of environmental preferences, they would also have required using many more items on environmental preferences.

All participants of the study had the possibility to earn money by participating. Payments depended on the decisions made in the different incentivized choice tasks (Dictator Game, Envy Game, Time Preferences elicitation task), of which one was randomly selected to be paid. To ensure trust in the random selection of the payoff-relevant decision, we assigned a two-digit number to each decision which was linked to last digits of the Swiss public lottery (*Joker*).[13] On average, payments amounted to 40 Swiss francs. Participants received their payment via bank transfer or mail about one month after we received the questionnaire (and were informed about this procedure).[14] In the two following sections, we present the obtained measures for energy efficiency investments, risk, time, environmental and social preferences in more detail.

[7] Although our sample is not representative in general, we cover a wide spectrum of characteristics of homeowners' included in the (representative) Swiss Household Panel (SHP). Appendix B provides comparisons in terms of homeowners' age, saving potential, risk attitudes, and environmental preferences.

[8] A translated version of the letter sent to homeowners including the questionnaire and the experimental decision tasks is available in the Online Appendix.

[9] The response rate may appear low but it is of similar size as other experimental survey studies, as for instance in Riedl and Smeets (2017).

[10] For a further discussion of barriers and drivers of energy efficient renovations that are different from individual preferences, for instance retrofit costs or future energy prices, see Cameron (1985), who provides an early study that analyzes house retrofit decisions with data from the U.S. More recent studies highlight and discuss such barriers for Switzerland (Banfi et al., 2008), Canada (Sadler, 2003), the Netherlands (Poortinga et al., 2003), South Korea (Kwak et al., 2010), Sweden (Nair et al., 2010) and Germany (Achtnicht and Madlener, 2014).

[11] It has been shown that answers to these questions correlate highly with personal wealth (see Boersch-Supan and Essig, 2005, p.33).

[12] Dohmen et al. (2011) find that answers to the general risk attitude question predict actual behavior in lottery tasks with safe options.

[13] As mentioned above, we conducted two waves. In the first wave, on average every fourth participant received a variable amount determined by her own or some other participant's decision in one of the decision tasks. In the second wave, every participant received a fixed payment of 10 Swiss francs for participating plus a variable amount that was determined by the participants' decision in the choice task. We did so, as some participants in the first wave complained about the fact that not everyone was paid.

[14] As participants in the time preference elicitation task decided on whether to receive their payments either 1 or 7 months after the reception of their questionnaire, we also transferred all other "immediate" payments one month after the reception of the questionnaire.

4. Data description

4.1. Background information

The sample used in the analysis encompasses a total of 341 participants. The reduction of the sample size from the 489 living in their house to 341 homeowners results for two reasons. First, we only include homeowners, who made all decisions in the preference elicitation tasks and answered all questions that are used our analysis. Second, we restrict the analysis to those participants who made consistent choices in the time preference tasks.[15] Table C1 in Appendix C shows that homeowner characteristics (such as gender, house age, house size, financial position) between the final sample and the households who have been excluded due to incomplete or inconsistent decisions do not differ significantly (Mann-Whitney tests, all p-values >0.10); solely homeowner's age differs significantly (Mann-Whitney tests, all p-values <0.05), as incomplete or inconsistent answers occurred more often among older homeowners.

Concerning the final sample, the age of houses ranges from 2 to 405 years with a median of 17 years (standard deviation = 43.10). In order to cope with the possibility of a non-linear relationship between house age and renovation behavior, we generated four house age classes based on a quartile split (1st quartile = 14 years, 2nd quartile = 17 years, 3rd quartile = 32 years), including their upper bounds. The size of houses ranges from 44 square meters to 2400 (median = 170; std. deviation = 160.95). Concerning households' financial situation, we asked individuals to answer the following question: "If you think back to how you (and your partner) managed on with your income in 2010: What describes the situation best?" Homeowners could tick one of the following options "At the end of the month there was lots of money left", "At the end of the month there was frequently some money left", "There was only money left, if a nonrecurring income occurred", "At the end of the month it was often not enough", or "At the end of the month it was never enough" (see also Boersch-Supan and Essig, 2005). Only 2% of participants have either often not enough or never enough money at the end of the month, 12 % have money left only if a nonrecurring income occurred and 86 % have either frequently some money left or lots of money left.

4.2. Measures of energy investments

Our main analysis focuses on investments in energy efficiency. We understand the investment decision as deciding whether to renovate and if so, to what extent to invest in energy efficiency. Thus, our main dependent variables will be homeowners' renovation behavior in general, i.e. whether houses were renovated and whether a future renovation is planned, and an index of the energy efficiency of the house.[16]

With respect to renovations we find that in total, 29.3 % of houses are renovated, 10.3 % are planned to be renovated, 13.2 % are both renovated and planned to be renovated while 47.2 % are not renovated and not planned to be renovated. Years of renovation range from 1980 to 2011 with the median being in 2007, the first quartile in 1997 and the last quartile in 2009. 75 % of the renovations occurred in the last 15 years.

Concerning the energy efficiency of the house, we construct an index that allows us to use all available information on the energy efficiency of the house in a single dependent variable, weighting different components of the house objectively (because window, roof and façade quality certainly affect house energy quality differently). To do so, we first ask participants to evaluate the quality of their windows, roof and façade on a four point scale by answering questions similar to those used in Banfi et al. (2008) and second, to judge the overall energy efficiency of their house using a question on their subjective estimation of their home measured on a 5-point Likert scale (very low, low, medium, high and very high).

Table 1 shows the share of respondents for each category of the quality variables of the different components of the house. The majority of respondents have standard insulated windows as well as standard roof and façade quality. Around one quarter of homeowners report enhanced insulation with respect to window quality. One third report enhanced roof and façade quality. Less than 10 percent report the lower two quality categories for each of the three measures.

Using households' subjective evaluations of efficiency (mean = 3.35, std. deviation = 0.65)[17], we estimate how homeowners weight the importance of window, roof, and façade quality for the efficiency of their house. We regress the subjective efficiency measure on window, roof, and façade quality. As Table 2 shows, homeowners attribute on average slightly stronger weights to façade quality and roof quality than to window quality. Using the regression results, we calculate for each household the estimated overall quality of the house (estimated overall quality = 0.276 * roof quality + 0.215 * window quality + 0.372 * façade quality + 0.593). The estimated overall quality ranges from 1.67 and 4.05 (mean = 3.35, std. deviation = 0.42).[18]

[15] For instance, we excluded homeowners who preferred 80.50 in 7 months over 80 in 1 month but preferred 80 in 1 month over 81 in 7 months.

[16] We further included questions on the heating system, the use of energy efficient light bulbs and questions concerning heating and electricity costs (see Online Appendix).

[17] About 51% of homeowners rate their house as medium- efficient and about 39.4% as highly so. 7.1% consider the efficiency of their house as low, 1.8% as very high and 0.3% as very low.

[18] For robustness purposes, we also generated a proxy for the global energy efficiency of the house that is the unweighted sum of window, façade and roof qualities. The results obtained are qualitatively similar to the analysis presented in the paper and presented in Appendix E.2 (Table E13)

Table 1
Window, roof, and façade quality.

	Percent of respondents (n = 341)
Window quality	
Enhanced window	23
Standard insulated[a]	73
Medium old window	4
Very old window	0
Roof quality	
Enhanced roof insulation	32
Standard roof insulation[b]	61
Medium old roof insulation	5
Very old roof insulation	2
Façade quality	
Enhanced façade insulation	32
Standard insulation[c]	58
Repainted façade	6
Old façade	4

[a] Standard window refers to coated window glass with complete gasket.
[b] Participants could choose among very good, "normal" (standard), medium old and old insulation.
[c] Participants had no additional information on façade insulation other than reported in the table.

Table 2
OLS estimation of subjective energy efficiency of the house[a].

	Subjective energy efficiency
Roof quality	**0.276*****
	(0.054)
Window quality	**0.215*****
	(0.065)
Façade quality	**0.372*****
	(0.052)
Constant	**0.593*****
	(0.213)
Observations	335
R-squared	0.414

Note: robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
[a] Six subjects did not indicate a subjective level of the efficiency of their house. We do not use these six homeowners to construct the overall efficiency measure of the house. However, as all six subjects have indicated the façade, window and roof quality of their house, we calculate the overall efficiency of their house using the weights from the estimation shown in Table 2 (as for all other participants).

4.3. *Measures of individual preferences*

4.3.1. *Risk preferences*

We measure risk preferences using the experimentally validated questionnaire by Dohmen et al. (2011). The risk questionnaire allows participants to indicate their willingness to take risks in general and context specific risks.[19] Participants tick a box on a five point scale ranging from "not ready to take risks" (value 1) to "very risk-taking" (value 5). Fig. 1 presents the distribution of participants' answers to the risk task.

4.3.2. *Time preferences*

Our measure of homeowners' time preferences is based on 11 decision situations in which homeowners had to decide whether they wanted to receive 80 Swiss francs in one month or a higher amount in seven months. The amounts available in the more distant future, i.e. in seven months, ranged from 80.50 Swiss francs to 108 Swiss francs. A person values future payments more strongly the lower the monetary amount at which the person switches to the payment in the far future is.[20] For the analysis we focus on homeowners' minimum discount factor (for six months), i.e., at which the respondent chooses the future amount for the first time. The distribution of participants' discount factors is provided in Fig. 2.

While some participants exhibit rather low discount factors, our results in general are in line with previous findings and add to a literature that has observed substantial differences in discount rates (see e.g. Frederick et al., 2002; Meier and Sprenger, 2010). The mean minimum discount factor (for six months) in our data amounts to 0.9, which corresponds to an annual discount factor of 0.81. Matousek et al. (2019, p. 11) provide evidence from a meta-study including 34 individual studies – using mostly data from laboratory experiments (68 percent) with a large fraction of student participants - and

[19] The context specific risk attitudes encompass risk-taking in financial matters, car driving, leisure and sports, and professional career. We present additional analyses concerning the domain specific risk attitudes in Appendix E (see Tables E4 to E7 and Tables E17 to E20).
[20] For a critical review on discounting and time preferences see also Frederick et al. (2002).

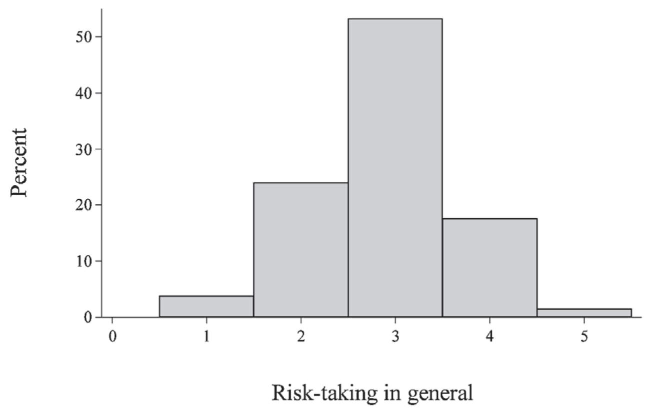

Fig. 1. Risk-taking in general (n = 341, not risk seeking = 1, very risk seeking = 5).

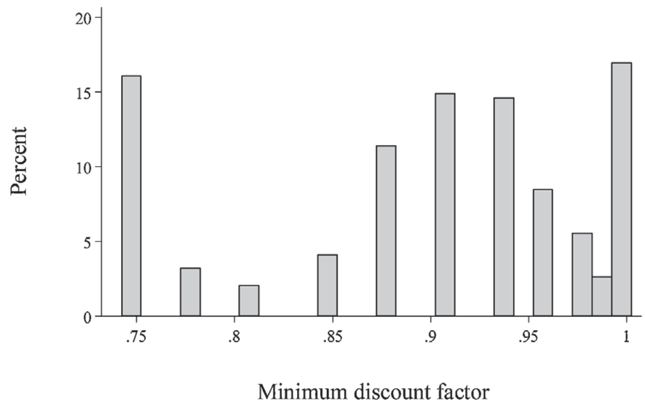

Fig. 2. Minimum discount factors (n = 341).

find strong heterogeneity in annual discount rates across studies. The mean annual discount rate amounts to 0.68, with a standard deviation of 1.26. As the mean discount rate observed in Matousek et al. (2019) is equivalent to a mean annual discount factor of 0.60, homeowners appear to place more weight on the future as compared to the samples considered in the meta-study. More similar to our approach, Enzler et al. (2014) include a written survey with a serial choice task in which both early and late payments occur in the future. They focus on a sample representative with respect to the Swiss general population and find a discount factor of 0.71, which amounts to 0.79 when excluding discount rates above 100 percent. Thus, homeowners' average discount factors are similar to discount factors observed in a sample representative of the Swiss general population. Finally, as has been observed in other studies using multiple price lists (see e.g. Reuben et al., 2015), the distribution of discount factors observed in our study looks non-normal. We thus also report additional robustness analyses, in which we exclude the 16 % of our sample with an estimated discount factor lower than 0.75 and the 17 % of our sample with a discount factor higher than 0.99 in Appendix E (see Table E25). Doing so, the observed relationships between time preferences, renovation behavior and energy efficiency of houses remain robust.

4.3.3. Environmental preferences

We measure environmental preferences with a subset of questions of the New Environmental Paradigm Scale (Dunlap and Van Liere, 1978), one of the most widely used questionnaires to elicit whether individuals hold a pro-environmental worldview (Dunlap, 2008; Ziegler, 2019). Participants were asked to state their agreement with the following three statements (on a 5-point scale): "We are approaching the limit of the number of people the earth can support", "To survive, people have to live in harmony with nature", and "People do not have to adapt to nature, because they can restore it." We built an index on the following three statements by adding positively framed questions and subtracting negatively framed questions. The obtained environmental preference index then ranges from 0 to 9. Fig. 3 presents the distribution of individuals' environmental preference index. The attractiveness of the NEP measure stems from the fact that it elicits a simple proxy for environmental preferences. We also present analyses using two different proxies for environmental preferences: stated donations to environmental associations and a one-time donation decision at the end of the survey experiment (see Tables E8 to E11 and E21 to E24 in Appendix E). While these additional measures are interesting as they capture (stated) behaviors, they may also serve as substitutes for other pro-environmental investments (such as energy efficient retrofits) and, hence, may confound the analyses of environmental preferences and renovation behaviors.

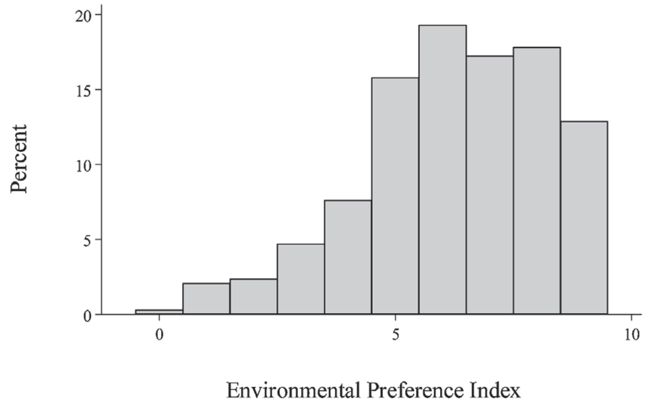

Fig. 3. Environmental preference index (n = 341).

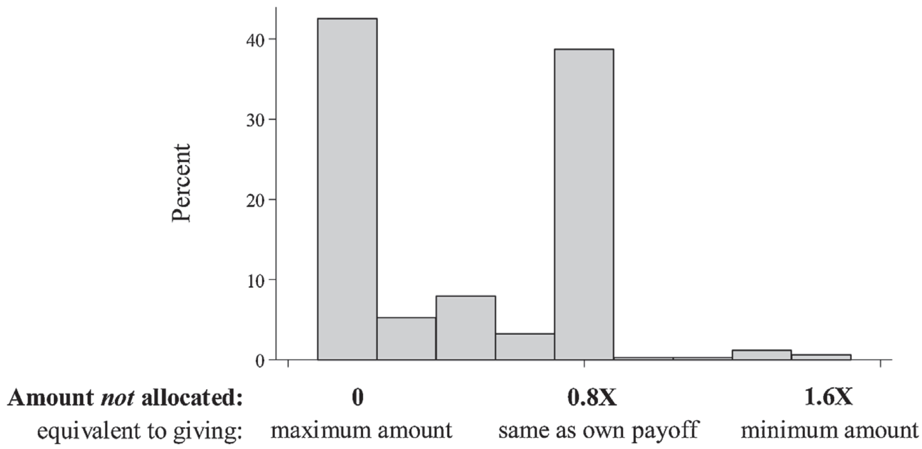

Fig. 4. Amount not allocated to the other player (Envy). (n = 341, X = decision maker's payoff).

4.3.4. Social preferences

We elicit social preferences using two incentivized experiments. In the first experiment (Envy Game) we measure envy, i.e. how much participants care about being behind when they can allocate money to others without incurring any cost (see also Fehr et al., 2008). In the second experiment (Dictator game), we focus on pro-social preferences, i.e. how participants care about the welfare of others when they have to pay for it (see e.g. Forsythe et al., 1994). The advantage of these monetarily incentivized experiments comes from the fact that they achieve construct validity by theory (see e.g. Fehr et al., 2008). The dictator game and the envy game are simple, belief independent measures that capture the main dimensions of social preferences and avoid more complex strategic concerns existent in standard or global public good games (see, e.g., Milinski et al., 2006).

4.3.4.1. The envy game. Homeowners play a two-person Envy game in which a decision maker (Player 1) receives a fixed payoff of X and has to decide on the payoff Y for Player 2, with and. Player 2 is passive. The less money the decision maker allocates to Player 2, the more envious we consider the decision maker.[21] Fig. 4 shows a histogram for the amount *not* allocated to Player 2 (envy) in terms of the fixed amount Player 1 receives (X). As can be seen in Fig. 4 our envy measure splits the main part of our sample into two types of behavior: Envious participants do not allocate more than they receive themselves, i.e. the share not given to the other player is $\geq$ X. Less envious participants chose to allocate a higher amount than X to the other player.

4.3.4.2. The dictator game. We used a dictator game in order to measure fairness regarding another participant, a motive of pro-social preferences. In the dictator game, Player 1 receives an amount of money Z which she can distribute between herself and another Player. Thus, in this game being pro-social is costly. In our Dictator Game, the minimum share Player 1 can allocate to a player is restricted to 10 percent of Z.[22] Fig. 5 shows a histogram for the share of Z allocated to the other

[21] In the experiment: d = 0.8X with X = 50 Swiss francs for the households in the first wave and X=25 for households in the second wave (as the latter households received a flat payment of 10 Swiss francs for participating).

[22] Z = 100 Swiss francs for the households in the first wave and 50 Swiss francs for households in the second wave (as the latter households received a flat payment of 10 Swiss francs for participating).

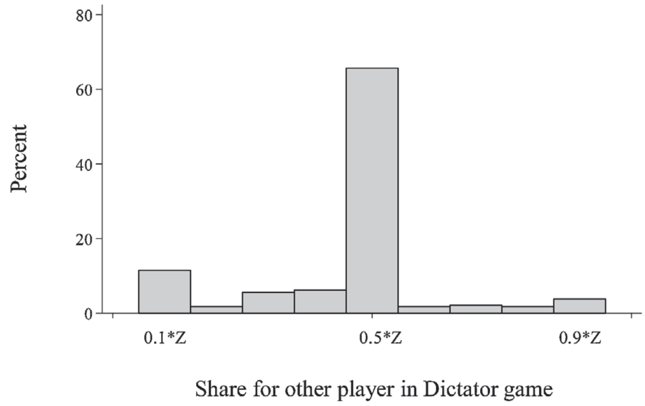

Fig. 5. Share for other participant in the dictator game. (n = 341, Z = pie to be divided among the two players).

Table 3
Spearman correlations between preferences.

	Discount factor (from 0.747 to 1)	Pro-environmental (from 0 to 9)	Envy (from 0.1 to 0.9)	Pro-social (from 0.1 to 0.9)
Risk-taking (from 1 to 5)	0.070	0.008	−0.074	−0.041
Discount factor (from 0.747 to 1)		0.086	−**0.113****	−**0.097***
Pro-environmental (from 0 to 9)			0.035	0.002
Envy (from 0.1 to 0.9)				−0.044

Note: *** p < 0.01, ** p < 0.05, * p < 0.1.

player. More than 60 percent of participants establish perfect equality.[23] The second largest fraction of participants chooses the selfish option.

To be able to compare the role of pro-social preferences and envy in our regression analyses, we rescale the share for the other participant in the Envy Game such that the decisions range - as in the Dictator Game - from 0.1 to 0.9. Envy is considered low (and equals 0.1) when the participant chooses 1.8X for the other participant and high (equals 0.9) when the participant chooses to allocate 0.2X to the other participant. A participant who chooses exactly X for the other participant looks for equality and the value of envy is 0.5.[24]

4.3.5. Correlations between preference measures

Table 3 below shows Spearman correlations between our preferences measures. Most correlations are close to zero and statistically insignificant. Only the individual discount factor is negatively correlated with envy and pro-social preferences, although to a minor extent.

5. Heterogeneous preferences, energy efficiency and consumption

Finally, we turn to the relation of our preference measures and energy efficiency and consumption. A natural way to think about investments in energy efficiency is to assume that households first decide on whether to renovate at all and second, they decide on the exact energy enhancements they want to achieve by retrofitting their home. Therefore, we first focus on the decision to renovate the house in general and second analyze how the energy quality of the house relates to preferences contingent on renovation activity. As previous studies have shown that social norms impact households' decisions in energy conservation (Allcott, 2011b; Baddeley, 2011) and therefore, house energy quality as well as renovation behavior of homeowners living in the same area may be correlated, we use cluster-robust standard errors with clustering on postal codes.[25] In Section 5.1 we analyze how preferences relate to the renovation decision of homeowners. Section 5.2 presents the relation of respondents' preferences and the energy efficiency of their home. Finally, in Section 5.3 we discuss the results and shed light on how preferences affect energy consumption behavior.

[23] As already documented by Engel (2011), also our non-student subjects give much more than usual student subjects.
[24] Apart from our incentivized measures of social preferences, we present additional results from an alternative proxy for social preferences (self-stated donations to social organizations) in Appendix E (see Tables E8 -E9 and E21-E22).
[25] We also ran the analysis with clustering on cantons. The results are qualitatively similar and can be found in Appendix E (Table E12 regarding the renovation decision and Table E26 regarding the energy efficiency of the house).

Table 4
Decision to renovate (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(4)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.059****	**0.052*****	**0.055****	**0.041****	**0.047****	0.037
	(0.031)	(0.020)	(0.025)	(0.021)	(0.020)	(0.023)
Discount factor (from 0.747 to 1)	0.140	0.035	0.164	−0.030	−0.025	−0.043
	(0.346)	(0.226)	(0.298)	(0.345)	(0.224)	(0.287)
Pro-environmental (from 0 to 9)	0.015	0.002	0.014	0.005	−0.001	0.005
	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.068	−**0.245****	−**0.204***	0.130	−**0.193****	−0.017
	(0.097)	(0.104)	(0.109)	(0.089)	(0.093)	(0.099)
Pro-social (from 0.1 to 0.9)	−**0.232****	0.040	−**0.209****	−0.010	0.092	0.004
	(0.097)	(0.072)	(0.103)	(0.088)	(0.079)	(0.099)
14–17-year-old house				0.024	−0.022	−0.004
				(0.053)	(0.056)	(0.050)
18–32-year-old house				**0.295*****	**0.114****	**0.312*****
				(0.075)	(0.048)	(0.075)
House older than 32 years				**0.594*****	**0.094***	**0.607*****
				(0.047)	(0.048)	(0.037)
Log(House size)				0.003	−0.014	0.070
				(0.058)	(0.046)	(0.053)
Female				−0.064	0.047	−0.021
				(0.057)	(0.040)	(0.054)
Age				−0.001	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.009	0.086	0.005
				(0.087)	(0.061)	(0.071)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.016	0.023	0.018	0.275	0.047	0.237

Note: robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.1. Renovation decision

Table 4 presents average marginal effects from probit regressions explaining participants' decisions and plans to renovate (coefficients are reported in Table E1 in Appendix E; Tables E2 E3 provide results for logit estimations). In Model (1) we estimate the probability of having renovated in the past, which measures past behavior and serves thus as the main outcome variable.[26] In Model (2), we estimate the probability that homeowners state to plan future renovations. Finally, in Model (3), we combine the two measures for completeness and estimate the probability that participants either renovated in the past, plan to renovate in the future, or both. Explanatory variables are the preference measures presented in the previous section: general risk preferences, time preferences, environmental preferences, as well as envy and pro-social preferences. Model (4), Model (5) and Model (6) replicate models (1), (2) and (3) controlling for the homeowners' gender, age, and financial position as well as additional characteristics of the house. We control for the age class of houses as we expect the age class of the house to be mechanically positively correlated with the house's probability to be renovated (Jakob, 2007a) and its size in square meters, which should take other (unobserved) factors about renovation costs and benefits into account.

Table 4 shows that among our preference measures, homeowners' risk preferences are the major driver of our main outcome variable, past renovations. Past renovations are significantly more likely for participants who declare being more risk seeking in general. A similar relationship exists for stated future renovation plans (models (2) and (3)). Hence, in line with Hypothesis 2, households seem to perceive renovations as risky investments.[27] This effect remains statistically significant when adding additional control variables for past and future renovations (when considered separately).

The coefficient of the discount factor is positive in specifications (1) to (3), however, it fails to be statistically significant (with and without additional controls). While surprising at first sight, this result is in line with the idea that homeowners may first focus on the uncertainty in present costs and hazzles before considering the future cost savings of a renovation related to better energy efficiency. In line with this idea, also pro-environmental preferences seem to play a minor role for the decision to renovate. Concerning social preferences, pro-social concerns appear important to explain past renovations in model (1) but turns out to statistically insignificant when including additional control variables. Envy relates negatively

[26] Past renovations took on average place 6.7 years ago. We present additional analyses on the timing of renovations in appendix D (see Table D1).
[27] As mentioned in section 4.3.1, we also elicited risk attitudes in specific domains. Conducting the same econometric analysis using domain specific risk measures, we found similar results for the impact of risk-taking in financial matters and in professional career on the renovation decision, but not for risk-taking in car driving or in leisure and sports (see Tables E4 to E7 in Appendix E). Further, note that observed effect of risk attitudes is not necessarily limited to renovation behavior but may apply also to other consumer durables (see also Volland, 2017).

Table 5
Estimated overall energy quality of houses and Heckman selection.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.072***** (0.021)	0.009 (0.044)	**0.077***** (0.022)	0.017 (0.042)	**0.140**** (0.066)	0.044 (0.045)
Discount factor (from 0.747 to 1)	0.208 (0.238)	**1.139***** (0.395)	0.362 (0.286)	**1.257***** (0.448)	0.063 (1.224)	**1.029***** (0.309)
Pro-environmental (from 0 to 9)	0.003 (0.006)	0.001 (0.006)	**0.012*** (0.006)	**0.020**** (0.009)	0.012 (0.028)	**0.021***** (0.008)
Envy (from 0.1 to 0.9)	**0.190**** (0.079)	**0.350***** (0.106)	0.021 (0.071)	0.136 (0.101)	0.401 (0.309)	**0.204*** (0.116)
Pro-social (from 0.1 to 0.9)	**0.240**** (0.093)	**0.335***** (0.100)	0.080 (0.075)	**0.203***** (0.071)	−0.207 (0.291)	**0.186**** (0.082)
14–17-year-old house			−0.026 (0.041)	0.162 (0.120)	−0.016 (0.164)	
18–32-year-old house			**−0.149***** (0.036)	0.048 (0.075)	**0.849***** (0.240)	
House older than 32 years			**−0.449***** (0.034)	**−0.280***** (0.076)	**2.070***** (0.145)	
Log(House size)			**0.102**** (0.044)	**0.205***** (0.028)	0.030 (0.225)	**0.207***** (0.036)
Female			0.038 (0.036)	−0.003 (0.039)	−0.219 (0.186)	−0.021 (0.057)
Age			**0.007***** (0.003)	**0.007*** (0.004)	0.001 (0.009)	**0.007**** (0.003)
Good financial position (from 1 to 3)			0.023 (0.027)	0.068 (0.041)	−0.017 (0.299)	0.068 (0.086)
Constant	2.767*** (0.311)	1.933*** (0.466)	1.818*** (0.631)	0.278 (0.687)	−1.513 (1.150)	0.090 (0.715)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.033	0.060	0.221	0.252	0.316	
Robust Std. Error of λ					(0.031)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

to stated plans on future renovations with and without controls (potentially highlighting the fact that envious homeowners like to appear as owners of homes that do not need to be renovated in the future).

Concerning control variables, we find that, as expected, older houses are more likely to have been renovated or to be renovated in the future. Further, while we expected homeowners' financial position to impact the likelihood of renovations, we do not observe a strong relationship between financial position and renovation behavior. This result may be due to the fact that financial constraints are of minor importance to most homeowners in our sample (a large majority of homeowners stated that, at the end of the month, they have either frequently some money left or lots of money left, see also Section 4.1). Finally, we find that house size, age and gender of the respondent have no significant impact on the decision to renovate. The impact of risk is robust to the robustness tests (see Appendix E). We conclude with Result 1:

Result 1. Homeowners who are more likely to take risks are more likely to have renovated their home.

5.2. Energy efficiency of the house

In the following we present results on how individual preferences relate to the energy quality of the house. We report results from OLS regressions explaining the estimated overall quality of the house in Table 5. In models (1) and (2), we regress the estimated overall quality of the house based on risk, time, environmental, and social preferences (envy and pro-social preferences). In models (3) and (4), we add the age and size of the house and participants' gender, age, and financial position as additional controls. In models (1) and (3), we consider all households. If we think about a renovation decision as a two-step procedure in which households first decide on whether or not to renovate and second, decide on the exact energy enhancements they want to achieve by retrofitting their home, it is worthwhile to investigate whether heterogeneity of preferences can explain the efficiency of houses among renovators separately. Therefore, in models (2) and (4), we restrict the analysis to households who already renovated their house. Additionally, we run a Heckman selection analysis in Model

(5), which takes the potential selection of homeowners who renovated into account and uses variables indicating the age of houses solely in the selection equation.[28]

Result 1 has shown that the more risk-taking homeowners are, the higher is the probability to renovate. In turn, models (1) and (3) in Table 5 indicate that participants who are more risk-taking have a higher estimated overall home quality with respect to energy efficiency. Models (2) and (4) shed more light on those households who decided to renovate their house. First, note that risk attitudes do not predict higher energy efficiency among renovators. Instead, risk attitudes appear to matter for the decision to renovate in general.[29] Second, the estimated overall quality of renovated houses increases in households' discount factor. The Heckman selection Model (5) confirms these findings. It shows that risk taking is important for the decision to renovate (selection) but discount factors significantly relate to the estimated efficiency of the house (conditional on having been renovated). In line with Hypothesis 1, more future-oriented renovators have a significantly higher overall energy quality.

Result 2. Future-oriented renovators have a significantly higher estimated energy quality.

In regression models (3), (4) and (5) we include additional controls. We find that also pro-environmental preferences relate positively to the overall quality of their house.

Result 3. Pro-environmental homeowners have a significantly higher estimated energy quality.

We now turn to social preferences. Recall, we use two different measures for social preferences, pro-social preferences and envy. We find that the share offered to the other player in a Dictator Game tends to relate positively to the energy quality of the house. Interestingly, also envy as measured in the Envy Game tends to relate positively to the energy quality. Those who dislike being behind in the experiment are also more likely to invest in energy efficiency. Focusing on Model (4), which includes our additional controls, only the pro-social coefficient is significant. However, taking the potential selection into account, both coefficients are insignificant for the renovation decision but significant for the estimated efficiency of renovated houses (see Model (5)). We summarize this finding in Result 4:

Result 4. Renovators with social preferences, i.e. those who are pro-social in the Dictator Game and envious in the Envy Game, have a higher estimated energy quality.

Finally, additional controls themselves play a minor role. If at all, older homeowners appear more likely to live in houses with better quality. The proxy for homeowners' financial position turns out to relate positively to energy quality but fails to be statistically significant.[30] For robustness tests, we provide in Appendix E (see Tables E13 to E16) the same specifications for the unweighted sum of window, roof, and façade quality (instead of the estimated energy quality), which yield consistent results. Further, we use window, roof and façade quality as separate outcome variables and relate them to our preference measures and controls. Results on preferences are particularly consistent for window and roof quality. Façade quality instead, relies more strongly on the age of houses such that homeowners' discount factor turns out to be the only significant predictor among the preference measures. Further we observe a positive relationship between financial position for window and façade quality.

Our analysis provides interesting insights on the relationships of homeowners' preferences, renovation behavior and the energy efficiency of their house. However, our analyses do not explicitly model buying decisions. Although we cannot identify the role of preferences on such decision, our results are unlikely to overestimate the identified relationships between preferences and homeowners' renovation decision or energy efficiency of their house. Let us first focus on renovation behavior. If risk preferences and time preferences impact also homeowners' buying decision, the effect we identify for the renovation decision will count households who bought a house that had already been renovated not among renovators (or future renovators). In turn, we would underestimate the impact of preferences on renovations. Second, considering the energy efficiency of the house, not taking the preferences that affect buying decisions into account does not impact our analysis of the role of preferences, because the energy quality of the house does not depend on who did the renovation.

[28] The qualitative results on the relation between our preference measures and outcome variables are robust to alternative specifications of the Heckman model. As one alternative selection criterion, we used whether a house was built before or after the announcement (1985) or official recommendation (1988) of new building standards (SIA 380/1), as these standards reduce the scope for energy efficient renovations (see also Jakob, 2007a). However, changes in building standards may also, or even stronger correlate with the energy efficiency than house age classes. A second alternative criterion was whether the house was built before 2000 (controlling for the age of the house) and thus whether renovations were eligible for receiving subsidies for energy efficient renovations by the Swiss Gebaeudeprogramm (www.dasgebaeudeprogramm.ch) at that time. However, too few (only 16) houses in our sample are not eligible for these subsidies.

[29] These findings suggest that a negative relationship between risk aversion and energy efficient retrofits (as observed e.g. in Qiu et al., 2014), may mainly stem from the perceived uncertainty of the act of renovating than from uncertainty about the benefits from energy efficient retrofits. Focusing on domain specific risk attitudes indicates, however, that some context specific risk attitudes (risk-taking in financial matters and in professional career) do relate also positively to the energy quality of renovated houses while others (risk-taking in car driving or in leisure and sports) do not (see Tables E17 to E20).

[30] As explained above for the analysis of the renovation decision, the small variance of this variable among participants in our sample may explain that the financial position is insignificant.

Table 6
Annual heating and electricity costs.

	(1)	(2)
Dependent variable:	Log of Annual Heating and Electricity Costs	
Risk-taking (from 1 to 5)	0.034	0.045
	(0.039)	(0.041)
Discount factor (from 0.747 to 1)	**−0.547***	**−0.635****
	(0.312)	(0.281)
Pro-environmental (from 0 to 9)	**−0.047*****	**−0.041*****
	(0.015)	(0.015)
Envy (from 0.1 to 0.9)	−0.101	−0.058
	(0.152)	(0.147)
Pro-social (from 0.1 to 0.9)	−0.057	0.019
	(0.227)	(0.199)
14−17-year-old house		−0.010
		(0.061)
18−32-year-old house		−0.124
		(0.096)
House older than 32 years		0.128
		(0.117)
Log(House size)		**0.180***
		(0.101)
Number of household members		**0.155*****
		(0.051)
Number of household members^2		**−0.014****
		(0.006)
Female		−0.028
		(0.078)
Age		**0.007****
		(0.003)
Good financial position (from 1 to 3)		−0.030
		(0.080)
Estimated energy quality (from 2.535 to 4.045)		−0.071
		(0.092)
Constant	**8.601*****	**7.232*****
	(0.341)	(0.711)
Observations	169	169
# of clusters	153	153
R-squared	0.085	0.214

Cluster-robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

5.3. Energy consumption and preferences

We now turn to the question of whether our preference measures significantly relate to energy consumption behavior. To be able to do so, we elicited for the subsample of homeowners in the second wave the annual heating and electricity costs. In Table 6, we regress the logarithm of total heating and energy costs on our preference measures.

Model (1) includes only the preference measures as dependent variables. As hypothesized, pro-environmental preferences relate negatively to the annual heating and electricity costs, but social preferences do not significantly relate to electricity and heating costs. In Model (2), we additionally add a set of control variables that are likely to influence heating and electricity cost (the age and size of the house, the number of persons in the household as well as gender, age and the financial position of the owner). To control for the energy efficiency of the house, we also include the estimated energy quality of the house as an explanatory variable in Model (2). Even if we do so, pro-environmental homeowners have lower heating and electricity costs. Similarly, the regressions in Table 6 indicate that homeowners with higher discount factors have lower heating and electricity costs; even when we control for the energy efficiency of the house. Among our controls, larger households (both concerning size and number of household members) and older homeowners have higher annual heating and electricity costs whereas gender of the respondent and financial position are of minor importance. We conclude with Result 5:

Result 5. Pro-environmental and future oriented homeowners have lower heating and electricity costs (controlling for the estimated energy quality of the house).

6. Conclusions and policy implications

The building sector is one of the most energy consuming sectors. Consequently, many countries provide incentives to reduce the energy consumption of buildings and their greenhouse emissions. Governments foster a sustainable development of housing, and often encourage homeowners to renovate efficiently. Even though many programs exist, there is large variation in homeowners' renovation behavior. To better understand this heterogeneity in homeowners' investments in energy efficiency, this study analyzes whether homeowners' time, risk, social and environmental preferences relate to investments in energy saving measures. This analysis is valuable, as it highlights whether preferences may render investments individually (un)attractive, that may (or may not) benefit the environment and society at large. We find that elicited preference measures relate systematically to investment behavior. First, homeowners' willingness to take risks relates positively to the likelihood of having renovated the house. Second, renovators who value the far future more than the near future, are pro-environmental, or pro-social, live in houses with higher energy efficiency. Third, pro-environmental and future oriented homeowners have lower heating and electricity costs (controlling for the quality of their home).

Our findings provide a better understanding of households' investments into a public good (the environment) in a complex environment. Although our approach did not result in a sample of respondents' representative of the general population, insights on the identified relationships between homeowners' preferences and investment behaviors certainly provide interesting opportunities to develop suggestions for more generally applicable policies. Our findings highlight that the fact that returns from investments are uncertain and occur in the future appears as the main driver of homeowners' decisions to renovate, and to what extent. Policies aimed at enhancing energy efficient building renovation (or construction) should take these insights into account. Risk preferences appear crucial for the decision to renovate, as engineering estimates on energy savings from renovations involve uncertainty, and not all retrofitting investments appear to pay, even when externalities are considered (Fowlie et al., 2018). Further, risk averse homeowners may not be willing to take the risks involved in investments, even if renovations have positive expected returns and can thus be considered reasonable from a societal perspective. As homeowners may face uncertainty with respect to energy saving outcomes, both, due to variance in renovation quality (Giraudet et al., 2018) and due to the development of future energy prices (Alberini et al., 2013), policies may focus at explicitly reducing such individual risks for renovations with positive expected returns. They may require providers of renovation services to provide guarantees or free maintenance or reduce moral hazard in renovations by introducing third-party ownership models (as be seen e.g. in the case of solar energy). In terms of risk due to future energy prices, governments may also provide better information on how different future scenarios may affect individual savings from energy investments, reducing potential misperceptions by homeowners. (Allcott, 2011a). Finally, governments may seek more insights on where and how insurance against uncertainty in future energy prices could be feasible (conditional on economic returns of renovations being positive in expectation).

As time preferences appear to play a crucial role for the energy efficiency of renovated buildings, there might also be scope for government programs that reduce present costs of renovations and help homeowners enjoy future benefits from energy savings today (rather than tomorrow). Like zero-percent financing and leasing models that help customers to buy energy efficient refrigerators or washing machines, such policies may help making the housing sector more sustainable. Here, specific loans could not only cover costs of the renovation itself, but additionally deliver an immediate bonus payment for renovating efficiently, which is re-financed by future savings in energy consumption. Alternatively, governments could also help to ease outsourcing such tradeoffs via the market. For instance, energy saving companies (ESCOs), implementing similar polices so far mainly in industrial and commercial sectors, may engage in energy efficient renovations of residential buildings by bearing the costs and risks, but also receiving the benefits of future energy savings.[31] Such market-based solutions could potentially also reduce problems of free-riding present in more general programs such as subsidies or tax rebates (Alberini et al., 2014).

With respect to social preferences, we found that they play a minor role for the renovation decision, where the main obstacle for action appeared to be a reluctance to take risks. However, social preferences related to some extent positively to the energy efficiency of the house. Thus, policies aiming mainly at the renovation decision may prefer material incentives whereas appeals to societal benefits may be used to encourage more efficient renovations.

Finally, as our findings reveal that preference measures and renovation behavior relate in systematic ways, heterogeneity in renovations should be understood as a (partial) reflection of homeowners' preferences. In turn, policies to reduce externalities for society and the environment should consider to what extent decision makers' preferences are in line with societal goals

CRediT authorship contribution statement

Urs Fischbacher: Conceptualization, Methodology, Supervision, Writing - review & editing. **Simeon Schudy:** Conceptualization, Methodology, Project administration, Writing - original draft, Writing - review & editing. **Sabrina Teyssier:** Conceptualization, Methodology, Project administration, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[31] For discussion of the ESCO sector see Vine et al. (1999) and Vine (2005).

Acknowledgements

We thank Guy Meunier, Nicolas Treich as well as participants at the workshop on “Behavioral experimental economics” in Toulouse, the ESA North-American meeting in Fort Lauderdale and the Workshop on Natural Experiments and Controlled Field Studies in Ohlstadt, the editor and two anonymous referees for helpful thoughts and comments. Also, we thank the buildings insurance of the Kanton of Zurich (GVZ) for their assistance. Financial support is acknowledged from the Swiss Federal Office of Energy. Further, we compare characteristics of homeowners in our sample to a representative sample of the Swiss population. This part has been realized using the data collected by the Swiss Household Panel (SHP), which is based at the Swiss Centre of Expertise in the Social Sciences FORS (financed by the Swiss National Science Foundation).

Appendix

A. Model insights

To provide some structure, we briefly describe the theoretical framework we have in mind when deriving our hypotheses concerning investments in energy saving measures. The framework is based on the model of investment in energy efficiency measures developed by Allcott and Greenstone (2012). We assume that energy efficiency investments are associated with present costs and future benefits. To simplify, consider the case in which individuals exist only in two periods: in the first period the individual decides whether or not to renovate and, if so, chooses how much to invest in energy efficiency. In the second period, the individual incurs costs from energy consumption, which depend on the investments chosen in the first period. That is, in the second period, the individual minimizes costs for a given level of comfort (i.e. a given level of utility).[32] In the first period, each individual compares her expected utility of future savings in terms of costs to the immediate cost of investment in energy-saving measures. The individual chooses to invest only if the expected utility of the investment outweighs the direct cost of the investment:

$$EU_{\alpha}\left(\delta, \gamma, p, \ \Delta E(q)\right) > C(q) \tag{1}$$

The expected utility of the investment depends on the individuals discount factor, her internalization of externalities (i.e. her preferences for the environment and social preferences), energy prices and the potential energy savings, which occur in the future and are uncertain. The parameter indicates the energy efficiency of the house which increases the direct costs of the investment as well as the energy savings. The energy savings correspond to the difference between the energy intensity of the house, if it has not been renovated, and the uncertain energy intensity of the house if it has been renovated, which decreases in the quality of the renovation.[33] The individual knows that for but, nevertheless, the difference is uncertain. The parameter reflects the individual’s risk aversion. The individual’s discount factor also affects expected utility. The stronger an individual discounts the future (the smaller), the lower will be her expected utility from investments.[34] Further, as the individual puts more weight on the environment or the welfare of others (higher), her expected utility of the investment increases (if she considers her investment in energy savings an investment in a public good). For the rest of the paper we label this type of social preferences as *pro-social* and measure it in our empirical analysis using a Dictator Game. To capture an additional aspect of social preferences, we introduce an Envy game that measures to what extent people dislike being behind. *Envy* may play an important role for energy investments of homeowners. On the one hand envy could reduce investments in the public good (if people do not want to be behind in a monetary dimension). On the other hand, envy may increase investments, if people do not want to be behind in terms of having a house with lower efficiency than others.[35] This basic framework yields the following hypotheses concerning the investment behavior of homeowners:

H1. More future-oriented homeowners are more likely to invest in energy efficiency.

H2. More risk tolerant homeowners are more likely to invest in energy efficiency.

H3. Pro-environmental homeowners are more likely to invest in energy efficiency.

H4. Homeowners with pro-social preferences are more likely to invest in energy efficiency.

Energy consumption in the second period yields certain present costs and benefits. However, energy consumption affects others and the environment. We therefore expect that pro-environmental and pro-social homeowners consume less energy and formulate our hypothesis regarding consumption behavior (H-C1) as follows:

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[32] We assume here that the objective regarding the level of utility to attain in the second period does not change depending on the individual’s decision in the first period. This assumption might be violated if people over-consume after they have invested in energy efficiency in the first period. This may be the case if green technologies (e.g. solar panels) are not only be seen as an investment but also provide an additional consumption values for “green” consumers (see Dastrup et al., 2012).

[33] We abstract here from the fact that future energy prices themselves are uncertain. If we would allow for future prices to be uncertain also E_{NR} is uncertain. Clearly, Hypothesis 1 stems on this assumption.

[34] The market interest rate is taken into account with δ representing the individual’s discount factor net of the interest rate.

[35] As it is ex-ante unclear to what extent and in which direction envy will affect investments, we refrain from formulating any directional hypothesis. Instead, we let our data inform us on the role of envy for investments.

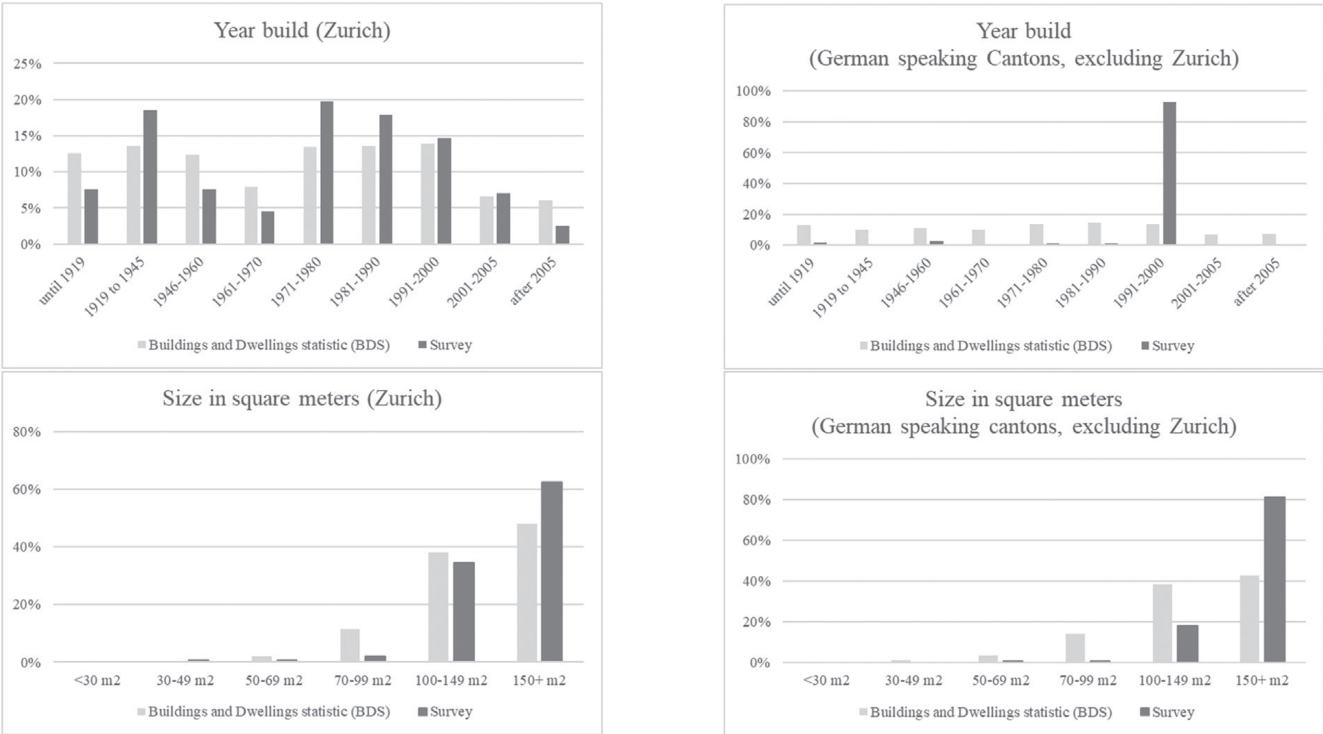

Fig. B1. Age and size of buildings.

H-C1. Pro-environmental and pro-social homeowners consume less energy.

B. House age, size, and homeowner characteristics

In Fig. B1, we present the distribution of house age and size (in m^2) for households in our study (survey) and relate it to the distribution in the respective cantons (Source: Swiss Federal Statistical Office "Buildings and Dwellings statistic (since 2009)"). The left panels focus on the first wave (which was conducted in the Canton of Zurich). The right panels focus on the second wave (German-speaking Cantons excluding Zurich). In the first wave, the age distribution of houses in the survey deviates slightly from the age distribution of single-family houses in Zurich at the same time. Homeowners in our study live in slightly younger houses as compared to the existing houses in the Canton of Zurich. As explained in the main text, a marketing agency helped us contacting homeowners living in houses that were between ten and twenty years old in German-speaking cantons excluding Zurich. Consequently, most respondents report to live in houses built in the nineties. Concerning the size of respondents' houses, participants in both samples are more likely to live in larger houses as compared to the size of existing houses (in the respective canton(s)). Further, we relate additional characteristics of our homeowners (age, saving potential, risk attitudes, and environmental preferences) to characteristics of homeowners included in the representative Swiss Household Panel (SHP). We compare our homeowners in terms of age, saving potential, and environmental preferences with the SHP sample of 2011, and homeowners' risk attitudes with the SHP sample of 2014 (as the latter covers responses to a general risk question of more than 700 homeowners living in German-speaking Swiss cantons). These analyses show that we cover a large range of characteristics of homeowners included in the Swiss Household Panel (SHP).

Fig. B2 presents histograms of homeowners' age in the SHP (left panel) and our survey (right panel). On average homeowners in our sample are only slightly younger as compared to the SHP (55 as compared to 56 years) but our sample covers relatively fewer homeowners in the tails of the age distribution. Nevertheless, we cover almost the full age range covered by the SHP.

In terms of homeowners' savings potential, the SHP includes the following question on income and spending: "If you consider the total of your household's income and expenses, would you say that currently your household can save money, your household spends what it earns, your household eats into its assets and savings, or your household gets into debts?". Our survey includes a closely related question: "If you reflect how you (and your partner) managed on with your income: What describes the situation best? At the end of the month there was a lot of money left, at the end of the month there was frequently some money left, there was only money left, if an additional non-recurring income occurred, at the end of the month it was often not enough, at the end of the month the money was never enough." To make our 5-point scale comparable to the 4-point scale used in the SHP, we pool our first two categories, as both indicate that the household can save money. Fig. B3 shows the result for the SHP (left panel) and our sample (right panel). Our study includes slightly more

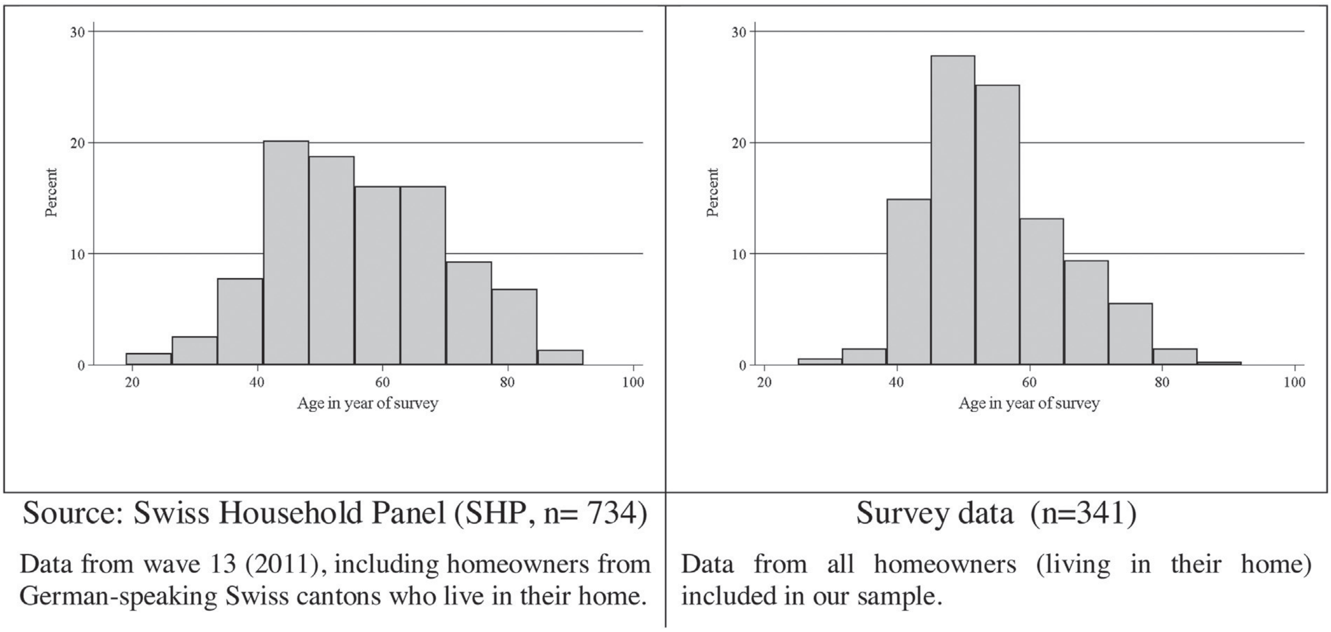

Fig. B2. Age and size of buildings.

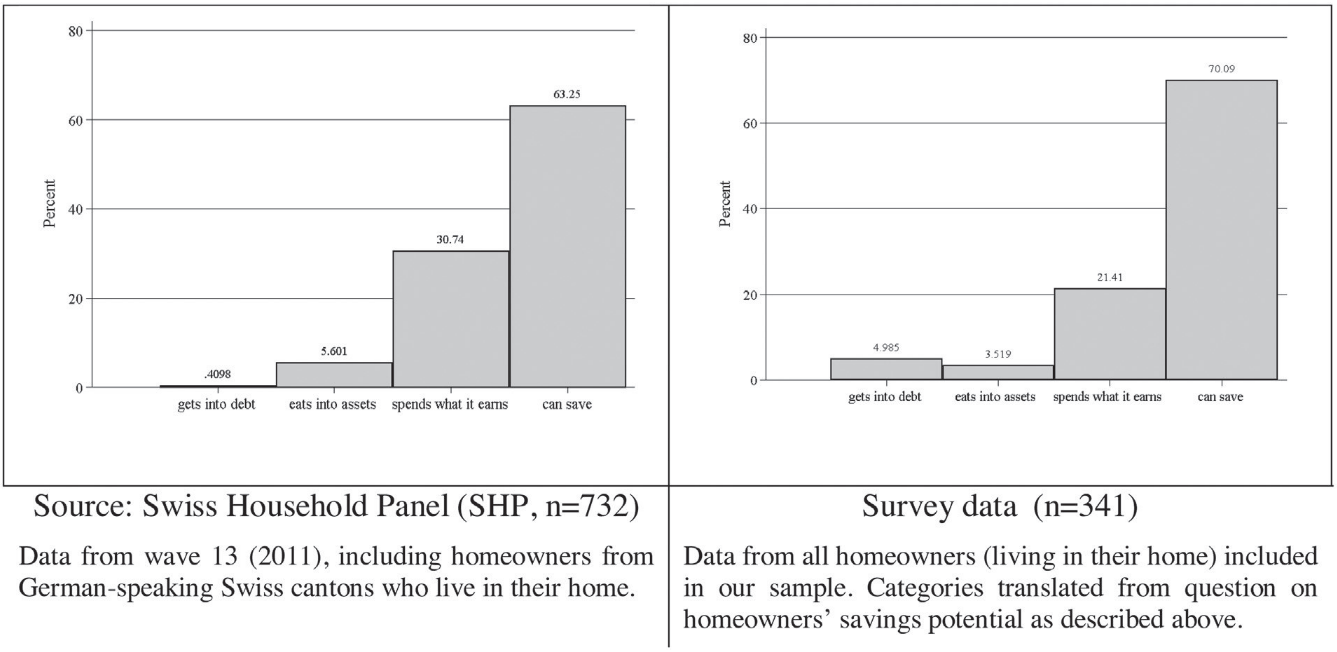

Fig. B3. Age and size of buildings.

homeowners with a potential to save (70.09 vs. 63.25 percent) and slightly fewer homeowners who spend roughly what they earn (21.41 vs. 30.74 percent). The fraction of homeowners who eat into their assets is small in the SHP as well as in our sample.

In terms of risk attitudes, we contrast our risk question (5-point scale ranging from 1 "not ready to take risks" (value 1) to 5 "very risk-taking" to a question on the general willingness to take risks in the SHP (Wave 16) "Are you generally a person who is fully prepared to take risk or do you try to avoid taking risks" (11-point scale, ranging from 0 "avoid taking risks" to 10 "fully prepared to take risk"). To ease the comparison, Fig. B4 presents cumulative distribution functions for both the SHP (left panel) and our (right panel) sample. It becomes aware that we cover a large range of risk attitudes, but our sample includes relatively fewer homeowners in the tails and slightly more homeowners with an intermediate willingness to take risks.

Finally, in Fig. B5, we compare our environmental preference index with a question related to the importance of environmental protection in the SHP: "How important is the protection of the environment for you?" (11-point scale, ranging from 0 "not important at all" to 10 "very important"). Like the SHP, our sample covers a substantial range of environmental

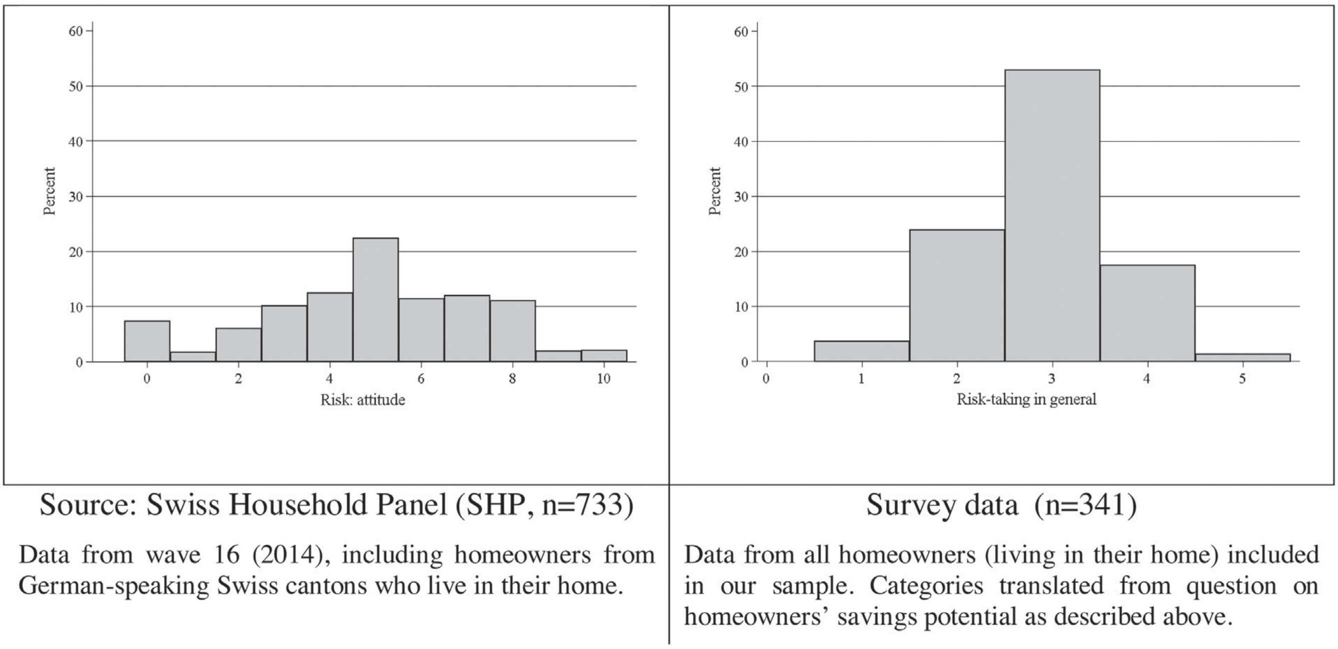

Fig. B4. General willingness to take risks (cumulative distributions).

Fig. B5. Environmental preferences.

preferences. In particular, it is worthwhile to note that it includes also homeowners with rather weak preferences for the environment. Further, it becomes apparent that our environmental preferences index is more smoothly distributed, which may be due to its construction (see Section 4.3.3).

C. Characteristics of the sample

Table C1 below presents the characteristics of the final sample (341 households) in column 2. In column 3, we show the characteristics of the excluded households, who did not complete all decisions in the survey or made some inconsistent decisions (489 households). Column 4 presents the Mann-Whitney statistics without stars if the difference between the two samples is insignificant and ** if it is significant at 5%. The two samples look similar, except for the age of homeowners, which seems higher for those who made either incomplete or inconsistent decisions.

Table C1
Balance table.

	Final sample (341 households)	Homeowners in the sample with incomplete decisions (148 households)	Mann-Whitney statistics
Female	18.77 %	19.57 %	0.201
Age	Interval: [25–92] Median: 53 Standard deviation: 10.17	Interval: [22–96] Median: 56 Standard deviation: 13.25	2.114**
House age	Interval: [2–405] Median: 17 Standard deviation: 43.10	Interval: [2–556] Median: 17 Standard deviation: 72.58	1.389
House size	Interval: [44–2400] Median: 170 Standard deviation: 160.95	Interval: [53–1000] Median: 178.5 Standard deviation: 119.28	0.193
Good financial position	Level 1: 1.76 %Level 2: 12.02 % Level 3: 86.22 %	Level 1: 4.26 %Level 2: 14.89 %Level 3: 80.85 %	1.551

D. Timing of renovations

In our survey, we asked homeowners not only to indicate whether they renovated their house, but if so, also when. Hence, we do have information on the timing of (the most recent) renovation but we do not know whether or when any previous renovation(s) took place. There are basically two ways how we can exploit this information. First, we can study how many years ago (at the point in time when the survey took place) homeowners renovated their house. Second, we can test whether preferences relate to the age of the house when being renovated. Thereby, we learn whether risk, time, social and environmental preferences cause systematic differences in the timing of (most recent) renovations. Table D1 shows the results of these analyses. In Models (1) and (2), we focus on the time since renovation (year of taking part in the study - year of (most recent) renovation). We see that more risk-taking renovators in our sample are more likely to have renovated more recently, which – considering the time since renovation – indirectly reflects also a higher propensity to renovate among more risk-taking homeowners. Interestingly, risk preferences play a less important role when focusing on the age of the house when renovating (see models (3) and (4)). This outcome variable proxies the state of buildings at the point where

Table D1
Timing of renovations.

	(1)	(2)	(3)	(4)
Dependent Variable	Years since renovation		Age at renovation	
Risk-taking (from 1 to 5)	**−1.785****	**−1.898****	4.388	4.080
	(0.722)	(0.771)	(2.641)	(3.084)
Discount factor (from 0.747 to 1)	**13.680****	**12.737****	68.945	69.257
	(6.737)	(6.089)	(44.348)	(51.505)
Pro-environmental (from 0 to 9)	**0.299***	0.330	**3.450*****	**3.790*****
	(0.173)	(0.201)	(0.905)	(1.004)
Envy (from 0.1 to 0.9)	−0.837	0.417	**−23.932****	**−20.110***
	(2.340)	(2.215)	(10.291)	(11.357)
Pro-social (from 0.1 to 0.9)	**4.030***	**3.798***	10.337	15.580
	(2.073)	(2.090)	(14.704)	(18.378)
14−17-year-old house		3.131		
		(1.976)		
18−32-year-old house		1.546		
		(2.284)		
House older than 32 years		**5.171***		
		(2.582)		
Log(House size)		−0.556		−6.339
		(0.995)		(5.406)
Female		**−1.884***		−6.295
		(1.002)		(5.162)
Age		0.022		**−0.588***
		(0.119)		(0.307)
Good financial position (from 1 to 3)		−0.005 (1.059)		−6.077 (10.441)
Constant	−3.815	−4.026	−50.614	28.557
	(7.150)	(5.656)	(38.744)	(29.035)
Observations	145	145	145	145
# of clusters	41	41	41	41
R-squared	0.069	0.136	0.039	0.059

Note: Cluster-robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

the renovation takes place and the positive but insignificant coefficient for risk preferences indicates that – if at all – more risk-taking homeowners renovate slightly older houses.

Focusing on time preferences, we observe results in line with our findings on the energy quality of renovated houses. Renovating homeowners who put more weight on the future live in houses with better energy quality and, respectively, renovate their houses later (see models (1) and (2)). Similarly, homeowners with pro-environmental preferences tend to renovate later and less recently, which may also indicate that they consume durables for longer. Finally, more envious renovators renovate younger houses, in line with the idea that they care more about how their homes appear as compared to others' homes. Pro-social preferences in the dictator game appear to play a minor role for the timing of renovations. We find that, if at all, homeowners who care about others in the dictator game renovate their homes slightly later.

E. Robustness tests

In this section we present a series of additional analyses and robustness tests. Regarding the decision to renovate, we first present the coefficients of the probit regression associated to the average marginal effects presented in Table 4. Then, we present the coefficients and average marginal effects of a logit regression based on the assumption of a standard logistic distribution of the error terms instead of a normal distribution. We also estimate the impact of risk preferences in diverse dimensions such as in financial matters, in career, in car driving and in sports. We then conduct the analysis using the self-stated donations to environmental or social organizations as a proxy for environmental and social preferences, respectively. We also use the one-time decision to donate to an environmental organization within the survey using their earnings from the experiment (the donation equals the share of the amount earned in the experiment, from 0 to 0.6 with 0.1 steps). Finally, we use clustering at the canton level instead of the postal code level, which reduces the number of clusters.

Regarding the energy efficiency of the house, we first conduct additional regressions with a different proxy for energy efficiency: we test the impact of preferences on another index that is simply the sum of roof, window and façade quality and also on the roof quality, window quality and façade quality separately. We also estimate the impact of risk preferences in diverse dimensions such as in financial matters, in career, in car driving and in sports. Then, we conduct the analysis using the stated donations to environmental or social organizations. We also present results using the one-time decision to donate to an environmental organization within the survey. We look at effects of preferences on energy efficiency excluding outliers in terms of time preferences: we exclude the 16 % of homeowners who have a discount factor lower than 0.75 and 17 % who have a discount factor higher than 0.99. Finally, we use clustering at the canton level.

E.1. Renovation decision

1. *Coefficients of the probit regression that generated the average marginal effects presented in Table 4*

Table E1
Decision to renovate (coefficients, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.152****	**0.173*****	**0.141****	**0.147****	**0.161****	0.125
	(0.077)	(0.066)	(0.065)	(0.074)	(0.069)	(0.077)
Discount factor (from 0.747 to 1)	0.363	0.117	0.420	−0.110	−0.084	−0.144
	(0.911)	(0.752)	(0.762)	(1.242)	(0.766)	(0.965)
Pro-environmental (from 0 to 9)	0.038	0.008	0.036	0.016	−0.005	0.016
	(0.024)	(0.026)	(0.026)	(0.029)	(0.028)	(0.031)
Envy (from 0.1 to 0.9)	−0.176	**−0.818****	**−0.523***	0.469	**−0.662****	−0.058
	(0.252)	(0.337)	(0.285)	(0.322)	(0.328)	(0.332)
Pro-social (from 0.1 to 0.9)	**−0.603****	0.134	**−0.536****	−0.038	0.316	0.012
	(0.266)	(0.237)	(0.263)	(0.317)	(0.266)	(0.333)
14−17-year-old house				0.087	−0.077	−0.013
				(0.192)	(0.192)	(0.169)
18−32-year-old house				**1.063*****	**0.392****	**1.049*****
				(0.259)	(0.171)	(0.262)
House older than 32 years				**2.144*****	**0.321***	**2.039*****
				(0.168)	(0.172)	(0.149)
Log(House size)				0.012	−0.049	0.235
				(0.209)	(0.157)	(0.178)
Female				−0.232	0.160	−0.070
				(0.204)	(0.136)	(0.182)
Age				−0.003	−0.003	−0.005
				(0.009)	(0.006)	(0.011)

Table E1 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
Good financial position (from 1 to 3)				−0.033	0.296	0.017
				(0.314)	(0.211)	(0.239)
Constant	−0.870	−1.211*	−0.533	−1.196	−1.660	−1.777
	(0.919)	(0.708)	(0.889)	(1.191)	(1.127)	(1.365)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.016	0.023	0.018	0.275	0.047	0.237

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

2. *Average marginal effects and coefficients of the logit regression explanatory the renovation decision*

Table E2
Decision to renovate (average marginal effects, logit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.058***	**0.052*****	**0.055****	**0.041***	**0.047****	0.037
	(0.032)	(0.020)	(0.025)	(0.022)	(0.020)	(0.023)
Discount factor (from 0.747 to 1)	0.140	0.033	0.163	−0.061	−0.014	−0.037
	(0.346)	(0.223)	(0.299)	(0.347)	(0.225)	(0.284)
Pro-environmental (from 0 to 9)	**0.015***	0.001	0.014	0.004	−0.002	0.004
	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.010)
Envy (from 0.1 to 0.9)	−0.066	**−0.250****	**−0.204***	0.136	**−0.199****	−0.018
	(0.098)	(0.106)	(0.110)	(0.091)	(0.094)	(0.102)
Pro-social (from 0.1 to 0.9)	**−0.236****	0.040	**−0.210****	−0.014	0.082	−0.000
	(0.100)	(0.071)	(0.103)	(0.093)	(0.078)	(0.103)
14–17-year-old house				0.022	−0.024	−0.004
				(0.055)	(0.058)	(0.050)
18–32-year-old house				**0.280*****	**0.111****	**0.299*****
				(0.076)	(0.047)	(0.076)
House older than 32 years				**0.576*****	**0.091***	**0.611*****
				(0.048)	(0.049)	(0.036)
Log(House size)				0.000	−0.015	0.068
				(0.058)	(0.051)	(0.054)
Female				−0.062	0.048	−0.019
				(0.059)	(0.037)	(0.058)
Age				−0.001	−0.001	−0.001
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.008	0.089	0.007
				(0.094)	(0.065)	(0.077)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.016	0.023	0.018	0.275	0.047	0.237

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E3
Decision to renovate (coefficients, logit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.243***	**0.296*****	**0.228****	**0.259***	**0.277****	0.209
	(0.125)	(0.112)	(0.106)	(0.134)	(0.119)	(0.134)
Discount factor (from 0.747 to 1)	0.584	0.190	0.670	−0.385	−0.083	−0.207
	(1.469)	(1.270)	(1.229)	(2.164)	(1.323)	(1.602)
Pro-environmental (from 0 to 9)	0.063	0.008	0.058	0.024	−0.011	0.024
	(0.039)	(0.044)	(0.041)	(0.051)	(0.046)	(0.054)
Envy (from 0.1 to 0.9)	−0.274	**−1.427****	**−0.841***	0.853	**−1.170****	−0.099
	(0.408)	(0.586)	(0.464)	(0.573)	(0.570)	(0.577)
Pro-social (from 0.1 to 0.9)	**−0.987****	0.231	**−0.864****	−0.088	0.480	−0.003
	(0.451)	(0.403)	(0.425)	(0.580)	(0.453)	(0.580)
14–17-year-old house				0.141	−0.138	−0.022
				(0.339)	(0.342)	(0.281)

Table E3 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
18–32-year-old house				**1.753*****	**0.651****	**1.686*****
				(0.456)	(0.291)	(0.446)
House older than 32 years				**3.602*****	**0.536***	**3.449*****
				(0.298)	(0.297)	(0.247)
Log(House size)				0.003	−0.090	0.386
				(0.360)	(0.301)	(0.304)
Female				−0.390	0.280	−0.109
				(0.361)	(0.221)	(0.326)
Age				−0.006	−0.005	−0.006
				(0.015)	(0.011)	(0.019)
Good financial position (from 1 to 3)				−0.049	0.523	0.037
				(0.586)	(0.384)	(0.433)
Constant	−1.392	−1.973	−0.861	−1.756	−2.798	−3.074
	(1.472)	(1.226)	(1.423)	(2.104)	(2.075)	(2.290)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.016	0.023	0.018	0.275	0.047	0.237

Note: robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3. *Risk taking in financial matters, in career, in car driving and in sports as explanatory variables*

Table E4
Decision to renovate with risk taking in financial matters (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(4)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking in financial matters (from 1 to 5)	0.032	0.004	0.012	**0.050*****	0.003	0.023
	(0.024)	(0.017)	(0.021)	(0.018)	(0.018)	(0.019)
Discount factor (from 0.747 to 1)	0.129	0.051	0.152	−0.049	−0.008	−0.056
	(0.331)	(0.229)	(0.296)	(0.320)	(0.228)	(0.280)
Pro-environmental (from 0 to 9)	**0.016***	0.002	0.013	0.008	−0.001	0.006
	(0.009)	(0.007)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.088	**−0.265****	**−0.224****	0.118	**−0.210****	−0.032
	(0.097)	(0.104)	(0.108)	(0.089)	(0.094)	(0.098)
Pro-social (from 0.1 to 0.9)	**−0.245****	0.028	**−0.223****	−0.014	0.083	−0.002
	(0.100)	(0.073)	(0.106)	(0.082)	(0.077)	(0.096)
14–17-year-old house				0.026	−0.021	−0.001
				(0.053)	(0.057)	(0.050)
18–32-year-old house				**0.289*****	**0.121****	**0.313*****
				(0.072)	(0.049)	(0.075)
House older than 32 years				**0.606*****	**0.099****	**0.616*****
				(0.048)	(0.048)	(0.036)
Log(House size)				−0.005	−0.010	0.068
				(0.058)	(0.048)	(0.054)
Female				−0.065	0.037	−0.024
				(0.055)	(0.040)	(0.054)
Age				−0.001	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.004	0.095	0.014
				(0.088)	(0.064)	(0.070)
Observations	340	340	340	340	340	340
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.012	0.015	0.013	0.280	0.040	0.234

Note: robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table E5
Decision to renovate with risk taking in professional career (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(4)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking in professional career (from 1 to 5)	0.042	−0.005	0.024	**0.029***	−0.007	0.010
	(0.026)	(0.015)	(0.020)	(0.017)	(0.016)	(0.018)

Table E5 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(4)
Discount factor (from 0.747 to 1)	0.134	0.092	0.137	−0.036	0.046	−0.065
	(0.336)	(0.229)	(0.299)	(0.329)	(0.225)	(0.290)
Pro-environmental (from 0 to 9)	0.013	0.004	0.013	0.003	0.000	0.004
	(0.009)	(0.007)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.080	**−0.273******	**−0.224*****	0.128	**−0.228*****	−0.033
	(0.101)	(0.104)	(0.109)	(0.093)	(0.093)	(0.101)
Pro-social (from 0.1 to 0.9)	**−0.250*****	0.019	**−0.229*****	−0.020	0.064	−0.012
	(0.099)	(0.073)	(0.105)	(0.089)	(0.075)	(0.098)
14–17-year-old house				0.036	−0.023	0.007
				(0.054)	(0.057)	(0.051)
18–32-year-old house				**0.303******	**0.096****	**0.322******
				(0.078)	(0.053)	(0.081)
House older than 32 years				**0.600******	**0.097****	**0.616******
				(0.046)	(0.049)	(0.037)
Log(House size)				0.001	−0.008	0.071
				(0.059)	(0.049)	(0.054)
Female				−0.069	0.050	−0.027
				(0.061)	(0.040)	(0.058)
Age				−0.001	0.000	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position				−0.001	**0.117****	0.016
(from 1 to 3)				(0.087)	(0.062)	(0.068)
Observations	334	334	334	334	334	334
# of clusters (postal code)	162	162	162	162	162	162
Pseudo R-squared	0.015	0.016	0.015	0.270	0.043	0.229

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E6
Decision to renovate with risk taking in car driving (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(4)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking in car driving	−0.004	0.004	−0.002	0.027	0.011	0.027
(from 1 to 5)	(0.024)	(0.019)	(0.022)	(0.023)	(0.020)	(0.021)
Discount factor (from 0.747 to 1)	0.162	0.066	0.185	−0.019	0.000	−0.029
	(0.345)	(0.228)	(0.299)	(0.337)	(0.227)	(0.286)
Pro-environmental (from 0 to 9)	0.015	0.003	0.014	0.006	−0.000	0.007
	(0.009)	(0.007)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.084	**−0.263*****	**−0.219*****	0.120	**−0.209*****	−0.027
	(0.097)	(0.105)	(0.109)	(0.090)	(0.094)	(0.099)
Pro-social (from 0.1 to 0.9)	**−0.245*****	0.029	**−0.223*****	−0.004	0.086	0.003
	(0.100)	(0.073)	(0.105)	(0.086)	(0.078)	(0.099)
14–17-year-old house				0.021	−0.024	−0.006
				(0.053)	(0.057)	(0.050)
18–32-year-old house				**0.300******	**0.121*****	**0.318******
				(0.076)	(0.048)	(0.076)
House older than 32 years				**0.599******	**0.099*****	**0.612******
				(0.050)	(0.048)	(0.037)
Log(House size)				0.001	−0.012	0.067
				(0.057)	(0.047)	(0.053)
Female				−0.061	0.041	−0.019
				(0.054)	(0.041)	(0.053)
Age				−0.001	−0.001	−0.001
				(0.002)	(0.002)	(0.003)
Good financial position				−0.005	0.093	0.009
(from 1 to 3)				(0.088)	(0.064)	(0.071)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.010	0.015	0.013	0.273	0.041	0.235

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E7
Decision to renovate with risk taking in sports (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(4)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking in sports (from 1 to 5)	0.012	**0.035****	**0.037***	0.018	**0.035****	**0.039****
	(0.020)	(0.016)	(0.022)	(0.015)	(0.015)	(0.019)
Discount factor (from 0.747 to 1)	0.159	0.048	0.177	−0.018	−0.013	−0.030
	(0.345)	(0.224)	(0.301)	(0.350)	(0.224)	(0.297)
Pro-environmental (from 0 to 9)	**0.015***	0.003	0.015	0.006	−0.001	0.006
	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.083	**−0.260****	**−0.214***	0.126	**−0.208****	−0.019
	(0.097)	(0.106)	(0.109)	(0.091)	(0.095)	(0.100)
Pro-social (from 0.1 to 0.9)	**−0.245****	0.031	**−0.222****	−0.013	0.087	−0.004
	(0.100)	(0.074)	(0.108)	(0.084)	(0.077)	(0.097)
14–17-year-old house				0.021	−0.027	−0.009
				(0.053)	(0.057)	(0.050)
18–32-year-old house				**0.299*****	**0.117****	**0.313*****
				(0.077)	(0.049)	(0.077)
House older than 32 years				**0.596*****	**0.096****	**0.604*****
				(0.050)	(0.049)	(0.037)
Log(House size)				0.002	−0.018	0.065
				(0.059)	(0.047)	(0.053)
Female				−0.071	0.038	−0.025
				(0.059)	(0.039)	(0.053)
Age				−0.001	−0.000	−0.001
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.002	0.090	0.009
				(0.090)	(0.064)	(0.074)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.010	0.020	0.016	0.272	0.045	0.238

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

4. *Self-stated donations to environmental or social organizations as explanatory variables*

Table E8
Decision to renovate with self-stated donations as explanatory variables without environmental and social preferences (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.057***	**0.056*****	**0.057****	**0.040***	**0.050****	**0.038***
	(0.031)	(0.020)	(0.025)	(0.021)	(0.020)	(0.022)
Discount factor (from 0.747 to 1)	0.174	0.087	0.244	−0.039	0.011	−0.014
	(0.357)	(0.221)	(0.300)	(0.346)	(0.218)	(0.290)
Donation to env. org. (from 0 to 2)	**0.084****	**0.039***	**0.119*****	**0.035***	0.022	**0.066****
	(0.035)	(0.020)	(0.044)	(0.020)	(0.019)	(0.029)
Donation to social org. (from 0 to 2)	**0.083*****	−0.006	0.042	−0.017	−0.031	**−0.063***
	(0.021)	(0.021)	(0.030)	(0.021)	(0.023)	(0.034)
14–17-year-old house				0.021	−0.017	−0.004
				(0.055)	(0.056)	(0.050)
18–32-year-old house				**0.274*****	**0.133*****	**0.319*****
				(0.077)	(0.048)	(0.079)
House older than 32 years				**0.577*****	**0.116****	**0.620*****
				(0.048)	(0.047)	(0.038)
Log(House size)				0.003	−0.014	0.067
				(0.058)	(0.045)	(0.052)
Female				−0.060	0.037	−0.027
				(0.058)	(0.036)	(0.053)
Age				−0.000	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.010	0.094	0.007
				(0.082)	(0.066)	(0.070)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.048	0.014	0.043	0.274	0.040	0.244

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E9
Decision to renovate with self-stated donations as explanatory variables and environmental and social preferences (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.057***	**0.053*****	**0.054****	**0.041****	**0.047****	**0.038***
	(0.030)	(0.020)	(0.025)	(0.021)	(0.020)	(0.023)
Discount factor (from 0.747 to 1)	0.144	0.052	0.187	−0.011	−0.004	−0.013
	(0.358)	(0.225)	(0.303)	(0.351)	(0.222)	(0.295)
Pro-environmental (from 0 to 9)	0.008	0.001	0.007	0.003	−0.002	0.004
	(0.009)	(0.008)	(0.011)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	0.045	**−0.223****	−0.094	**0.156***	**−0.190***	0.007
	(0.098)	(0.107)	(0.114)	(0.090)	(0.098)	(0.101)
Pro-social (from 0.1 to 0.9)	−0.114	0.060	−0.095	0.011	0.096	0.018
	(0.093)	(0.071)	(0.101)	(0.091)	(0.079)	(0.100)
Donation to env. org. (from 0 to 2)	**0.080****	0.029	**0.108****	**0.044***	0.016	**0.065****
	(0.036)	(0.021)	(0.044)	(0.024)	(0.019)	(0.031)
Donation to social org. (from 0 to 2)	**0.083*****	−0.006	0.040	−0.018	−0.030	**−0.063***
	(0.021)	(0.020)	(0.030)	(0.022)	(0.022)	(0.034)
14–17-year-old house				0.024	−0.023	−0.004
				(0.053)	(0.056)	(0.050)
18–32-year-old house				**0.284*****	**0.127*****	**0.322*****
				(0.076)	(0.047)	(0.075)
House older than 32 years				**0.588*****	**0.104****	**0.621*****
				(0.047)	(0.048)	(0.038)
Log(House size)				0.002	−0.019	0.069
				(0.059)	(0.046)	(0.053)
Female				−0.072	0.042	−0.033
				(0.056)	(0.039)	(0.052)
Age				−0.001	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.009	0.089	0.007
				(0.085)	(0.061)	(0.071)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.051	0.025	0.045	0.278	0.049	0.244

Note: robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. *Real donations from the money earned in the experiment to an environmental organization as explaining variables*[36]

Table E10
Decision to renovate with real donations as explaining variables without environmental and social preferences (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.061****	**0.058*****	**0.062****	**0.040***	**0.052****	**0.039***
	(0.030)	(0.020)	(0.025)	(0.020)	(0.020)	(0.023)
Discount factor (from 0.747 to 1)	0.244	0.061	0.271	−0.052	−0.035	−0.065
	(0.332)	(0.221)	(0.295)	(0.327)	(0.219)	(0.282)
Real donation to env. org. (from 0 to 0.6)	−0.102	0.128	0.058	−0.124	0.123	0.038
	(0.091)	(0.096)	(0.097)	(0.081)	(0.088)	(0.090)
14–17-year-old house				0.022	−0.019	−0.008
				(0.057)	(0.056)	(0.050)
18–32-year-old house				**0.284*****	**0.123****	**0.310*****
				(0.081)	(0.048)	(0.080)
House older than 32 years				**0.584*****	**0.107****	**0.606*****
				(0.052)	(0.049)	(0.039)
Log(House size)				−0.003	−0.007	0.068
				(0.054)	(0.046)	(0.052)
Female				−0.050	0.043	−0.015
				(0.061)	(0.037)	(0.055)
Age				−0.000	−0.001	−0.002
				(0.002)	(0.002)	(0.003)

[36] Some homeowners had the possibility to choose to have their name in the newspapers if they made a real donation with the money they earned in the experiment but some did not. We control for this difference between households in the regressions. We find no significant effect and then do not report the values in the tables.

Table E10 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
Good financial position (from 1 to 3)				−0.009	0.089	0.003
				(0.086)	(0.063)	(0.069)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.011	0.017	0.011	0.277	0.044	0.239

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E11
Decision to renovate with real donations as explaining variables and environmental and social preferences (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.058***	**0.054*****	**0.056****	**0.040****	**0.049****	**0.038***
	(0.030)	(0.019)	(0.025)	(0.020)	(0.020)	(0.023)
Discount factor (from 0.747 to 1)	0.134	0.013	0.138	−0.038	−0.048	−0.075
	(0.331)	(0.226)	(0.293)	(0.334)	(0.224)	(0.284)
Pro-environmental (from 0 to 9)	**0.017***	0.002	0.014	0.006	−0.002	0.005
	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.009)
Envy (from 0.1 to 0.9)	−0.092	−**0.234****	−**0.207***	0.109	−**0.180****	−0.019
	(0.100)	(0.096)	(0.111)	(0.093)	(0.090)	(0.100)
Pro-social (from 0.1 to 0.9)	−**0.219****	0.029	−**0.217****	0.007	0.082	−0.001
	(0.100)	(0.072)	(0.104)	(0.083)	(0.079)	(0.097)
Real donation to env. org.	−0.108	0.099	0.041	−0.117	0.098	0.033
(from 0 to 0.6)	(0.094)	(0.087)	(0.105)	(0.078)	(0.083)	(0.090)
14−17-year-old house				0.026	−0.025	−0.007
				(0.055)	(0.056)	(0.050)
18−32-year-old house				**0.296*****	**0.112****	**0.310*****
				(0.077)	(0.048)	(0.076)
House older than 32 years				**0.595*****	**0.093***	**0.604*****
				(0.050)	(0.048)	(0.038)
Log(House size)				−0.001	−0.012	0.071
				(0.055)	(0.046)	(0.052)
Female				−0.064	0.047	−0.022
				(0.059)	(0.041)	(0.055)
Age				−0.001	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.007	0.084	0.004
				(0.088)	(0.059)	(0.070)
Observations	341	341	341	341	341	341
# of clusters (postal code)	166	166	166	166	166	166
Pseudo R-squared	0.019	0.028	0.021	0.280	0.052	0.239

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

6. Cluster-robust standard errors with clustering on cantons

Table E12
Decision to renovate with clustering on cantons (average marginal effects, probit).

	(1)	(2)	(3)	(4)	(5)	(6)
	Past renovation	Future renovation	Past or future renovation	Past renovation	Future renovation	Past or future renovation
Risk-taking (from 1 to 5)	**0.059****	**0.052*****	**0.055****	**0.041***	**0.047****	**0.037***
	(0.030)	(0.019)	(0.026)	(0.022)	(0.018)	(0.021)
Discount factor (from 0.747 to 1)	0.140	0.035	0.164	−0.030	−0.025	−0.043
	(0.399)	(0.194)	(0.259)	(0.352)	(0.187)	(0.262)
Pro-environmental (from 0 to 9)	0.015	0.002	0.014	0.005	−0.001	0.005
	(0.009)	(0.007)	(0.012)	(0.009)	(0.008)	(0.012)
Envy (from 0.1 to 0.9)	−0.068	−**0.245*****	−**0.204****	0.130	−**0.193*****	−0.017
	(0.078)	(0.094)	(0.095)	(0.091)	(0.066)	(0.101)
Pro-social (from 0.1 to 0.9)	−**0.232****	0.040	−**0.209****	−0.010	0.092	0.004
	(0.101)	(0.091)	(0.103)	(0.121)	(0.109)	(0.136)
14−17-year-old house				0.024	−0.022	−0.004
				(0.038)	(0.030)	(0.024)

Table E12 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
18–32-year-old house				**0.295*** **	**0.114*** **	**0.312*** **
				(0.077)	(0.041)	(0.078)
House older than 32 years				**0.594*** **	**0.094** **	**0.607*** **
				(0.047)	(0.040)	(0.027)
Log(House size)				0.003	−0.014	0.070
				(0.069)	(0.040)	(0.054)
Female				−0.064	**0.047* **	−0.021
				(0.050)	(0.026)	(0.048)
Age				−0.001	−0.001	−0.002
				(0.002)	(0.002)	(0.003)
Good financial position (from 1 to 3)				−0.009	0.086	0.005
				(0.091)	(0.069)	(0.074)
Observations	341	341	341	341	341	341
# of clusters (canton)	20	20	20	20	20	20
Pseudo R-squared	0.016	0.023	0.018	0.275	0.047	0.237

Note: robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1.

E.2. Energy efficiency of the house

1. Sum of energy efficiency, roof, window, and façade quality

Table E13
Sum of overall energy quality of houses and Heckman selection.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Sum energy quality				Selection: Renovated (Yes/No)	Sum energy quality
Risk-taking (from 1 to 5)	**0.271*** **	0.056	**0.285*** **	0.083	**0.142** **	0.162
	(0.071)	(0.145)	(0.072)	(0.138)	(0.068)	(0.143)
Discount factor (from 0.747 to 1)	0.596	**3.670*** **	1.055	**4.091*** **	0.066	**3.339*** **
	(0.792)	(1.286)	(0.943)	(1.434)	(1.231)	(1.003)
Pro-environmental (from 0 to 9)	0.019	0.010	**0.044** **	**0.068** **	0.011	**0.071*** **
	(0.021)	(0.020)	(0.022)	(0.028)	(0.028)	(0.025)
Envy (from 0.1 to 0.9)	**0.661** **	**1.194*** **	0.148	0.555	0.416	**0.737* **
	(0.267)	(0.372)	(0.240)	(0.358)	(0.312)	(0.401)
Pro-social (from 0.1 to 0.9)	**0.820** **	**1.256*** **	0.330	**0.852*** **	−0.186	**0.784*** **
	(0.350)	(0.366)	(0.281)	(0.283)	(0.295)	(0.288)
14–17-year-old house			−0.095	0.551	−0.007	
			(0.137)	(0.403)	(0.169)	
18–32-year-old house			**−0.464*** **	0.247	**0.868*** **	
			(0.111)	(0.236)	(0.251)	
House older than 32 years			**−1.356*** **	**−0.766*** **	**2.066*** **	
			(0.106)	(0.243)	(0.153)	
Log(House size)			**0.330** **	**0.682*** **	0.023	**0.689*** **
			(0.153)	(0.098)	(0.224)	(0.111)
Female			0.165	0.007	−0.216	−0.039
			(0.127)	(0.130)	(0.188)	(0.182)
Age			**0.023*** **	**0.022* **	0.001	**0.022** **
			(0.009)	(0.012)	(0.009)	(0.010)
Good financial position (from 1 to 3)			0.095	0.212	−0.017	0.212
			(0.092)	(0.144)	(0.301)	(0.273)
Constant	**7.571*** **	**4.841*** **	**4.504** **	−0.722	−1.479	−1.165
	(1.071)	(1.569)	(2.185)	(2.236)	(1.151)	(2.281)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.033	0.060	0.221	0.252	0.931	
Robust Std. Error of λ					(0.114)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E14
Roof quality of houses and Heckman selection.

	(1) Full sample	(2) Renovated houses	(3) Full sample	(4) Renovated houses	(5) Heckman selection model	(6) Full sample
Dependent variable	Roof quality				Selection: Renovated (Yes/No)	Roof quality
Risk-taking (from 1 to 5)	**0.135***** (0.042)	0.086 (0.082)	**0.143***** (0.043)	0.097 (0.082)	**0.153**** (0.072)	0.124 (0.081)
Discount factor (from 0.747 to 1)	0.319 (0.316)	**1.353*** (0.780)	0.503 (0.347)	**1.476*** (0.759)	−0.009 (1.211)	**1.263**** (0.598)
Pro-environmental (from 0 to 9)	**0.020**** (0.010)	0.015 (0.013)	**0.029***** (0.010)	**0.028*** (0.014)	0.013 (0.029)	**0.031**** (0.014)
Envy (from 0.1 to 0.9)	**0.390***** (0.125)	**0.560***** (0.150)	**0.193*** (0.111)	**0.305**** (0.148)	0.472 (0.317)	**0.338**** (0.142)
Pro-social (from 0.1 to 0.9)	0.322 (0.246)	0.585 (0.372)	0.149 (0.242)	0.495 (0.373)	−0.073 (0.310)	0.463 (0.353)
14–17-year-old house			−0.023 (0.080)	0.187 (0.192)	0.044 (0.178)	
18–32-year-old house			**−0.263***** (0.058)	0.054 (0.128)	**0.981***** (0.255)	
House older than 32 years			**−0.468***** (0.064)	−0.208 (0.129)	**2.122***** (0.154)	
Log(House size)			0.043 (0.053)	0.056 (0.109)	−0.011 (0.219)	0.055 (0.084)
Female			−0.013 (0.069)	−0.053 (0.088)	−0.244 (0.189)	−0.058 (0.108)
Age			**0.010***** (0.004)	**0.014**** (0.005)	−0.002 (0.009)	**0.014***** (0.005)
Good financial position (from 1 to 3)			−0.017 (0.050)	−0.036 (0.099)	−0.023 (0.305)	−0.036 (0.130)
Constant	**2.161***** (0.485)	1.154 (1.033)	**1.517*** (0.817)	0.163 (1.001)	−1.209 (1.180)	−0.035 (1.013)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.049	0.064	0.136	0.137	0.325	
Robust Std. Error of λ					(0.073)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table E15
Window quality of houses and Heckman selection.

	(1) Full sample	(2) Renovated houses	(3) Full sample	(4) Renovated houses	(5) Heckman selection model	(6) Full sample
Dependent variable	Window quality				Selection: Renovated (Yes/No)	Window quality
Risk-taking (from 1 to 5)	**0.100***** (0.023)	0.022 (0.030)	**0.099***** (0.022)	0.028 (0.029)	**0.147**** (0.075)	0.029 (0.028)
Discount factor (from 0.747 to 1)	−0.109 (0.254)	**0.620**** (0.258)	−0.110 (0.273)	**0.790***** (0.236)	−0.110 (1.245)	**0.606***** (0.234)
Pro-environmental (from 0 to 9)	0.013 (0.011)	0.010 (0.009)	0.009 (0.013)	**0.016*** (0.010)	0.016 (0.029)	0.014 (0.009)
Envy (from 0.1 to 0.9)	0.118 (0.093)	0.260 (0.181)	0.099 (0.103)	0.264 (0.214)	0.470 (0.323)	0.254 (0.219)
Pro-social (from 0.1 to 0.9)	**0.219*** (0.125)	**0.485***** (0.118)	**0.181*** (0.093)	**0.422***** (0.106)	−0.037 (0.312)	**0.395***** (0.100)
14–17-year-old house			−0.044 (0.048)	0.162 (0.131)	0.088 (0.194)	
18–32-year-old house			0.009 (0.041)	**0.244***** (0.077)	**1.065***** (0.268)	

Table E15 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
House older than 32 years			−0.067	0.093	**2.145*****	
			(0.045)	(0.101)	(0.169)	
Log(House size)			0.104	**0.276*****	0.012	**0.280*****
			(0.073)	(0.054)	(0.208)	(0.055)
Female			**0.155*****	**0.071***	−0.233	**0.081****
			(0.049)	(0.041)	(0.205)	(0.039)
Age			0.002	0.001	−0.004	0.001
			(0.002)	(0.002)	(0.009)	(0.002)
Good financial position (from 1 to 3)			**0.086*****	**0.091****	−0.033	**0.095****
			(0.026)	(0.035)	(0.313)	(0.037)
Constant	**2.775*****	**2.228*****	**1.945*****	0.196	−1.195	0.461
	(0.326)	(0.281)	(0.741)	(0.429)	(1.186)	(0.395)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.049	0.064	0.136	0.137	−0.004	
Robust Std. Error of λ					(0.073)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E16
Façade quality of houses and Heckman selection.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Façade quality				Selection: Renovated (Yes/No)	Façade quality
Risk-taking (from 1 to 5)	0.036	−0.052	0.043	−0.041	**0.128****	0.025
	(0.030)	(0.054)	(0.029)	(0.049)	(0.064)	(0.066)
Discount factor (from 0.747 to 1)	0.386	**1.698*****	0.662	**1.826*****	0.170	**1.410*****
	(0.358)	(0.520)	(0.436)	(0.637)	(1.193)	(0.465)
Pro-environmental (from 0 to 9)	−0.013	−0.014	0.006	0.024	0.012	0.029
	(0.011)	(0.012)	(0.010)	(0.017)	(0.027)	(0.018)
Envy (from 0.1 to 0.9)	0.153	**0.374****	−0.145	−0.013	0.312	0.148
	(0.120)	(0.159)	(0.121)	(0.147)	(0.302)	(0.192)
Pro-social (from 0.1 to 0.9)	**0.279****	0.186	0.000	−0.065	−0.286	−0.083
	(0.127)	(0.235)	(0.127)	(0.168)	(0.285)	(0.265)
14−17-year-old house			−0.028	0.202	−0.018	
			(0.065)	(0.165)	(0.147)	
18−32-year-old house			−**0.210*****	−0.051	**0.799*****	
			(0.077)	(0.129)	(0.218)	
House older than 32 years			−**0.820*****	−**0.651*****	**2.143*****	
			(0.088)	(0.135)	(0.126)	
Log(House size)			**0.183*****	**0.349*****	0.053	**0.337*****
			(0.067)	(0.054)	(0.224)	(0.112)
Female			0.023	−0.010	−0.222	−0.050
			(0.047)	(0.056)	(0.189)	(0.090)
Age			**0.012*****	0.008	0.003	0.007
			(0.004)	(0.006)	(0.008)	(0.005)
Good financial position (from 1 to 3)			0.025	**0.157*****	−0.008	0.155
			(0.043)	(0.038)	(0.278)	(0.139)
Constant	**2.635*****	**1.458*****	1.042	−1.080	−1.724	−1.612
	(0.374)	(0.501)	(0.761)	(0.970)	(1.162)	(1.137)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.009	0.033	0.233	0.255	0.700	
Robust Std. Error of λ					(0.065)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

2. Risk taking in financial matters, in career, in car driving and in sports as explanatory variables

Table E17
Estimated overall energy quality of houses and Heckman selection with risk taking in financial matters.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking in financial matters (from 1 to 5)	**0.071*****	**0.123*****	**0.051****	**0.065*****	**0.135****	**0.086*****
	(0.024)	(0.018)	(0.022)	(0.020)	(0.061)	(0.025)
Discount factor (from 0.747 to 1)	0.249	**1.230****	0.401	**1.282****	0.050	**1.102*****
	(0.272)	(0.475)	(0.304)	(0.491)	(1.215)	(0.363)
Pro-environmental (from 0 to 9)	0.010	0.010	**0.017*****	**0.023****	0.011	**0.026*****
	(0.006)	(0.007)	(0.006)	(0.010)	(0.028)	(0.009)
Envy (from 0.1 to 0.9)	**0.173****	**0.347*****	0.010	0.148	0.413	**0.213****
	(0.079)	(0.092)	(0.072)	(0.095)	(0.309)	(0.104)
Pro-social (from 0.1 to 0.9)	**0.223****	**0.343*****	0.066	**0.216*****	−0.189	**0.208*****
	(0.102)	(0.103)	(0.083)	(0.075)	(0.297)	(0.079)
14–17-year-old house			−0.028	0.140	0.008	
			(0.041)	(0.122)	(0.167)	
18–32-year-old house			−**0.149*****	0.025	**0.888*****	
			(0.039)	(0.076)	(0.253)	
House older than 32 years			−**0.431*****	−**0.265*****	**2.083*****	
			(0.033)	(0.074)	(0.148)	
Log(House size)			**0.095****	**0.201*****	0.028	**0.199*****
			(0.042)	(0.034)	(0.228)	(0.031)
Female			0.032	0.001	−0.218	−0.020
			(0.034)	(0.039)	(0.192)	(0.051)
Age			**0.007*****	0.006	0.001	**0.006***
			(0.003)	(0.004)	(0.009)	(0.003)
Good financial position (from 1 to 3)			0.032	0.052	−0.017	0.050
			(0.026)	(0.048)	(0.300)	(0.083)
Constant	**2.742*****	**1.525*****	**1.885*****	0.218	−1.484	0.059
	(0.358)	(0.471)	(0.631)	(0.654)	(1.159)	(0.695)
Observations	340	145	340	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.043	0.115	0.215	0.265	0.288	
Robust Std. Error of λ					(0.033)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table E18
Estimated overall energy quality of houses and Heckman selection with risk taking in professional career.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking in professional career (from 1 to 5)	**0.047****	**0.076***	**0.053*****	**0.091****	**0.167*****	**0.100*****
	(0.018)	(0.038)	(0.020)	(0.035)	(0.062)	(0.039)
Discount factor (from 0.747 to 1)	0.266	**1.162****	0.412	**1.297*****	−0.092	**1.126*****
	(0.237)	(0.440)	(0.281)	(0.458)	(1.246)	(0.335)
Pro-environmental (from 0 to 9)	0.005	0.006	**0.015***	**0.029*****	0.004	**0.028*****
	(0.008)	(0.008)	(0.008)	(0.007)	(0.028)	(0.007)
Envy (from 0.1 to 0.9)	**0.164****	**0.312*****	−0.012	0.066	0.346	0.151
	(0.082)	(0.115)	(0.072)	(0.100)	(0.314)	(0.121)
Pro-social (from 0.1 to 0.9)	**0.231****	**0.335*****	0.064	**0.178****	−0.206	**0.172***
	(0.097)	(0.112)	(0.072)	(0.073)	(0.283)	(0.093)
14–17-year-old house			−0.035	0.164	0.010	
			(0.041)	(0.117)	(0.168)	

Table E18 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	
18–32-year-old house			**−0.155***** (0.041)	0.005 (0.081)	**0.908***** (0.261)	
House older than 32 years			**−0.456***** (0.038)	**−0.308***** (0.080)	**2.090***** (0.152)	
Log(House size)			**0.122**** (0.054)	**0.264***** (0.027)	0.022 (0.212)	**0.269***** (0.042)
Female			0.053 (0.034)	0.041 (0.040)	−0.220 (0.209)	0.014 (0.056)
Age			**0.008**** (0.003)	**0.009*** (0.005)	−0.003 (0.009)	**0.008**** (0.004)
Good financial position (from 1 to 3)			0.036 (0.027)	0.064 (0.046)	−0.017 (0.281)	0.071 (0.094)
Constant	**2.781***** (0.331)	**1.679***** (0.548)	**1.669**** (0.744)	−0.405 (0.788)	−1.192 (1.117)	−0.613 (0.845)
Observations	334	140	334	140	336	336
# of clusters	162	39	162	39	164	164
R-squared / λ	0.025	0.072	0.224	0.305	0.310	
Robust Std. Error of λ					(0.031)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E19
Estimated overall energy quality of houses and Heckman selection with risk taking in car driving.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking in car driving (from 1 to 5)	0.016 (0.020)	−0.005 (0.028)	0.015 (0.017)	−0.005 (0.029)	**0.114*** (0.061)	0.001 (0.032)
Discount factor (from 0.747 to 1)	0.231 (0.237)	**1.137***** (0.395)	0.385 (0.280)	**1.253***** (0.447)	0.070 (1.225)	**1.022***** (0.308)
Pro-environmental (from 0 to 9)	0.004 (0.007)	0.001 (0.006)	**0.013**** (0.007)	**0.020**** (0.008)	0.013 (0.028)	**0.020***** (0.007)
Envy (from 0.1 to 0.9)	**0.173**** (0.081)	**0.352***** (0.104)	0.005 (0.073)	0.140 (0.097)	0.396 (0.311)	**0.205*** (0.115)
Pro-social (from 0.1 to 0.9)	**0.223**** (0.103)	**0.336***** (0.099)	0.062 (0.084)	**0.204***** (0.071)	−0.213 (0.289)	**0.189**** (0.080)
14–17-year-old house			−0.026 (0.042)	0.165 (0.115)	−0.015 (0.166)	
18–32-year-old house			**−0.138***** (0.034)	0.051 (0.075)	**0.857***** (0.250)	
House older than 32 years			**−0.440***** (0.032)	**−0.276***** (0.074)	**2.076***** (0.149)	
Log(House size)			**0.105**** (0.043)	**0.203***** (0.032)	0.035 (0.227)	0.202*** (0.035)
Female			0.024 (0.038)	−0.008 (0.044)	−0.227 (0.191)	−0.033 (0.065)
Age			**0.007***** (0.003)	**0.007*** (0.004)	0.001 (0.009)	0.006** (0.003)
Good financial position (from 1 to 3)			0.038 (0.026)	0.073* (0.043)	−0.013 (0.305)	0.078 (0.087)
Constant	**2.920***** (0.319)	**1.978***** (0.436)	**1.922***** (0.619)	0.349 (0.643)	−1.476 (1.149)	0.240 (0.667)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.016	0.060	0.202	0.251	0.310	
Robust Std. Error of λ					(0.034)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E20
Estimated overall energy quality of houses and Heckman selection with risk taking in sports.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking in sports	**0.072***	0.009	**0.077***	0.017	**0.140**	0.044
(from 1 to 5)	(0.021)	(0.044)	(0.022)	(0.042)	(0.066)	(0.045)
Discount factor	0.208	**1.139***	0.362	**1.257***	0.063	**1.029***
(from 0.747 to 1)	(0.238)	(0.395)	(0.286)	(0.448)	(1.224)	(0.309)
Pro-environmental	0.003	0.001	**0.012***	**0.020**	0.012	**0.021***
(from 0 to 9)	(0.006)	(0.006)	(0.006)	(0.009)	(0.028)	(0.008)
Envy	**0.190**	**0.350***	0.021	0.136	0.401	**0.204***
(from 0.1 to 0.9)	(0.079)	(0.106)	(0.071)	(0.101)	(0.309)	(0.116)
Pro-social	**0.240**	**0.335***	0.080	**0.203***	−0.207	**0.186**
(from 0.1 to 0.9)	(0.093)	(0.100)	(0.075)	(0.071)	(0.291)	(0.082)
14−17-year-old house			−0.026	0.162	−0.016	
			(0.041)	(0.120)	(0.164)	
18−32-year-old house			**−0.149***	0.048	**0.849***	
			(0.036)	(0.075)	(0.240)	
House older than 32 years			**−0.449***	**−0.280***	**2.070***	
			(0.034)	(0.076)	(0.145)	
Log(House size)			**0.102**	**0.205***	0.030	**0.207***
			(0.044)	(0.028)	(0.225)	(0.036)
Female			0.038	−0.003	−0.219	−0.021
			(0.036)	(0.039)	(0.186)	(0.057)
Age			**0.007***	**0.007***	0.001	**0.007**
			(0.003)	(0.004)	(0.009)	(0.003)
Good financial position			0.023	0.068	−0.017	0.068
(from 1 to 3)			(0.027)	(0.041)	(0.299)	(0.086)
Constant	2.767***	1.933***	1.818***	0.278	−1.513	0.090
	(0.311)	(0.466)	(0.631)	(0.687)	(1.150)	(0.715)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.033	0.060	0.221	0.252	0.316	
Robust Std. Error of λ					(0.031)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3. *Self-stated donations to environmental or social organizations as explaining variables*

Table E21
Estimated overall energy quality of houses and Heckman selection with self-stated donations as explanatory variables without environmental and social preferences.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.069***	0.002	**0.077***	0.012	**0.129**	0.040
	(0.020)	(0.044)	(0.022)	(0.046)	(0.065)	(0.052)
Discount factor (from 0.747 to 1)	0.134	**0.908**	0.341	**1.113***	0.034	**0.907***
	(0.205)	(0.338)	(0.262)	(0.376)	(1.239)	(0.294)
Donation to env. org. (from 0 to 2)	**−0.054***	**−0.073***	−0.031	**−0.083***	0.140	**−0.057***
	(0.016)	(0.012)	(0.019)	(0.010)	(0.085)	(0.012)
Donation to social org. (from 0 to 2)	−0.029	0.053	0.035	**0.127***	−0.030	**0.118***
	(0.029)	(0.037)	(0.023)	(0.014)	(0.081)	(0.019)
14−17-year-old house			−0.028	0.148	−0.032	
			(0.040)	(0.125)	(0.159)	
18−32-year-old house			**−0.166***	−0.036	**0.824***	
			(0.040)	(0.071)	(0.231)	
House older than 32 years			**−0.462***	**−0.357***	**2.005***	
			(0.038)	(0.072)	(0.148)	

Table E21 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
Log(House size)			**0.102****	**0.225*****	0.050	**0.232*****
			(0.048)	(0.028)	(0.224)	(0.048)
Female			**0.062****	0.065	−0.212	0.028
			(0.031)	(0.042)	(0.192)	(0.066)
Age			**0.008*****	**0.008****	0.002	**0.008****
			(0.003)	(0.004)	(0.008)	(0.003)
Good financial position (from 1 to 3)			0.021	0.057	−0.018	0.052
			(0.027)	(0.036)	(0.276)	(0.087)
Constant	**3.077*****	**2.416*****	**1.930*****	0.498	−1.523	0.233
	(0.240)	(0.427)	(0.616)	(0.712)	(1.156)	(0.751)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.034	0.037	0.220	0.270	0.345	
Robust Std. Error of λ					(0.029)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table E22
Estimated overall energy quality of houses and Heckman selection with self-stated donations as explanatory variables and environmental and social preferences.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.073*****	0.004	**0.077*****	0.015	**0.140****	0.042
	(0.020)	(0.044)	(0.022)	(0.044)	(0.066)	(0.048)
Discount factor (from 0.747 to 1)	0.203	**1.097*****	0.340	**1.166*****	0.125	**0.989*****
	(0.231)	(0.381)	(0.276)	(0.421)	(1.276)	(0.305)
Pro-environmental (from 0 to 9)	0.006	0.002	**0.013****	**0.022****	0.005	**0.022*****
	(0.006)	(0.006)	(0.006)	(0.009)	(0.029)	(0.008)
Envy (from 0.1 to 0.9)	**0.143***	**0.339*****	0.010	0.109	0.510	**0.225***
	(0.080)	(0.112)	(0.072)	(0.105)	(0.318)	(0.118)
Pro-social (from 0.1 to 0.9)	**0.188***	**0.313*****	0.072	**0.159****	−0.126	**0.187****
	(0.102)	(0.104)	(0.072)	(0.071)	(0.304)	(0.093)
Donation to env. org. (from 0 to 2)	−**0.043*****	−**0.045*****	−**0.031***	−**0.074*****	0.165	−**0.040*****
	(0.015)	(0.014)	(0.019)	(0.011)	(0.102)	(0.014)
Donation to social org. (from 0 to 2)	−0.026	0.053	0.035	**0.125*****	−0.033	**0.119*****
	(0.030)	(0.034)	(0.022)	(0.014)	(0.083)	(0.018)
14−17-year-old house			−0.027	0.142	−0.013	
			(0.041)	(0.116)	(0.156)	
18−32-year-old house			−**0.156*****	−0.017	**0.828*****	
			(0.040)	(0.073)	(0.226)	
House older than 32 years			−**0.458*****	−**0.349*****	**2.049*****	
			(0.037)	(0.076)	(0.136)	
Log(House size)			**0.106****	**0.242*****	0.038	**0.247*****
			(0.046)	(0.028)	(0.227)	(0.042)
Female			0.046	0.032	−0.239	−0.005
			(0.035)	(0.041)	(0.177)	(0.060)
Age			**0.008*****	**0.007****	0.001	**0.006****
			(0.003)	(0.004)	(0.008)	(0.003)
Good financial position (from 1 to 3)			0.020	0.045	−0.013	0.043
			(0.027)	(0.039)	(0.289)	(0.089)
Constant	**2.829*****	**1.973*****	**1.814*****	0.199	−1.659	−0.118
	(0.319)	(0.478)	(0.631)	(0.659)	(1.133)	(0.686)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.044	0.068	0.224	0.284	0.342	
Robust Std. Error of λ					(0.032)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

4. *Real donations from the money earned in the experiment to an environmental organization as explanatory variables*[36]

Table E23
Estimated overall energy quality of houses and Heckman selection with real donations as explanatory variables without environmental and social preferences.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.066***	0.011	**0.076***	0.015	**0.134**	0.042
	(0.022)	(0.046)	(0.023)	(0.045)	(0.066)	(0.047)
Discount factor (from 0.747 to 1)	0.114	**0.992***	0.373	**1.188***	−0.023	**0.959***
	(0.203)	(0.352)	(0.269)	(0.405)	(1.187)	(0.300)
Real donation to env. org. (from 0 to 0.6)	−0.077	−0.063	−0.071	−0.054	−0.386	−0.118
	(0.059)	(0.080)	(0.053)	(0.066)	(0.296)	(0.078)
14–17-year-old house			−0.026	0.173	−0.030	
			(0.040)	(0.125)	(0.172)	
18–32-year-old house			**−0.158***	0.023	**0.866***	
			(0.037)	(0.073)	(0.267)	
House older than 32 years			**−0.453***	**−0.288***	**2.053***	
			(0.035)	(0.075)	(0.166)	
Log(House size)			**0.098**	**0.188***	0.012	**0.195***
			(0.046)	(0.028)	(0.218)	(0.043)
Female			**0.056***	0.026	−0.189	0.008
			(0.033)	(0.042)	(0.208)	(0.065)
Age			**0.008***	**0.008***	0.001	**0.007**
			(0.003)	(0.004)	(0.009)	(0.003)
Good financial position (from 1 to 3)			0.027	**0.083**	−0.018	0.078
			(0.027)	(0.037)	(0.292)	(0.084)
Constant	**3.087***	**2.283***	**1.956***	0.609	−1.157	0.436
	(0.261)	(0.449)	(0.626)	(0.764)	(1.131)	(0.771)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.019	0.040	0.219	0.238	0.315	
Robust Std. Error of λ					(0.035)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table E24
Estimated overall energy quality of houses and Heckman selection with donation as explanatory variables and environmental and social preferences.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	0.071***	0.011	0.076***	0.017	0.141**	0.043
	(0.021)	(0.044)	(0.022)	(0.041)	(0.067)	(0.042)
Discount factor (from 0.747 to 1)	0.215	1.156***	0.374	1.266***	0.011	1.030***
	(0.229)	(0.386)	(0.284)	(0.447)	(1.219)	(0.310)
Pro-environmental (from 0 to 9)	0.004	0.005	0.013**	0.023**	0.020	0.025***
	(0.006)	(0.006)	(0.006)	(0.008)	(0.028)	(0.008)
Envy (from 0.1 to 0.9)	0.178**	0.292***	0.009	0.107	0.326	0.159
	(0.077)	(0.100)	(0.072)	(0.097)	(0.333)	(0.111)
Pro-social (from 0.1 to 0.9)	0.250***	0.338***	0.091	0.214***	−0.159	0.205***
	(0.088)	(0.096)	(0.071)	(0.068)	(0.280)	(0.079)
Real donation to env. org. (from 0 to 0.6)	−0.080	−0.051	−0.085	−0.074	−0.346	−0.135
	(0.064)	(0.090)	(0.054)	(0.070)	(0.291)	(0.083)
14–17-year-old house			−0.024	0.164	−0.014	
			(0.040)	(0.117)	(0.169)	

Table E24 (*Continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
18–32-year-old house			−0.147***	0.051	0.858***	
			(0.036)	(0.075)	(0.259)	
House older than 32 years			−0.448***	−0.275***	2.083***	
			(0.034)	(0.077)	(0.154)	
Log(House size)			0.101**	0.203***	0.017	0.207***
			(0.044)	(0.027)	(0.221)	(0.038)
Female			0.039	−0.008	−0.226	−0.028
			(0.037)	(0.043)	(0.194)	(0.062)
Age			0.008***	0.007*	0.001	0.006**
			(0.003)	(0.004)	(0.009)	(0.003)
Good financial position (from 1 to 3)			0.026	0.068*	−0.015	0.068
			(0.027)	(0.039)	(0.302)	(0.083)
Constant	2.790***	1.868***	1.836***	0.297	−1.365	0.124
	(0.323)	(0.481)	(0.631)	(0.706)	(1.124)	(0.713)
Observations	341	145	341	145	341	341
# of clusters	166	41	166	41	166	166
R-squared / λ	0.035	0.071	0.224	0.254	0.313	
Robust Std. Error of λ					(0.037)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

5. *Without outliers in time preferences (16 % with a discount factor lower than 0.75 and 17 % with a discount factor higher than 0.99)*

Table E25
Estimated overall energy quality of houses and Heckman selection, without outliers in time preferences.

	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	Full sample
Dependent variable	Estimatced energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.072****	0.045	**0.088*****	0.056	**0.253*****	**0.101****
	(0.031)	(0.063)	(0.031)	(0.053)	(0.088)	(0.051)
Discount factor (from 0.747 to 1)	0.694	**1.569*****	**0.665****	**1.567*****	−1.666	**1.288****
	(0.423)	(0.534)	(0.322)	(0.464)	(1.538)	(0.608)
Pro-environmental (from 0 to 9)	0.010	0.001	**0.016****	0.018	−0.051	**0.014****
	(0.007)	(0.007)	(0.008)	(0.011)	(0.047)	(0.007)
Envy (from 0.1 to 0.9)	**0.139***	**0.366*****	−0.028	0.139	**0.742***	**0.242****
	(0.083)	(0.098)	(0.081)	(0.089)	(0.397)	(0.108)
Pro-social (from 0.1 to 0.9)	**0.143***	0.077	−0.020	−0.066	−0.421	−0.093
	(0.080)	(0.161)	(0.071)	(0.126)	(0.322)	(0.143)
14–17-year-old house			0.008	0.220	0.371	
			(0.049)	(0.177)	(0.231)	
18–32-year-old house			**−0.133*****	0.014	**1.339*****	
			(0.045)	(0.098)	(0.263)	
House older than 32 years			**−0.390*****	**−0.226****	**2.511*****	
			(0.038)	(0.107)	(0.211)	
Log(House size)			**0.163****	**0.260*****	0.241	**0.298*****
			(0.066)	(0.032)	(0.267)	(0.031)
Female			0.043	**0.094***	−0.138	0.078
			(0.039)	(0.049)	(0.361)	(0.067)
Age			**0.006****	0.005	0.001	0.004
			(0.003)	(0.004)	(0.007)	(0.004)
Good financial position (from 1 to 3)			**−0.060***	−0.032	0.282	−0.022
			(0.033)	(0.063)	(0.320)	(0.111)
Constant	**2.340*****	**1.558*****	**1.541*****	0.081	−2.129	−0.196
	(0.323)	(0.367)	(0.374)	(0.360)	(1.972)	(0.470)
Observations	228	107	228	107	228	228
# of clusters	101	25	101	25	101	101
R-squared / λ	0.037	0.064	0.228	0.269	0.299	
Robust Std. Error of λ					(0.037)	

Note: Cluster-robust standard errors in parentheses. Model (5): λ = ρσ, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** p < 0.01, ** p < 0.05, * p < 0.1.

5. *Cluster-robust standard errors with clustering on cantons*

Table E26
Estimated overall energy quality of houses with clustering on cantons.

	(1)	(2)	(3)	(4)	(5)	
	Full sample	Renovated houses	Full sample	Renovated houses	Heckman selection model	
Dependent variable	Estimated energy quality				Selection: Renovated (Yes/No)	Estimated energy quality
Risk-taking (from 1 to 5)	**0.072*****	0.009	**0.077*****	0.017	**0.140****	0.044
	(0.018)	(0.044)	(0.021)	(0.041)	(0.068)	(0.047)
Discount factor	0.208	**1.139****	0.362	**1.257****	0.063	**1.029*****
(from 0.747 to 1)	(0.258)	(0.459)	(0.305)	(0.503)	(1.244)	(0.361)
Pro-environmental	0.003	0.001	**0.012***	**0.020****	0.012	**0.021*****
(from 0 to 9)	(0.006)	(0.008)	(0.006)	(0.009)	(0.033)	(0.007)
Envy	**0.190***	**0.350****	0.021	0.136	0.401	**0.204***
(from 0.1 to 0.9)	(0.100)	(0.115)	(0.084)	(0.110)	(0.320)	(0.121)
Pro-social	**0.240****	**0.335****	0.080	**0.203****	−0.207	**0.186***
(from 0.1 to 0.9)	(0.097)	(0.119)	(0.072)	(0.069)	(0.419)	(0.100)
14–17-year-old house			−0.026	0.162	−0.016	
			(0.048)	(0.129)	(0.092)	
18–32-year-old house			**−0.149*****	0.048	**0.849*****	
			(0.040)	(0.075)	(0.232)	
House older than 32 years			**−0.449*****	**−0.280*****	**2.070*****	
			(0.036)	(0.076)	(0.123)	
Log(House size)			**0.102****	**0.205*****	0.030	**0.207*****
			(0.044)	(0.029)	(0.263)	(0.048)
Female			0.038	−0.003	−0.219	−0.021
			(0.038)	(0.032)	(0.161)	(0.053)
Age			**0.007****	0.007	0.001	**0.007****
			(0.003)	(0.004)	(0.009)	(0.003)
Good financial position			0.023	0.068	−0.017	0.068
(from 1 to 3)			(0.033)	(0.040)	(0.314)	(0.089)
Constant	**2.767*****	**1.933*****	**1.818****	0.278	−1.513	0.090
	(0.338)	(0.521)	(0.651)	(0.758)	(1.428)	(0.803)
Observations	341	145	341	145	341	341
# of clusters	20	13	20	13	20	20
R-squared / λ	0.033	0.060	0.221	0.252	0.316	
Robust Std. Error of λ					(0.026)	

Note: Cluster-robust standard errors in parentheses. Model (5): $\lambda = \rho\sigma$, where ρ=correlation of the error terms of the two regressions, σ= the standard error of the residual in the efficiency equation; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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