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Energy Efficiency, Information, and the Acceptability of Rent Increases: A Multiple Price List Experiment with Tenants

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Energy efficiency, information, and the acceptability of rent increases: A survey experiment with tenants *

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Abstract

This paper studies the role of imperfect information and attentional biases in the context of energy efficiency investments in rented properties and associated split incentives. We design a multiple price list experiment representing owners' decision to replace the central heating appliance, and employ both within-subject information disclosure and between-subject variation in information provision to quantify how tenants trade off energy efficiency and rent increases. Results show that informing tenants of a CHF 1 decrease in energy bills leads to CHF 1.12 in acceptable rent increase on average. Quantile regressions further indicate that the average treatment effect of information reflects heterogeneous changes along the entire distribution of acceptable rent increases. By contrast, information on energy bills variability dampens acceptable rent increase, and information about CO_2 tax payments has no incremental impact on choices. Our results highlight the importance of credible ex-ante estimates of financial savings associated with energy efficiency investments.

Keywords: Split incentives; Informational interventions; Energy efficiency; Rented properties; Survey experiments; Multiple price lists.

JEL Codes: D1; D8; H23; Q4; Q5; R31.

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1 Introduction

Despite positive private and social returns expected from energy efficiency investments, the adoption of energy efficient technologies is slow, and considerable resources are being directed to policies stimulating take-up (e.g. Allcott and Greenstone, 2012; Gillingham and Palmer, 2014). Considering residential energy consumption, rented dwellings represent a particularly challenging case. If tenants pay for energy bills, property owners have little incentives to invest in energy efficiency of their properties, whereas tenants have little incentives to invest themselves in a property they do not own. The resulting landlord-tenant split incentives constitute a major barrier to the improvement of energy efficiency in the stock of residential buildings (Gillingham et al., 2012; Davis, 2012).[1] Higher up-front investment costs associated with energy efficiency are borne by property owners, whereas tenants benefit from a reduction in the implicit price of energy services. For property owners, generating a positive return on these investments requires increasing rents, although they may encounter difficulties in signaling the value of future energy savings to tenants, leading to information asymmetries as documented in Myers (2020). This makes information a central aspect in tenants' acceptance of rent increases in exchange for lower energy bills.

In this paper, we study a hypothetical situation in which the owner of a rented property has to replace the central heating appliance, and can either install a standard option (efficiency label B, Council of European Union, 2013) or a more energy efficient one (labeled A^+).[2] Holding the level of comfort fixed across alternatives, we design a stated choice multiple price list (MPL, Andersen et al., 2006; Anderson et al., 2007) in which we expose tenants to a monthly "price" (rent increase) for the efficient technology, starting at zero and then sequentially increasing it. Subjects choose the efficient option until the proposed rent increase is deemed to be too high and the

[1] In the U.S. about 35% of dwellings are renter-occupied (U.S. Census Bureau, 2016), around 30% in the E.U. (Eurostat, 2017), and in China about 11% (Yang and Chen, 2014). Empirical evidence comparing energy consumption in owner-occupied and rented properties suggests tenants face significantly higher energy bills (see e.g. Bird and Hernandez, 2012; Charlier, 2015; Melvin, 2018).

[2] Our stated preferences MPL is motivated by the difficulty to harness revealed preferences in this setting, as observational data are constrained by supply-side restrictions such as rent control regulations, and a randomized control trial is not practical due to the cost of the interventions we consider. As we discuss in detail below, we take a number of steps to mitigate hypothetical bias and incentivize truthful preference revelation. Nevertheless, our results on the acceptable level of rent increase should be interpreted with caution, and our attention is mainly directed towards between- and within-subjects comparisons quantifying the role of information provision.

standard replacement option is chosen instead (with no associated rent increase).[3] After a baseline MPL task, which reflects perceived differences derived from mandatory energy efficiency labels, we quantify the impact of alternative informational interventions on tenant's valuation of improved energy efficiency. To do so, we follow Newell and Siikamäki (2014) and Allcott and Taubinsky (2015) and randomly assign subjects to alternative treatments that provide information about financial implications of their choices. We then employ a second MPL task to measure how within-subject information disclosure affects the acceptability of rent increases, and in turn the landlord-tenant split incentives problem. Furthermore, a between-subject comparison across information conditions provides detailed evidence on the role of financial savings information, energy bills variability, and CO_2 tax payments, based on illustrative figures derived from the Swiss context.

Our experimental design is motivated by the need to inform policies that incentivize energy efficiency investments in existing dwellings. Indeed, improving space heating efficiency in the stock of buildings is one of the key measures put forward by many governments in an attempt to reduce environmental externalities associated with fossil fuel consumption. Space heating is thought to offer large potential energy savings (IPCC, 2014) and the U.S., for example, plans to reduce buildings' energy use per square foot by 30% in 2030 relative to 2010 (U.S. Department of Energy, 2015), while China includes the improvement of buildings' energy efficiency in its national energy consumption targets (NDRC, 2017).[4] Importantly, heating systems have a relatively long average lifetime, so that space heating choices represent long-term investments (see Rapson, 2014).[5] Because property owners are "locked-in" a specific technology, evidence contributing to the design of policies targeting energy efficiency investments is crucial.

Previous research has identified a number of market distortions associated with energy ef-

[3] Also widely applied, discrete choice experiments allow preference elicitation among multi-attribute alternatives. In rental buildings, however, the multi-dimensional choice of a central heating appliance is made by the landlord, typically without consulting tenants. When studying tenants' willingness to contribute to the appliance's energy efficiency, the MPL procedure offers a more realistic choice setting.

[4] Space heating represents 32% of final residential building energy consumption in 2010, the largest share across end-uses (additional large contributors are cooking and water heating, see IPCC, 2014). The IEA (2011) further reports that 63% of buildings' potential energy savings in 2050 come from the residential sector, with space heating representing 39% of residential buildings' potential energy savings.

[5] A U.S. study by Seiders et al. (2007), for instance, estimates that gas boilers operate for 21 years on average, oil furnaces 15-20 years, and heat pumps 16 years. Most homeowners wait until building components reach the end of their useful life before considering renovation or replacement (Jakob, 2007; Achtnicht and Madlener, 2014).

ficiency investments (see Gerarden et al., 2017), and growing empirical evidence suggests that imperfect information and attentional biases are significant barriers to energy efficiency improvements (e.g. Allcott and Wozny, 2014; Jacobsen, 2015; Allcott and Knittel, 2019). In a landlord-tenant setting, Myers (2020) provides empirical evidence that tenants are uninformed about energy costs, and in turn that asymmetric information reduces energy efficiency investments. In line with this, in this paper we assess the potential to influence tenants' valuations of energy efficiency with financial information. Our experimental design delivers willingness to pay (WTP) space evidence about how simple efficiency labels are perceived by tenants, and quantifies the incremental impact of specific financial information on their choices. Relative to existing studies, a major contribution of our work is to provide experimentally controlled evidence on the role of information in a landlord-tenant split incentive context.

In particular, our experimental design identifies the impact of information along two important dimensions. First, recent research highlights financial and energy literacy as barriers to energy efficiency investments (see e.g. Brent and Ward, 2018), and emphasizes the importance of financial information in fostering consumers' ability to make rational and efficient choices. (as opposed to physical units, see Blasch et al., 2017). Building on these results, we study how illustrative information about financial savings associated with reduced energy consumption affects tenants' acceptance of rent increases. More specifically, a set of experimental conditions informs tenants that choosing option A^+ over B (approximately 30% higher energy efficiency, see Council of European Union, 2013) would reduce energy bills by CHF 40 per month (about USD 42). Within the conditions, we further vary salience of financial savings, thereby adding to the results of Newell and Siikamäki (2014) who study the context of owner-occupied properties. Moreover, because there is ample uncertainty about realizations of future energy bills, which implies that risk averse tenants hold a higher valuation for energy efficiency improvements, for another subset of tenants we couple illustrative financial savings figures to information about variability of energy bills over time.

Second, we test whether salience of CO_2 tax payments incorporated in energy bills has an impact on acceptable rent increases, leveraging the existing CO_2 tax on fossil heating fuels in Switzerland (CHF 84 or USD 87 per ton of CO_2 in 2017, see The Swiss Federal Council, 2012). More specifically, we design a set of conditions where we vary the salience of financial savings and reduced CO_2 expenditures related to their choices, allowing us to examine consumers' responses to tax-inclusive prices as compared to purely financial information. We thereby contribute to a growing literature on the behavioral effect of salience of externality-correcting taxes (see e.g. Li et al., 2014; Houde and Aldy, 2017; Lanz et al., 2018).

Our experimental survey is administered to an online panel of 406 Swiss tenants, the majority of which bears the energy cost of their dwelling separately from monthly rents.[6] Our results indicate that, in the baseline, around 70% of tenants in our sample are willing to accept a rent increase if their landlord replaces their existing heating appliance with an energy efficient option as opposed to a standard one. Quantitatively, average WTP for efficiency grading label A^+ vs. B is CHF 37.51 per month (about CHF 450 or USD 470 per year), roughly 3% of median rents in Switzerland. Providing financial information about expected energy bills associated with each option leads to an average endline WTP estimate of CHF 64.87 per month (about CHF 780 or USD 810 per year), which exceeds financial savings. In particular, informing tenants about CHF 1 in expected energy savings translates into CHF 1.12 in possible rent increases on average, and increasing salience of the information pushes this number to around CHF 1.62. This implies that a large share of our sample holds motives beyond purely financial concerns. By contrast, we find that information about past variability in energy bills dampens acceptable rent increase, and information on CO_2 tax payments has no incremental impact on tenants' valuation of energy efficiency. Our results thus suggest a differentiation between financial and pro-social preferences.

While average treatment effects are important, a policy interest persists in the impact on the tails of the WTP distribution (an ideal informational intervention incentivizes the lowest quantiles to correct their expectations of ex-post benefits upwards). In order to document heterogeneity in how the treatment effect of financial information varies across the distribution of valuations, we report results from a set of quantile regressions. Results show that, while values for mean and median treatment effect estimates are very similar, the average treatment effect reflects heterogeneous changes along the entire WTP distribution. Specifically, we doc-

[6] In Switzerland, tenants commonly pay heating costs for their dwelling separately from their rents, often in the form of down payments. In our sample, only 1% of tenants state that the energy cost is included in their rents, while 85% report paying it separately from their rents. 13% of tenants do not know the billing method (note that this group's WTP estimates are statistically indistinguishable from the remainder of the sample).

ument that the upward shift in WTP reflects an increased frequency of high energy efficiency valuations in particular, with lower quantiles remaining unaffected. In other words, providing tenants with information on expected energy bills reductions results in a WTP distribution that is less (positively) skewed, i.e., with a larger proportion of high valuations.

Our results also complement a small number of studies on tenants' preferences towards energy efficiency investments. Banfi et al. (2008) and Phillips (2012) employ discrete choice experiments to study tenants' preferences towards specific combinations of energy efficiency investments in Switzerland and New Zealand respectively, with mixed results. While Banfi et al. (2008) find that Swiss tenants' valuation of energy efficiency improvements such as window replacement and installing a ventilation system is generally higher than the corresponding investment costs, Phillips (2012) suggests that willingness to accept rent increases in exchange for an energy efficiency improvement of the heating system is economically insignificant. These results show that improved comfort plays an important role in tenants' choices, something we control for in our experimental design, and confirm that tenants may be ill-informed about financial savings associated with their investments. Studying a sample of university tenants in Ireland, Carroll et al. (2016) show that WTP for energy efficiency is substantially higher at the lower end of the energy efficiency distribution, but find no statistically significant WTP for improvements in buildings with energy efficiency grade B or above. Relative to Carroll et al. (2016), our contribution is to consider a replacement decision, thereby isolating the impact of energy efficiency on tenants' valuation of renting services. We also build on Hoppe (2012) and Glumac et al. (2013), who conduct in-depth (case study) analyses of specific renovation projects in the Netherlands, showing that rent increases are an important driver of ex-post acceptability. Our work instead emphasizes the role of ex-ante information for tenants' acceptance of rent increases. We show that obtaining and providing realistic measures of energy savings prior to renovation is an important step to foster the adoption of energy efficient technologies in a split-incentive context (see Fowlie et al., 2018; Burlig et al., 2017; Liang et al., 2018).

The paper proceeds as follows. In Section 2, we present a simple conceptual framework that allows us to identify the impact of information on WTP. Section 3 describes our experimental design, including MPL procedures, and provides the details of alternative informational interventions. Section 4 presents our results. Concluding comments are provided in Section 5.

2 Conceptual framework

Our survey experiment focuses on owners' decisions to *replace* the appliance supplying heat to the central heating system and, in that context, on the choice between a standard and an energy efficient appliance. Our main objectives are then to estimate (i) tenants' acceptance of rent increases in exchange for increased efficiency of their central heating system; and (ii) whether additional information about energy savings and CO_2 taxes affects tenants' WTP. In this section, we first lay out a simple conceptual framework representing tenants' decisions, which allows us to introduce some useful notation. Second, we describe our empirical strategy to quantify the impact of information on observed choices.

2.1 A model of tenants' decisions: Notation

As mentioned above, our identification strategy builds on Allcott and Taubinsky (2015). We consider a set of tenants indexed by i who are consulted for a choice between an efficient heating system (E) and a standard heating system (S). The two alternatives $j \in (E, S)$ are associated with prices p_j, and $p = p_E - p_S$ denotes relative prices. Both alternatives are financed by rents and are thus expressed in monthly outlays.[7] We refer to tenants' utility directly in monetary equivalents in the form of tenants' WTP (in rents), and define tenant i's WTP for selecting j as wtp_{ij}. Accordingly, we denote relative WTP as $wtp_i = wtp_{iE} - wtp_{iS}$. Notionally, a utility maximizing tenant would select E if and only if $wtp_i > p$, that is, the relative surplus from selecting the efficient system is greater than the associated increase in rents.

Given this notation, the objective of this study is to identify wtp_i. In particular, as discussed extensively below, we use a MPL procedure to identify the relative prices at which subjects switch from choosing option E to option S. This is achieved by offering a sequence of t choices between options E and S, where relative prices p^t vary in the form of increased monthly rents. Therefore, if tenant i prefers efficient option E at price p^1, but instead chooses the standard option S at price p^2, then the MPL task reveals that this particular tenant's relative valuation

[7] From the tenants' perspective, rents and energy costs are paid each month, so the decision problem is static. We therefore do not consider the role of time preferences. In our experimental setting, we further clarify that selecting the standard appliance as a replacement corresponds to usual maintenance of the property, so that choosing this option would not affect rents.

wtp_i lies within the interval [p^1,p^2].

Importantly, wtp_i includes all perceived differences between efficient (E) and standard (S) heating systems. In general, considering different heating systems involves expectations about potential cost savings, non-monetary costs associated with installation, different levels of comfort, differences in lifetime duration of appliances, or social benefits associated with lower energy use, among many other things (see Fowlie et al., 2015). As an attempt to fix subjects' heterogeneous expectations and thereby control for these potential confounders, we frame the experimental survey to focus exclusively on energy efficiency gains as measured by a simple energy label that is encountered in the marketplace.

The narrow focus on energy efficiency implies that wtp_i will reflect expected differences in energy consumption and associated financial savings. In particular, energy consumption directly affects exposure to variations in the price of heating fuels, so that risk aversion might act as a relevant source of heterogeneity in WTP for energy efficiency. In turn, a risk averse tenant may attribute a higher value to a given energy efficiency improvement, as lower energy expenditures reduce exposure to fuel price risk, so that wtp_i includes a component associated with risk reduction. Similarly, heterogeneity in wtp_i may be driven by differences in environmental preferences. In section 3.2, we lay out how we manipulate individual perceptions of heating cost savings, risk considerations, and CO_2 emissions, by means of various informational interventions.

2.2 Identifying the effect of information

In order to quantify how financial and environmental information affect choices, we first elicit wtp_i with a baseline MPL choice task, and then randomly assign tenants to one of several information treatments. As we describe in more detail in the next section, these conditions mainly focus on providing information about energy cost savings and CO_2 tax payments. Subsequently, we elicit wtp_i with an endline MPL choice task.

Formally, we denote tenant i's *baseline* WTP as wtp_i^0, and WTP *after* being subject to one of the interventions as wtp_i^1. We refer to the latter as *endline* WTP. We exploit within- and between-subject variation in wtp_i^s, $s \in \{0,1\}$ to identify the impact of information in WTP-space. This is achieved with a set of linear regressions in which the outcome variable is wtp_i^s measured by respective MPL tasks:[8]

$$wtp_i^s = \alpha + \sum_k \beta_k T_{ik} + \epsilon_i \tag{1}$$

where T_{ik} is a set of treatment indicators (i.e., one dummy variable for each treatment condition) and ϵ_i is an error term. The vector of coefficients in β_k represents average treatment effects, and provides direct evidence on how information affects WTP.

Similarly, we study how alternative treatment interventions affect the distribution of tenants' WTP. For this purpose, we employ a set of quantile regressions. Formally, we estimate the (unconditional) quantile function for quantile τ, denoted Q^τ, with the following quantile regression model:

$$Q^\tau(wtp_i^s) = \alpha^\tau + \sum_k \beta_k^\tau T_{ik} + \epsilon_i^\tau \tag{2}$$

where $Q^\tau(wtp_i^s)$ is the τth quantile of wtp_i^s and the vector of coefficients in β_k^τ denotes quantile treatment effects. In other words, β_k^τ provides evidence on the effect of information on the τth quantile of the WTP distribution.

3 Experimental design

In a nutshell, subjects go through the following sequence: (i) a baseline MPL choice task, (ii) random assignment to one of six information treatments plus a control group, and (iii) an endline MPL choice task. In the following, we provide details of the MPL elicitation tasks and informational interventions. We then provide some notes about how we administer the experimental survey. A full set of screenshots of the experimental material is provided in Appendix A.

3.1 Multiple price list procedures

The MPL exercise asks subjects to consider that the current appliance supplying heat to their dwelling needs replacement, and invites them to think about which option would be best suited

[8] Note that MPL tasks only provide bounds on wtp_i^s, as measured by the price intervals specified in the sequence of t MPL choices. An alternative to linear regression using the mid-point of the interval is to apply an interval data model (e.g. Cameron, 1988). With our data, however, we find that OLS and interval data models yield very similar treatment effects, and therefore stick with OLS specifications.

for their household. We also make them aware that the choice of heating appliance could influence their rents. The owner of the property may choose a "standard" replacement option, which is considered normal maintenance of the property and would therefore not affect monthly rents. Alternatively, the owner may invest in a more energy efficient central heating appliance, and may therefore increase rents to cover higher upfront investment costs.[9]

The choice focuses explicitly on replacing the appliance that supplies heat to the dwelling through the heating system. The two options considered by the owner only differ by a standard energy efficiency label of the form mandated by the European Union, ranging from A^{++} (most efficient) to G (least efficient). To keep it simple, we attribute label A^{+} to the efficient appliance and label B to the standard appliance, which corresponds to an approximate 30% improvement in energy efficiency (Council of European Union, 2013).[10] The description of the choice makes clear that both appliances perform equally well, meet general requirements, and are expected to have the same operating life of 15 years. We also emphasize that the installation of the new appliance would necessarily take place in the year of the survey (to mitigate discounting issues), and that other elements of the heating system (such as radiators) would not be affected. As mentioned previously, this relatively narrow focus allows us to abstract from comfort considerations associated with energy efficiency improvements, so that WTP estimates exclusively relate to expected benefits associated with energy efficiency.[11]

As we focus on a single dimension of space heating (the efficiency of the appliance that supplies heat), standard MPL elicitation procedure is particularly well suited. Moreover, MPL choice tasks are easy to explain to respondents, and allow elicitation of robust and relatively

[9] The distribution of efficiency grades among tenants' own heating equipment might influence the choice of acceptable rent increase. However, the impact of subjects' initial endowment on choices is not the focus of this study (to the extent that there are no concerns with sampling, see section 3.3). Much rather, we direct our attention to the role of information in tenants' decision-making by exploiting between- and within-subjects comparisons.

[10] In order to focus exclusively on energy efficiency, we do not mention specific energy technologies. Nevertheless, the standard option with label B corresponds to conventional and comparatively cheap oil boilers, whereas the option labeled A^{+} corresponds to either a heat pump appliance or, alternatively, a "package" combining a standard oil boiler coupled with solar panels. Because the choice is framed as a replacement decision, one of the two options would be installed in any case.

[11] The specific text we use is as follows: "Aside from the specific characteristics of the appliances, please assume that they meet your general requirements, perform equally well, and are expected to have the same operating life of 15 years," and "When making your choices, please assume that the change of appliance will necessarily take place in 2017. The selected heating appliance would fully replace your current central heating appliance, but the rest of your heating system, such as the radiators, would not need to be changed." Note that our experimental design does not allow us to test whether we have been successful in disciplining households' expectations.

precise valuations (see Andersen et al., 2006; Anderson et al., 2007). In order to mitigate possible biases associated with the MPL elicitation format, and foster incentives for truthful preference revelation in a stated preference context, we take the following steps. First, in order to eliminate the risk of subjects feeling inclined to pick a response in the middle of the MPL task (framing effect), we present the choice tasks sequentially, i.e., one MPL choice task per screen. Subjects therefore do not know, a priori, the upper bound used in the experimental survey. Second, to prevent multiple switching sometimes observed in MPLs, the sequence of choices stops whenever the respondent selects the standard appliance.[12] Third, to make sure that respondents fully understand the MPL task, we provide them with an example before they start each sequence. However, we do not display a specific price tag to avoid anchoring effects.

The last set of steps is more directly geared towards the hypothetical nature of the choice task.[13] On the one hand, we use a number of scripts in line with the literature on truthful preference revelation (e.g. Vossler et al., 2012; Newell and Siikamäki, 2014). More specifically, previous work on the topic has shown that a crucial element involves perceived consequentiality of stated choices. We therefore inform subjects that their answers will be used exclusively by academic researchers to inform the formulation of energy policy in Switzerland, and explain that it is in their best interest to answer the questions truthfully.[14] On the other hand, following important insights from the stated preference literature (see Johnston et al., 2017), we use a number of budget constraint reminders.[15] The full text underlying MPL choices is reported in

[12] Multiple switching behavior leads to inconsistent valuations and thus complicates inference, while preventing it imposes structure (strict monotonicity and transitivity) on the subject's responses that is not always justified (Anderson et al., 2007). However, while multiple switching behavior can be at least partly explained by subject's indifference between options (and therefore by weakly rather than strictly convex preferences), enforcing a single switching point has been shown to have no systematic effect on results (Andersen et al., 2006).

[13] We note that MPL choice tasks have similarities with two widely used stated preferences formats, namely dichotomous choice and payment card contingent valuation, although with costs presented sequentially. It follows from the literature (e.g. see Johnston et al., 2017) that the first MPL choice is incentive compatible, whereas subsequent choices are not. Another important result from the stated preference literature is that iterative bidding can potentially lead respondents to anchor their response to their first choice (see Bateman et al., 2001). Because we start with a price of zero, our approach would therefore tend to underestimate tenants' WTP.

[14] The exact wording is: "The information that we collect will be used to inform Swiss energy policy, and it is therefore important that your answers reflect your specific situation and your personal tastes." There is no deception involved, as our results are indeed part of a government-funded project directly feeding into policies at both federal and cantonal levels.

[15] We include two different budget reminders: "Some of the following questions will involve costs to your own household; please give careful consideration to how these costs would affect your financial budget," and "In making your choices, please remember that any money spent on your heating will not be available for other expenses by your household. The only right answer is what you would really choose."

Figure 1: Baseline multiple price list choice task

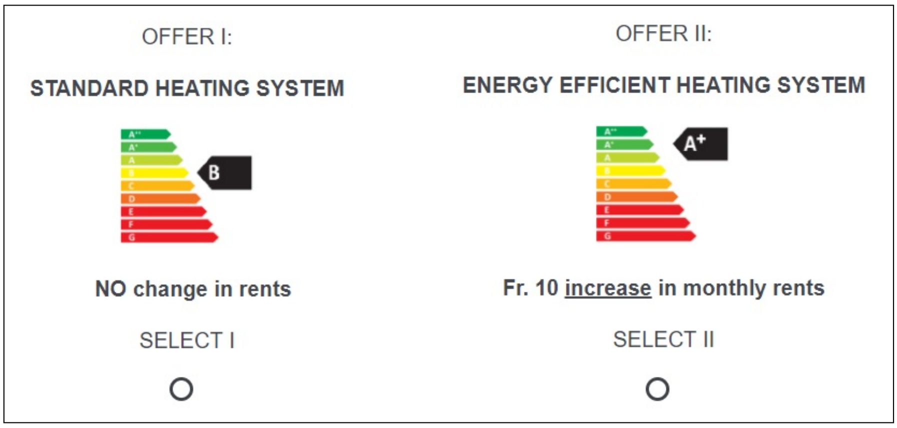


Table 1: Multiple price list payment ladder of rent increases

Choice task	Rent increase standard heating appliance	Rent increase energy efficient heating appliance
No. 1	0 CHF	0 CHF
No. 2	0 CHF	10 CHF
No. 3	0 CHF	20 CHF
No. 4	0 CHF	30 CHF
No. 5	0 CHF	40 CHF
No. 6	0 CHF	50 CHF
No. 7	0 CHF	75 CHF
No. 8	0 CHF	100 CHF
No. 9	0 CHF	150 CHF
No. 10	0 CHF	200 CHF

Appendix A, Figures A1 to A5.

Turning to the MPL choice task itself, shown in Figure 1, we ask subjects to consider a binary choice between a standard and an efficient appliance. At the beginning of the MPL task neither of the two alternatives is associated with a rent increase. Since both options have the same cost (zero) but one is more efficient, we would expect tenants to choose the efficient alternative. After that, the rent associated with the more efficient option increases gradually, with steps along the ladder shown in Table 1. Note that the price levels selected were piloted to ensure that they yield meaningful switch-points for respondents.

Table 2: Overview of informational treatment interventions

Treatment indicator	Treatment group name	1^{st} information screen	2^{nd} information screen	Endline choice task
T_{iA}	Control	Neutral I	Neutral II	Rent increase (baseline)
T_{iB}	Heating cost	Heating cost	Neutral I	Rent increase (baseline)
T_{iC}	Heating cost salient	Heating cost	Neutral I	Rent increase + Heating cost
T_{iD}	Heating cost variability	Heating cost	Heating cost variability	Rent increase + Heating cost
T_{iE}	CO_2 tax	Heating cost	CO_2 tax	Rent increase (baseline)
T_{iF}	CO_2 tax salient (A^+ lower tax)	Heating cost	CO_2 tax	Rent increase + Heating cost + CO_2 tax (A^+ lower tax)
T_{iG}	CO_2 tax salient (A^+ no tax)	Heating cost	CO_2 tax	Rent increase + Heating cost + CO_2 tax (A^+ no tax)

3.2 Informational interventions

The baseline MPL sequence ends either when respondents select the standard appliance or when they reach the maximum price level specified. Respondents are then randomly allocated to one of seven conditions, summarized in Table 2. Each condition consists of two consecutive information screens, all of which closely match each other in design, structure, complexity and length. Therefore, only the actual content of the screen should affect the MPL decision (see Figures A10 to A14).

Following Allcott and Taubinsky (2015) and Allcott and Knittel (2019), we take a number of steps to ensure that information is effectively conveyed to tenants. First, information is displayed both verbally and visually (in the form of a simple figure). Second, to incentivize attention, we announce upfront that each information screen will be followed by a one-question quiz (a simple question about the core information displayed on the screen). Respondents are required to answer the quiz question in order to move forward in the experimental survey (if they do not answer correctly, the correct answer is displayed). In our sample, 76% of respondents answered both quiz questions correctly on first attempt, and 89% gave at least one correct answer.

After being exposed to the two information screens and completing the quiz questions, subjects receive instructions for the second (endline) MPL task. As we discuss below, in some treatments the design of the MPL is modified to reinforce salience of the information provided. Thus, after being exposed to both information screens, respondents either repeat the same MPL task as in the baseline, or a slightly modified version of it. In the following subsections, we discuss our set of treatment conditions in more detail.

3.2.1 Control group ($\mathbf{T}_{iA}$)

Treatment group A represents the control intervention. It is designed to provide "placebo information" that should not affect the demand for efficient heating appliances, and thus tenants' acceptance of rent increases. Concretely, in this condition tenants are given information about the age of the Swiss building stock (information screen *Neutral I*, Figure A10) and the different energy sources used to heat buildings in Switzerland (information screen *Neutral II*, Figure A11). After the two information screens (and the associated quiz questions), respondents repeat the MPL choice task presented in the baseline.

3.2.2 Information about heating costs ($\mathbf{T}_{iB}$, $\mathbf{T}_{iC}$, $\mathbf{T}_{iD}$)

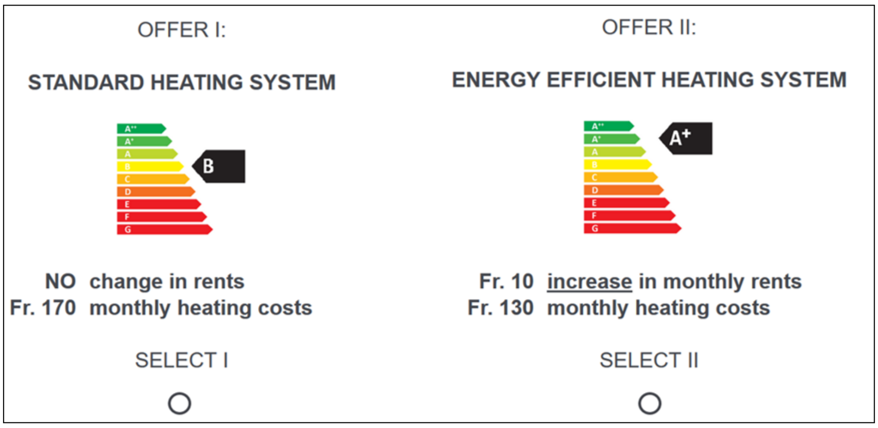
Treatments B and C both provide one information screen about average monthly heating costs associated with each option (information screen *Heating cost*, shown in Figure A12), and then the neutral information screen on the age of the Swiss building stock (information screen *Neutral I*, Figure A10). The information about heating costs aims at illustrating the importance of specific financial information for tenants' choices.[16] It is based on an average expenditure of CHF 170 per month (about USD 178) for a standard appliance and CHF 130 per month (about USD 136) for the energy efficient alternative. As a result, financial savings associated with the efficient alternative represent about 30%, which is consistent with the energy efficiency labels discussed.[17]

Treatments B and C differ in how the endline MPL task is designed. In particular, tenants in treatment B complete the MPL presented in the baseline, just as those in the control group. Thus endline WTP from treatment B allows us to measure the effect of our information screen

[16] Nonetheless, the empirical analysis relies on subjects perceiving the provided information as credible and trustworthy. Given the ambiguous findings in the literature regarding returns from energy efficiency investments (see e.g. Fowlie et al., 2018; Lang and Lanz, 2020), it is conceivable that some subjects doubt the magnitude of the provided ex-post savings. This would render our informational interventions ineffective in correcting imperfect information bias (the intervention would, however, still raise subjects' attention to the matter). As a result, we potentially underestimate the effect of (more credible) information on tenants' WTP.

[17] Naturally, energy bills are expected to vary across households and over time. The specific numbers we use mainly support our objective of quantifying how information on financial savings affects tenants' decisions. We come back to the issue of cost variability when we discuss treatment D below.

Figure 2: Endline multiple price list choice task with heating costs



about heating costs on tenants' WTP. Conditional on respondents not having been fully aware of financial savings associated with energy efficiency, we expect treatment B to increase endline WTP as compared to baseline WTP. We label this treatment "*Heating cost*."

By contrast, tenants in treatment C face an endline MPL task which explicitly includes the estimate of heating costs associated with each option. This modified MPL task is shown in Figure 2. Reminding tenants about heating costs *during* MPL choices increases salience of financial implications of energy efficiency, and should therefore reinforce the informational intervention. Treatment C, labeled "*Heating cost salient*," therefore provides further evidence about the importance of heating cost information for the acceptability of rent increases in exchange for energy efficiency improvements. This format is close to U.S. energy labels for water heating appliances discussed in Newell and Siikamäki (2014), and if salience matters endline WTP is expected to be higher in treatment C than in treatment B ($T_{iB} < T_{iC}$).

In treatment D, respondents first get to see the information screen *Heating cost*, and in the second screen we provide information about heating cost variability (information screen *Heating cost variability*, Figure A13). This second screen illustrates how heating costs may vary over time for reasons unrelated to technology choice, and we therefore label treatment D as "*Heating cost variability*." This sequence of information screens, while maintaining the cost advantage of the energy efficient option, provides historical evidence that heating cost savings are in fact uncertain. We explain this to subjects by means of past energy costs associated with an oil based heating appliance (a comparatively inexpensive heating source with visible price volatility).[18] After the second information screen, respondents complete a second MPL task in which energy cost differentials are also reported (Figure 2). Comparing treatments D and C provides evidence about the incremental effect of information on energy cost variability, and we expect that this treatment should generally decrease attractiveness of the more efficient option ($T_{iC} > T_{iD}$).

3.2.3 Information about carbon tax payments (T_{iE}, T_{iF}, T_{iG})

Treatments E, F and G all focus on environmental impacts of energy efficiency choices, which we achieve by providing information about the carbon tax levied on heating fuels in Switzerland.[19] Subjects in these treatments first face the information screen *Heating cost*, and the second screen provides information about the CO_2 tax in Switzerland and its implications on fossil-based heating costs (information screen *CO_2 tax* is shown in Figure A14). Note that in Switzerland, the tax is paid when heating oil is delivered, so that most tenants receive no details about CO_2 tax payments when they pay their heating bills.

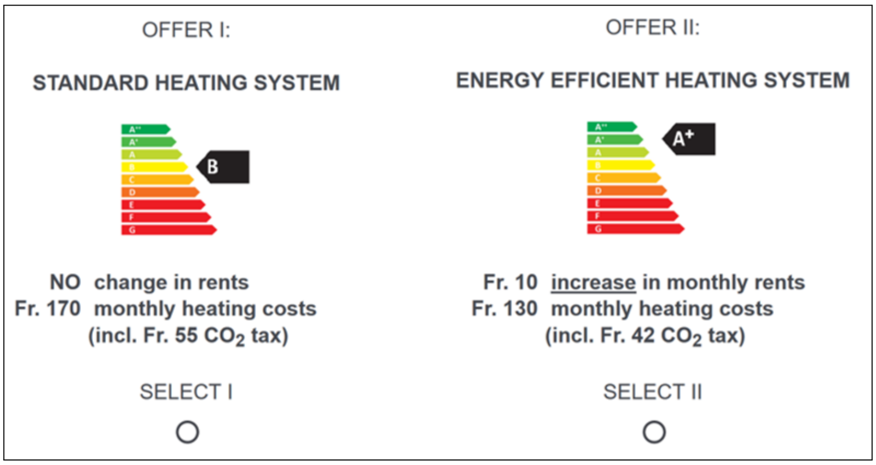
The difference between treatments E, F and G is again driven by whether and how the CO_2 tax information is included in the MPL task. In treatment E, we repeat the baseline MPL design reported in Figure 1, so that comparing treatments B and E provides evidence about whether the CO_2 information screen affects WTP. If environmental motives affect choices, one would expect WTP in treatment E to be higher than in treatment B ($T_{iE} > T_{iD}$). However, if respondents oppose government interventions in the form of taxes, they may react negatively to this information (Perino et al., 2014; Lanz et al., 2018).

In treatments F and G, respondents see the same information screens *Heating cost* and *CO_2 tax* and, in addition, the endline MPL task integrates financial information about both energy expenditures and CO_2 tax payments. In treatment F we consider a situation in which the more efficient option still uses oil (e.g. an oil boiler coupled with solar panels), so that CO_2 tax

[18] We frame the information as a risk that energy bills may not decline as much as expected, mainly because growing evidence suggests engineering projections tend to be overoptimistic (e.g. Fowlie et al., 2015).

[19] More precisely, the Swiss carbon tax is imposed on all fossil heating and process fuels (heating oil, natural gas, coal, petroleum coke, etc., see The Swiss Federal Council, 2012). At the time of the survey, the tax amounts to CHF 84 (about USD 87) per ton of CO_2, and carbon tax payments are indicated on fossil heating fuels invoices (in addition to the VAT amount). Importantly, the tax is set to increase over time, so that the cost associated with fossil-based central heating appliances can be expected to increase as well (The Swiss Federal Council, 2016).

Figure 3: Endline multiple price list choice task with heating costs and CO_2 tax (A^+ lower tax)



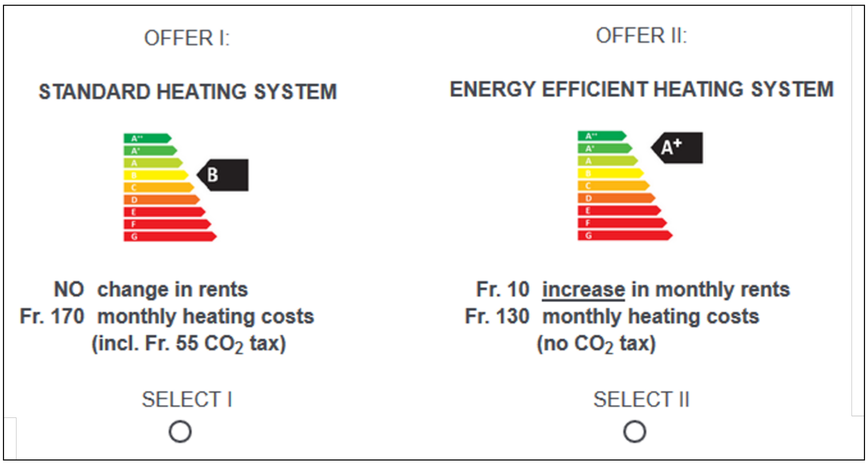
payments are positive for both options (they are of course proportionally lower for the efficient appliance). An example of the ensuing MPL task is shown in Figure 3. In treatment G, we instead consider an efficient option with no CO_2 tax payments, signaling that it implies no (direct) CO_2 emissions. This alternative corresponds, for example, to a heat pump appliance. The ensuing MPL task is displayed in Figure 4. Because the efficient option in treatment G is free of CO_2 emissions, WTP of respondents with pro-environmental motives is expected to be higher than in treatments F ($T_{iF} > T_{iG}$).

3.3 Implementation

Our survey experiment is fielded as an online survey scripted with Qualtrics and administered in April and May 2017 as part of a wider study on energy behavior in Switzerland (Weber et al., 2017). Survey participants are drawn from an online subject pool managed by the private marketing company Intervista, which holds over 90,000 self-subscribers. As per other projects managed by the company, participants are invited via email and they are compensated for their time with vouchers (the equivalent of CHF 6 for completion of the present survey).[20] Among a

[20] The e-mail invitation is neutral and reads as follows: "Dear Sir or Madam, we have the pleasure to invite you to participate in a new Intervista survey. With a click to the link below you can access the survey directly. If you are part of the target group and complete the survey integrally, you will receive 60 bonus points. Answering the survey will take about 30min of your time. We wish you a lot of fun answering this survey! Kind regards, your Intervista team." The response rate is approximately one third.

Figure 4: Endline multiple price list choice task with heating costs and CO_2 tax (A^+ no tax)



sample of 5,535 participants to the study, a subsample of 406 tenants is randomly selected and completes our survey.

Relying on a panel of self-subscribers implies that our sample is not random. However, in terms of observable characteristics of participating tenants (see Table B1 of Appendix B), our sample is in line with figures from the Federal Statistical Office on the Swiss population for gender (53% women in our sample compared to 50% in Switzerland, FSO 2017), high-education groups (47% of our sample completed tertiary education against 43% in the general population, FSO 2019a), average age (43 years in our sample compared to 42 years in Switzerland, FSO 2018b), income (CHF 6,000-8,999 compared to CHF 7,566 in Switzerland, FSO 2018c), and dwelling size (92m^2 compared to 99m^2 in Switzerland, FSO 2019b). The proportion of households living in multifamily houses and using oil as a heating fuel are also close to population figures (respectively 84% vs. 77%, FSO 2019b, and 37% vs. 39%, FSO 2019b).[21] In Table B2, Appendix B, we further summarize randomized treatment assignment across conditions. The average number of participant per condition is 58, and differences across subsamples are due to the fact that a small number of tenants dropped out of the experimental survey. Note that we find some small differences in baseline WTP across treatment groups, although Wald tests

[21] The second most prevalent heating source in our sample as well as in the general population is natural gas (with 19% vs. 21% respectively, FSO 2019b). Our sample also covers households heating with district heat (7%), electricity (7%), wood (6%), and heat pump (5%). 17% of tenants do not know the source.

indicate that the differences are statistically insignificant.[22]

4 Experimental results

This section reports the main results from the survey experiment. We first provide evidence on tenants' WTP for efficient heating appliances based on baseline MPL choices. Second, we exploit within- and between-subjects variations to identify the impact of information about energy costs and CO_2 tax payments on subjects' WTP. Third, we employ a set of quantile regressions to discuss the effect of information on the distribution of tenants' WTP.

4.1 Tenants' WTP estimates from baseline choices

Figure 5 shows the distribution of baseline WTP estimates for our sample of 406 tenants, as measured by the mid-point intervals reported in Table 1.[23] Average WTP associated with a central heating appliance of grade A^+ rather than B is $wtp_i^0 =$ CHF 37.51 per month. This corresponds to 3.07% of net median rents in Switzerland and 2.76% of net average rents.[24] Since in the baseline MPL task tenants have not received information about heating bills reductions and rely exclusively on labels (as they would in the marketplace), our estimate of wtp_i^0 includes both expectations about reductions in energy bills as well as other expected impacts (such as environmental benefits). We come back to this below.

Baseline MPL results also show that around 15% of respondents select the standard heating appliance in the first choice (i.e., no increase in rents). In other words, these tenants choose the inefficient appliance even though the more efficient option is provided at no additional cost. Another 12.8% of respondents switch from the more efficient option to the standard one in the second MPL question.[25] One interpretation is that these tenants value energy efficiency in principle, but refuse to pay (much) for it in the form of an increase in rents.[26] The remaining

[22] In particular, we fail to reject the hypothesis that T_{iA}=T_{iC}, the largest difference in baseline WTP across groups, with a p-value of 0.2.

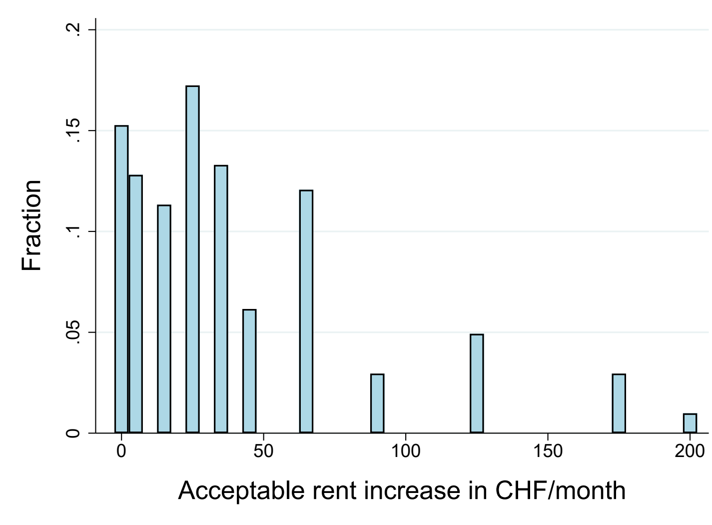
[23] To be conservative, WTP for the highest value on the list is set at its lower bound, which is CHF 200.

[24] In 2016, monthly median rent in Switzerland amounted to CHF 1322, while average rents were CHF 1220 (FSO, 2018a).

[25] By construction, these respondents are attributed a WTP of $wtp_i^0 =$ CHF 5 per month, or CHF 60 per year.

[26] An alternative interpretation is that tenants value energy efficiency but simply do not trust the accuracy of the official energy efficiency labels. See also footnote 16.

Figure 5: Distribution of baseline WTP (wtp_i^0)



72% of our sample accept an increase in rents for improved energy efficiency. Both median and mode WTP correspond to the fourth step in the MPL ladder, translating to a WTP of CHF 25 per month for the energy efficient option relative to the standard one.

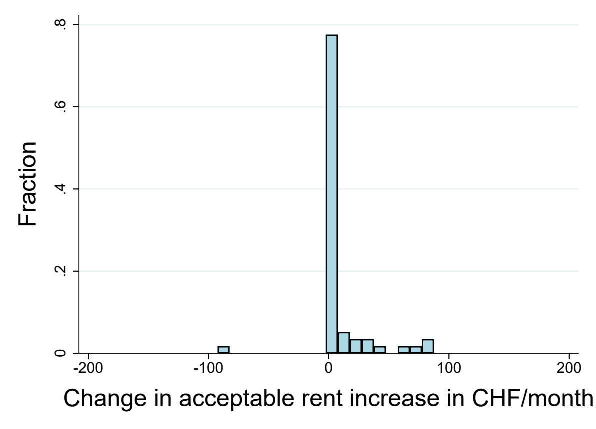
4.2 The impact of information on tenants' WTP

Table 3 tabulates average WTP estimates across baseline MPL choices (before treatment, wtp_i^0) and endline MPL choices (after treatment, wtp_i^1). For endline MPL choices, we break down average WTP across treatment conditions. This provides both within- and between-tenant information about the impact of information on WTP.

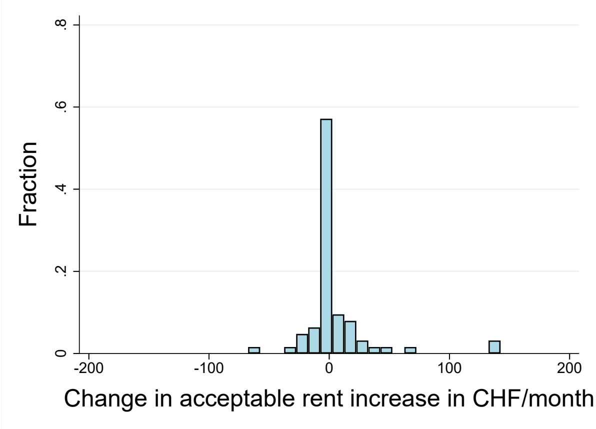
As average WTP from baseline MPL choices is discussed above, here we focus on endline choices for each treatment group. Starting with the control intervention (T_{iA}), as expected we find a very modest difference compared to average baseline WTP. Individual-level distribution of WTP changes (ΔWTP= $wtp_i^1 - wtp_i^0$), reported in Figure 6 panel (a), further shows that almost 80% of respondents switched at the same MPL payment level, while only a small number increased WTP (for one respondent, WTP declined from around CHF 90 per month to zero). This is an indication that the placebo information screens worked as intended, as they have very little effect on WTP for energy efficiency. We will get back to this below.

Turning to the set of informational interventions T_{iB} to T_{iG}, we find clear evidence that all

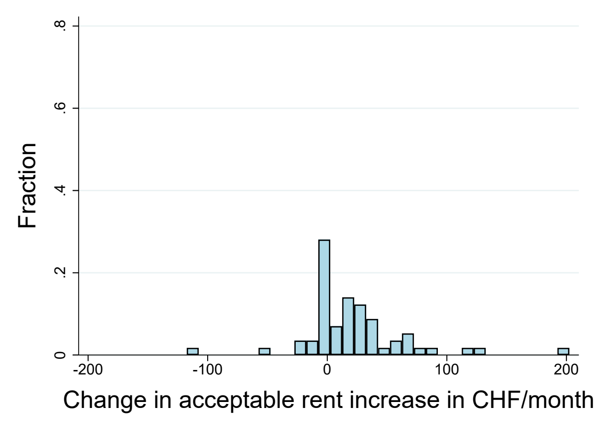
Figure 6: Distributions of the change in acceptable rent increases (ΔWTP= $wtp_i^1 - wtp_i^0$)



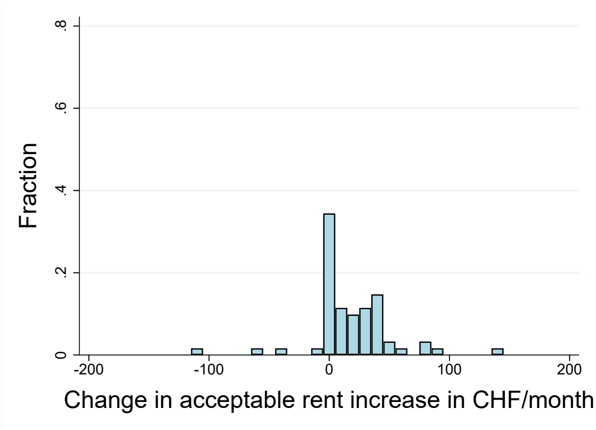
(a) Control (T_{iA})



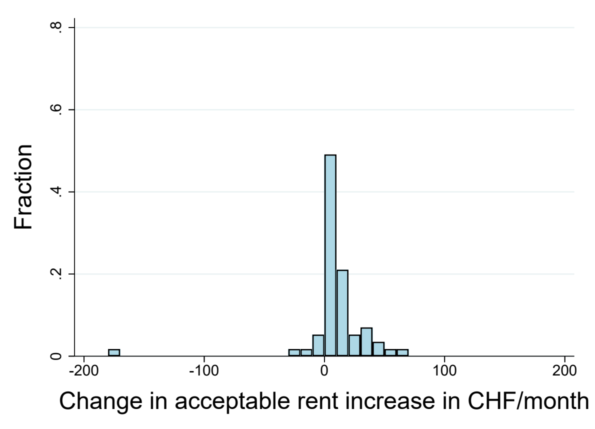
(b) Heating cost (T_{iB})



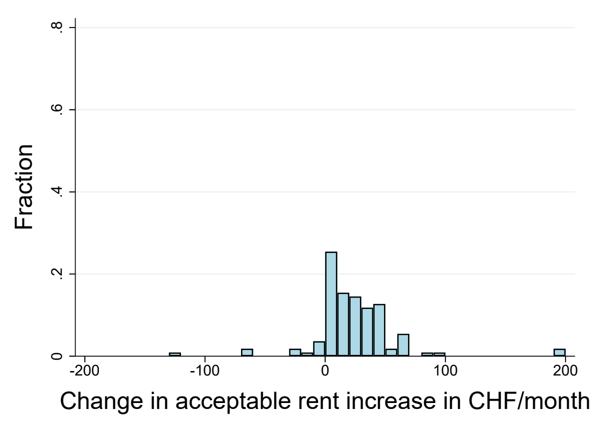
(c) Heating cost salient (T_{iC})



(d) Heating cost variability (T_{iD})



(e) CO_2 tax (T_{iE})



(f) CO_2 tax salient (T_{iF} and T_{iG})

Table 3: Descriptive results of WTP across baseline/endline choices and treatments

Treatment	N	Mean	Std.-dev.
Baseline choices (wtp_i^0)	406	37.51	42.29
Endline choices (wtp_i^1):			
Control (T_{iA})	58	38.71	43.55
Heating cost (T_{iB})	63	44.96	48.99
Heating cost salient (T_{iC})	57	64.87	51.74
Heating cost variability (T_{iD})	61	53.32	41.59
CO_2 tax (T_{iE})	57	43.95	38.72
CO_2 tax salient (T_{iF}, A^+ lower tax)	52	60.14	48.92
CO_2 tax salient (T_{iG}, A^+ no tax)	58	58.15	42.54

Notes: All WTP estimates are measured in in CHF per month (2017 exchange rate: CHF 1 = USD 1.04).

of them lead to an increase in the average valuation of energy efficiency. The largest increase is observed for treatments that provide information about financial implications of both options *and* also make the impact on energy bills salient in the endline MPL task (i.e. T_{iC}, T_{iD}, T_{iF} and T_{iG}). By contrast, in treatments that provide expected financial savings through an information screen but not in the endline MPL task (T_{iB} and T_{iE}), the change in average WTP is smaller. This is confirmed by looking at individual changes in WTP (Figure 6, panels b-f),[27] as we find that treatments T_{iB} and T_{iE} feature the largest proportion of respondents with no change in WTP.

Inference on these results is reported in Table 4. In column 1, we report OLS regression results for equation (1), which models baseline and endline individual WTP values (wtp_i^0 and wtp_i^1, respectively) as a function of treatment dummies and a constant term (the latter captures average baseline WTP). We therefore have two observations per respondent, and cluster standard-errors at the respondent level. Column 2 reports OLS results for the *change* in individual WTP, so that the dependent variable is $\Delta\text{WTP}_i = wtp_i^1 - wtp_i^0$. Finally, column 3 reports OLS

[27] Note that we find almost no difference between the distributions of treatment groups F and G, and therefore report observations for these two treatments together in panel (f) of Figure 6. For completeness, for group F endline WTP is CHF 60.14 on average, CHF 58.15 for group G, and the median for both groups is CHF 45.

Table 4: Average treatment effect of information on tenants' WTP

	(1) WTP (panel) wtp_i^s	(2) Δ WTP $wtp_i^1 - wtp_i^0$	(3) Endline WTP wtp_i^1
Control (T_{iA})	1.20	–	–
	(5.40)		
Heating cost (T_{iB})	7.45	-0.53	1.19
	(5.89)	(4.93)	(5.03)
Heating cost salient (T_{iC})	27.36***	15.34**	18.08***
	(6.62)	(6.54)	(6.28)
Heating cost variability (T_{iD})	15.81***	9.94*	11.12**
	(5.22)	(5.44)	(5.14)
CO_2 tax (T_{iE})	6.44	-1.63	0.11
	(4.98)	(5.09)	(4.65)
CO_2 tax salient (A^+ lower tax, T_{iF})	22.64***	14.09**	15.95***
	(6.47)	(6.21)	(5.85)
CO_2 tax salient (A^+ no tax, T_{iG})	20.64***	14.01**	15.38***
	(5.58)	(5.84)	(5.64)
Baseline WTP (wtp_i^0)	–	–	0.75***
			(0.06)
Constant	37.51***	7.16**	15.14***
	(2.11)	(3.23)	(3.41)
Observations	812	406	406
Adjusted R^2	0.04	0.03	0.50

Notes: Column (1) reports OLS estimates for a model with two observations per subject (baseline WTP wtp_i^0 and endline WTP wtp_i^1). Standard errors are clustered at the respondent-level and reported in parentheses. Column (2) reports OLS estimates for a model of $\Delta WTP_i = wtp_i^1 - wtp_i^0$. Column (3) reports OLS results for a model of endline WTP wtp_i^1. For models reported in columns (2) and (3), we report heteroskedasticity-robust standard errors in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

results for a model of endline WTP (wtp_i^1) as a function of treatment dummies, controlling for baseline WTP (wtp_i^0). Note that regressions in columns 2 and 3 only feature one observation per subject, and inference for these models is based on heteroskedasticity-robust standard errors.

Estimation results in column 1 confirm that salience of financial information significantly affect the valuation of energy efficiency. More specifically, treatments B and E that do not include financial information in the MPL task show comparatively small treatment effects. For these conditions, the difference in WTP between baseline and endline choices is around CHF 7 and not statistically significantly different from zero. By contrast, when energy costs are displayed in endline MPL tasks, information has a positive and highly statistically significant impact on WTP. Treatment C, which informs tenants about financial savings *and* introduces this information in the MPL task, shows an increase of WTP of about CHF 27 per month, a 73% increase compared to baseline WTP. This result parallels earlier findings on the role of financial information for choices reported by Newell and Siikamäki (2014) and Allcott and Taubinsky (2015). Moreover, because financial savings information provided to respondents is set to CHF 40 per month, whereas endline WTP in treatment C is higher at CHF 64.87 per month on average (CHF 780 per year, see also Table 3), financial considerations of energy efficiency only partly determine tenants' WTP.

Results for treatment D shows that information about energy cost variability dampens the impact of information on financial savings. Uncertainty about future energy savings thus reduces WTP.[28] We also find little evidence that additional information on CO_2 tax payments affects decisions by tenants, and in turn WTP. Specifically, T_{iB} and T_{iE} provide very similar average treatment effect estimates (both treatments do not include financial savings in the MPL task), and treatment effects for T_{iF} and T_{iG} are close in magnitude to T_{iC}.[29] Given our previous interpretation that tenants hold more than financial motives when choosing energy efficient appliances, insensitivity to CO_2 tax information may reflect a negative perception of environmental taxes, as already discussed in Perino et al. (2014) and Lanz et al. (2018).

Alternative models reported in columns 2 and 3 show similar results, with a few exceptions. First, OLS regression on ΔWTP (column 2) shows that within treatment changes in WTP are around CHF 15 for treatments C, F, and G. This number is lower as compared to column 1 because within-subject change in WTP for treatment group A (as represented by the constant in column 2) amounts to CHF 7.16. This is due to the fact that average baseline WTP differs slightly across treatment groups (see Table B2), and focusing on within-subject WTP estimation allows us to control for this discrepancy.[30] Second, OLS regression on endline WTP controlling for baseline WTP (column 3) shows that the coefficient for baseline WTP (wtp_i^0) is statistically significant, positive, and smaller than one as one would expect. This illustrates the fact that

[28] Interestingly, this information screen has the lowest rate of correct answers to the quiz question (63.93%, N=61), suggesting that this information is also more difficult to comprehend for respondents.

[29] Wald tests fail to reject equality of coefficients for T_{iB} and T_{iE} (p-value=0.84), and the same is true for the coefficients of T_{iC}, T_{iF} and T_{iG} (p-value=0.87 for $T_{iC}=T_{iF}$; p-value=0.99 for $T_{iF}=T_{iG}$; p-value=0.86 for $T_{iC}=T_{iG}$).

[30] Wald tests for column 2 again fail to reject equality for the coefficients of T_{iB} and T_{iE} (p-value=0.90), as well as for the coefficients of T_{iC}, T_{iF} and T_{iG} (p-value=0.62 for $T_{iC}=T_{iF}$; p-value=0.82 for $T_{iF}=T_{iG}$; p-value=0.45 for $T_{iC}=T_{iG}$).

baseline WTP plays a large though not the sole role in determining endline WTP. Coefficient estimates for treatments B and E again provide sharp evidence that simply providing tenants with information on heating cost savings and CO_2 tax payments prior to investment decisions has a limited impact on WTP, highlighting the importance of making information salient for decisions.

4.3 Heterogeneous treatment effects: Quantile regressions

In this section we study the treatment effect of information across all deciles of the WTP distribution (equation 2). In order to isolate the marginal impact of information on WTP, we code our treatment dummies according to their information content: (i) *Heating cost screen* equals one if the treatment includes the information screen *Heating cost* (i.e., all treatments except T_{iA}); (ii) *Cost MPL task* equals one if the endline MPL task includes heating costs (i.e. T_{iC}, T_{iD}, T_{iF}, and T_{iG}); (iii) *Cost variability screen* equals one if the treatment includes the information screen *Heating cost variability* (i.e. T_{iD}); (iv) *CO_2 tax screen* equals one if the treatment includes the CO_2 tax screen (i.e. T_{iE}, T_{iF}, and T_{iG}); and (v) *CO_2 tax MPL task* equals one if the endline MPL task includes CO_2 tax payments (i.e. T_{iF} and T_{iG}).[31] This allows us to decompose treatment effects into specific informational components, and thereby identify key drivers of WTP changes.

Estimation results are reported in Table 5. For comparison purposes, column 1 reports OLS estimates of average treatment effects for our dummy-coded specification. Columns 2-10 then report regression results for each decile of the WTP distribution. The dependent variable is individual WTP measured in baseline and endline MPL tasks (wtp_i^0, wtp_i^1, see Table 4, column 1), which allows us to exploit both within- and between-subject variations. Because we observe two outcomes for each tenant, we cluster standard errors at the subject level.

OLS results in column 1 confirm that the key element of our informational intervention is salience of heating cost differentials between efficient and standard appliances (*Cost MPL task*). Quantitatively, we find that this feature alone increases tenants' WTP by CHF 19.91 per month on average. This corresponds to a 53% increase compared to baseline estimates. Importantly, *Heating cost screen* also has a positive impact on WTP, although the average treatment effect is

[31] As mentioned in footnote 27, results for treatment groups F and G are very similar, and we therefore lump these together without affecting our results.

Table 5: Quantile treatment effect of information on tenants' WTP

	(1) WTP (panel) wtp_i^s	(2) WTP (panel) (10th quantile)	(3) WTP (panel) (20th quantile)	(4) WTP (panel) (30th quantile)	(5) WTP (panel) (40th quantile)	(6) WTP (panel) (50th quantile)	(7) WTP (panel) (60th quantile)	(8) WTP (panel) (70th quantile)	(9) WTP (panel) (80th quantile)	(10) WTP (panel) (90th quantile)
Control	1.20	0	0	0	-10^{***}	0	0	-10	0	37.50^{***}
	(5.34)	(3.02)	(4.19)	(6.60)	(2.98)	(2.61)	(3.14)	(7.96)	(15.91)	(11.86)
Heating cost screen	7.45	5	10	0	0	0	0	17.50^{**}	0	37.50^{**}
	(5.89)	(4.92)	(6.77)	(7.09)	(2.62)	(2.59)	(3.19)	(7.58)	(4.49)	(16.89)
Cost MPL task	19.91^{**}	0	10	30^{***}	20^{***}	20^{***}	27.50^{**}	0	62.50^{***}	0
	(9.19)	(7.90)	(28.37)	(8.84)	(4.74)	(4.66)	(10.91)	(10.79)	(6.15)	(16.38)
Cost variability screen	-11.55	0	0	-10	-10^{**}	0	0	0	-37.50^{***}	0
	(8.65)	(8.79)	(28.44)	(8.85)	(4.97)	(6.16)	(11.77)	(10.62)	(8.79)	(8.03)
CO_2 tax screen	-1.01	0	0	10	10^{**}	10^{**}	10^{*}	0	0	-37.50^{**}
	(8.00)	(7.08)	(11.38)	(19.04)	(4.58)	(4.52)	(5.28)	(7.59)	(6.48)	(18.94)
CO_2 tax MPL task	-4.77	10	0	-20	-10	-10	-10	0	-37.50^{***}	37.50^{*}
	(11.37)	(14.38)	(31.03)	(21.51)	(6.88)	(6.79)	(12.19)	(12.54)	(9.07)	(22.56)
Constant	37.51^{***}	0	5^{***}	15^{***}	25^{***}	25^{***}	35^{***}	45^{***}	62.50^{***}	87.50^{***}
	(2.11)	(1.12)	(1.44)	(4.18)	(1.27)	(1.25)	(1.30)	(6.66)	(2.45)	(10.44)
Observations	812	812	812	812	812	812	812	812	812	812
(Pseudo) R^2	0.04	0.01	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0.03

Notes: Dependent variable is baseline WTP wtp_i^0 and endline WTP wtp_i^1. Column 1 reports OLS estimates. Column 2-10 report regression results for each decile of the WTP distribution. Standard errors are clustered at the respondent-level and reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

smaller (around CHF 7) and not statistically significantly different from zero.

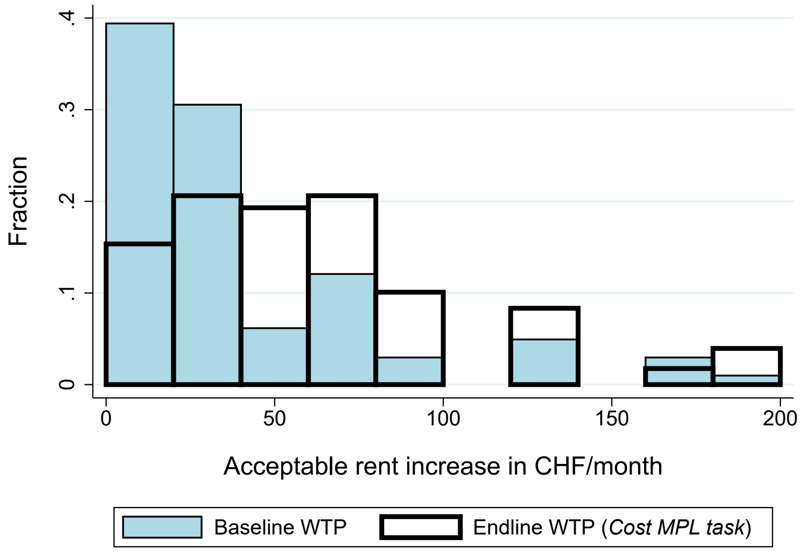
Quantile regression results for individual deciles reveal that the average treatment effect associated with salience of financial savings (*Cost MPL task*) is driven by heterogeneous effects along the entire WTP distribution. In particular, results reported in columns 2 and 3 show that treatment interventions are ineffective in shifting the lower tail of the WTP distribution. This part of the distribution does not respond to information. Moreover, we find statistically significant treatment effects in five out of nine decile regressions. The third, fourth and fifth decile (columns 4, 5 and 6) adjust WTP with reference to the provided information about financial cost savings. The treatment effect of financial information *declines* across these deciles, and implies that endline WTP for these respondents bunches around CHF 45. This is very close to expected financial cost savings highlighted in the experimental intervention (these respondents select the energy efficient option for a level of CHF 40, and the standard option at CHF 50). Finally, the upper tail increases WTP substantially.[32]

In a nutshell, salient information on financial savings leads to an upward shift in WTP of the middle and upper part of the distribution, without an accompanying shift of the lowest quantiles. These conclusions are further illustrated in Figure 7, which plots the distribution of baseline WTP and endline WTP for subjects exposed to treatment component *Cost MPL task*. The graph confirms that the treatment leads to a large majority of tenants adjusting their WTP in response to the CHF 40 information provided. It also shows that part of the distribution remains in place.

Taken together, our results suggest that financial information affects WTP for a large majority of our sample, and that the estimated average treatment effect is not driven by the tails of the distribution. Moreover, the treatment effect on median WTP is very close to the treatment effect on average WTP. However, providing information does not push the full distribution of tenants above the illustrative CHF 40 threshold, possibly on account of individual social and environmental motives. Finally, we note that the lack of average treatment effect for other

[32] Quantile coefficients provide information about effects on distributions, not individuals. In Appendix C, we document correlations between observable tenant characteristics and WTP, and also seek to identify heterogeneous treatment effects using a set of interaction terms. OLS regression results show that interaction terms have the expected signs, but are statistically insignificant except for the effect of having a university degree, which has a positive impact on baseline WTP but influences the treatment effect negatively. Nevertheless, these results suggest that heterogeneity in the impact of information is mostly driven by unobserved characteristics.

Figure 7: Distribution of tenants' WTP before and after treatment



interventions appears across deciles, with no clear-cut impact.

5 Discussion and conclusion

In this paper, we have applied a MPL procedure on a sample of 406 Swiss tenants in order to estimate their valuation of improved energy efficiency of their space heating system. We find that tenants' WTP for an efficiency upgrade from B to A^+ is statistically and economically significant, and that information about financial implications plays a crucial role in the acceptability of such measure. We also find that financial information has to be made salient, clearly associating it with the decision at hand, whereas providing information on CO_2 tax payments has virtually no impact on tenants' valuation of energy efficiency improvements.

From a policy perspective, our results have important implications. The fact that tenants are willing to support part of the additional investment cost imposed on property owners by paying higher rents could be leveraged to promote energy efficiency investments in rented properties. However, our work suggests that providing tenants with realistic and credible information about financial implications of energy efficiency investment is a necessary first step to make rent increase acceptable. In this sense, it is not sufficient to incentivize property owners to renovate. Rather, they should also be enabled to communicate with their tenants about the financial implications of renovations. Empirical research on the realizations of energy savings, which requires a credible counterfactual, is only burgeoning (see Fowlie et al., 2018; Burlig et al., 2017; Liang et al., 2018).

Finally, our results also confirm the more conventional view that informational interventions can substantially improve attitudes towards energy efficiency. Our results show that even in a country where the majority of tenants lives in multifamily housing without separate meters, salience of financial savings associated with energy efficiency is critical, and this has implications for the design of energy efficiency labels (see also Newell and Siikamäki, 2014). Moreover, we show that the average treatment effect of information reflects heterogeneous changes along the entire distribution. Identifying the specific drivers of the observed heterogeneity is left for further research.

Appendix A Experimental script *(for online publication)*

Figure A1: Introductory screen 1

tmpl_i1. In this part of the survey, we now focus on the use of energy to heat and produce warm water for your dwelling, also called central heating system. We will focus on the dwelling you currently rent and live in.

We want to understand your perceptions about alternative central heating choices. The information that we collect will be used to inform Swiss energy policy, and it is therefore important that your answers reflect your specific situation and your personal tastes.

In particular, some of the following questions will involve costs to your own household; please give careful consideration to how these costs would affect your financial budget.

Figure A2: Introductory screen 2

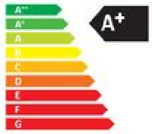
tmpl_i2. For the next set of questions, please imagine that your landlord plans to replace your building's current heating system. Note that this choice could influence your rent, and we will imagine different scenarios about such a choice and seek to understand which alternative would be best for your household.

We will consider a choice between two alternative replacement options, and these options are described by a standard label grading how efficient the appliance is at converting the energy in its fuel to heat. Energy efficiency is graded from G (very low) to A++ (very high), and the label for grade A looks like this:

Imagine that your landlord may choose a standard heating appliance, graded B, or alternatively a more energy efficient option, graded A+. Selecting the appliance graded B is considered standard maintenance, so as a tenant your rents would not change. However, if your landlord decides to install a more costly and highly energy efficient (A+) appliance, she/he may ask for an increase in rents to cover some of the additional costs.

Figure A3: Introductory screen 3

tmpl_i3. Here is an example of the choice we want you to consider. Each offer (I and II) describes an alternative central heating appliance that would fully replace your current one. Offer I has an energy efficiency label "B", and therefore this offer has no impact on the monthly rent you pay. Offer II is graded "A+", and this could mean that your rent would increase by a particular amount Fr. xx to cover the higher investment costs.

OFFER I:	OFFER II:
STANDARD HEATING SYSTEM	**ENERGY EFFICIENT HEATING SYSTEM**
	
NO change in rents	**Fr. xx increase in monthly rents**
SELECT I	SELECT II

Besides the different energy efficiency grades, these two appliances are exactly similar. They meet your general requirements, perform equally well, and are expected to have the same operating life of 15 years.

When making your choices, please assume that the change of appliance will necessarily take place in 2017. The selected heating appliance would fully replace your current central heating appliance, but the rest of your heating system, such as the radiators, would not be changed.

Figure A4: Instructions for baseline MPL choice task

tmpl_bc_i. You will now be asked to make a number of decisions such as the example displayed before. All decisions have the same format. In making your choices, please remember that any money spent on your dwelling will not be available for other expenses by your household.

There is no right or wrong answer. It is important that your choices reflect your preferred situation, as this research will contribute to inform energy policy in Switzerland.

Figure A5: First baseline MPL choice task

tmpl_bc1. Please make your choice below.

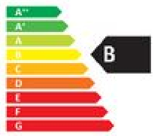
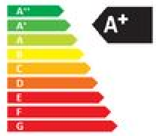
OFFER I:	OFFER II:
STANDARD HEATING SYSTEM	**ENERGY EFFICIENT HEATING SYSTEM**
	
NO change in rents	**NO change in rents**
SELECT I	SELECT II
○	○

Figure A6: Instructions for information screens (T_{iA})

tmpl_ta1. For the next part of the study, you will have the opportunity to learn more about Swiss residential buildings and energy. We will show you information about:

- The construction year of residential buildings
- Heating technologies and energy sources

The discussion of each issue will be followed by a one-question quiz. Please pay close attention to the discussion so that you can correctly answer the quiz question.

Figure A7: Instructions for information screens (T_{iB} and T_{iC})

tmpl_tb1. For the next part of the study, you will have the opportunity to learn more about Swiss residential buildings and energy. We will show you information about:

- Energy efficiency and heating costs
- The construction year of residential buildings

The discussion of each issue will be followed by a one-question quiz. Please pay close attention to the discussion so that you can correctly answer the quiz question.

Figure A8: Instructions for information screens (T_{iD})

tmpl_td1. For the next part of the study, you will have the opportunity to learn more about Swiss residential buildings and energy. We will show you information about:

- Energy efficiency and heating costs
- How heating costs can vary from year to year

The discussion of each issue will be followed by a one-question quiz. Please pay close attention to the discussion so that you can correctly answer the quiz question.

Figure A9: Instructions for information screens (T_{iE}, T_{iF} and T_{iG})

tmpl_tg1. For the next part of the study, you will have the opportunity to learn more about Swiss residential buildings and energy. We will show you information about:

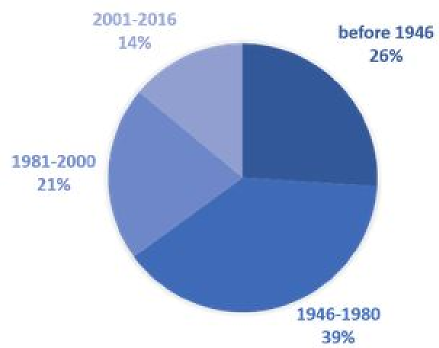
- Energy efficiency and heating costs
- The CO_2 tax on heating oil and natural gas

The discussion of each issue will be followed by a one-question quiz. Please pay close attention to the discussion so that you can correctly answer the quiz question.

Figure A10: Information screen - Neutral I (T_{iA}, T_{iB} and T_{iC})

tmpl_ta2. Compared to other countries, Switzerland has a relatively old building stock. According to official estimates, two thirds of the dwellings in Switzerland were built before 1980 (65%), and 14% of today's apartments were built within the last 15 years.

AGE OF DWELLINGS IN SWITZERLAND BY CONSTRUCTION PERIOD



Switzerland's settlement and urban areas have grown rapidly in recent years. The reasons for this are fast population growth and increased demands for housing, leisure and mobility. The transformation of the built environment is a reflection of social change.

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tmpl_ta3. How many % of Swiss apartments were built between 2001 and 2016?

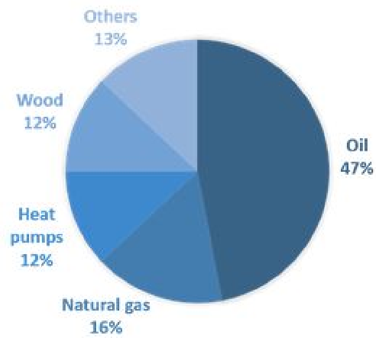
To answer this question, you can only enter integers between 0 and 100. Type your answer below:

[   ] %

Figure A11: Information screen - Neutral II (T_{iA})

tmpl_ta4. Swiss households use a variety of different heating technologies and energy sources to enjoy temperate dwellings and warm water. Official records show that heating oil is the most prevalent source of energy to produce residential heat (47%), followed by natural gas (16%).

HEATING SYSTEMS AND ENERGY SOURCES IN SWISS RESIDENTIAL BUILDINGS



Compared to 2009, there has been a 5% decline in the use of oil-based heating, and a 4% increase in the number of heat pumps installed.

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tmpl_ta5. How many % of Swiss residential buildings are heated with natural gas today?

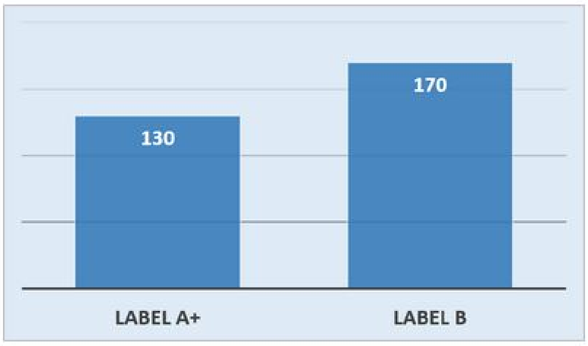
To answer this question, you can only enter integers between 0 and 100. Type your answer below:

[ ] %

Figure A12: Information screen - Heating costs (T_{iB}-T_{iG})

tmpl_te2. Choosing an energy efficient heating appliance can lower your household's heating costs significantly: keeping everything else equal, switching from an appliance graded B to one graded A+ would decrease energy use by 25 percent on average. This implies that heating costs for a household who pays Fr. 170 per month with an appliance graded B could decline to Fr. 130 per month with an A+ appliance.

HEATING COST IN SWISS FRANCS PER MONTH



Therefore, while more energy efficient appliances are typically more expensive to purchase(the investment cost), over a 15-year lifetime the additional cost may be more than compensated by lower heating costs.

---

tmpl_te3. Typically, if heating expenditures with an appliance graded A+ amount to Fr. 130 per month, how much would heating cost be with an appliance graded B?

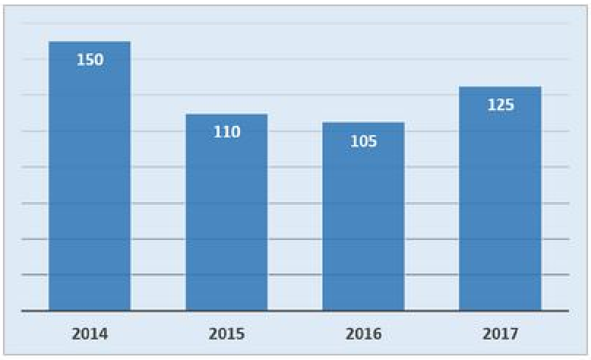
To answer this question, you can only enter integers. Type your answer below:

[ ] Fr.

Figure A13: Information screen - Heating cost variability (T_{iD})

tmpl_td4. Heating costs depend in great part on the cost of fuel. Yearly energy costs for a boiler operated with heating oil, for instance, vary from year to year with the price of oil: while average monthly heating costs were at Fr. 150 per household in 2014, they only amounted to Fr. 105 per household in 2016.

HEATING COST IN SWISS FRANCS PER MONTH



Therefore, because of varying energy prices, heating costs of households who select an energy efficient heating system may not necessarily decline as much as expected.

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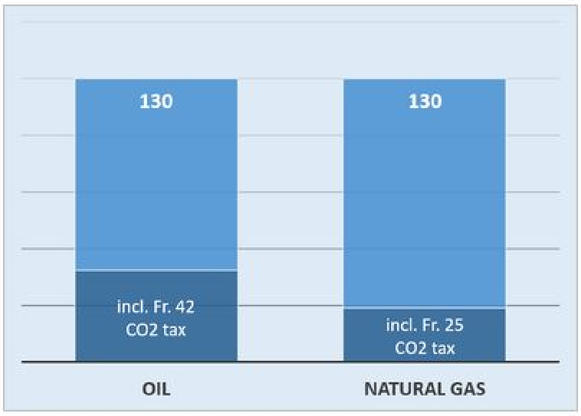
tmpl_td5. Does the purchase of energy efficient heating appliances always result in lower heating costs?

- Yes
- No

Figure A14: Information screen - CO_2 tax (T_{iE}, T_{iF} and T_{iG})

tmpl_te4. Switzerland participates in international efforts to reduce the risk of climate change, and the government has enacted laws that require a reduction in CO_2 emissions by 20 percent from 1990 to 2020. Fossil fuels are important contributors to CO_2 emissions and, since 2008, in Switzerland heating oil and natural gas are taxed in proportion to the CO_2 emitted when they are used in heating systems.

HEATING COST IN SWISS FRANCS PER MONTH



This CO_2 tax has increased from Fr. 12 per ton of CO_2 emitted in 2008 to Fr. 84 per ton of CO_2 in 2016. At the current rate, this corresponds to a tax on heating oil of around Fr. 42 for a monthly heating bill of Fr. 130, while the tax on natural gas amounts to Fr. 25 for a monthly heating bill of Fr. 130. For other fuels, including wood and electricity, the CO_2 tax is nil.

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tmpl_te5. If your heating system is operating on heating oil and your monthly heating bill amounts to CHF 130, how high is the associated CO_2 tax payment?

To answer this question, you can only enter integers. Type your answer below:

[ ] Fr.

Figure A15: Introductory screen 4 - Endline MPL

tmpl_ta_ec_i1. Now please consider again the possibility that the current primary heating appliance of your dwelling needs replacement. Imagine once again that your landlord may choose a standard heating appliance, graded B, or alternatively a more energy efficient option, graded A+.

Figure A16: Instructions for endline MPL with rent increase (i.e. T_{iA}, T_{iB} and T_{iE})

tmpl_tb_ec_i2. You will now be asked to make further choices between pairs of offers. Here is an example of the choice we want you to consider:

OFFER I:	OFFER II:
STANDARD HEATING SYSTEM	**ENERGY EFFICIENT HEATING SYSTEM**
	
NO change in rents	**Fr. xx <u>increase</u> in monthly rents**
SELECT I	SELECT II

Besides the the attributes described, these two appliances are again exactly similar and the change of appliance will again take place in 2017. All decisions have the same format.

Please consider your choices carefully, and remember that expenses for your dwelling will not be available for other things. It is important that your choices reflect your preferred situation, as this research will contribute to inform energy policy in Switzerland. The only right answer is what you would choose in reality.

Figure A17: Instructions for endline MPL with heating costs (T_{iC} and T_{iD})

tmpl_tc_ec_i2. You will now be asked to make further choices between pairs of offers. In addition, for each offer we now report approximate total heating and warm water cost for an average Swiss household:

OFFER I:

STANDARD HEATING SYSTEM

NO change in rents

Fr. 170 monthly heating costs

SELECT I

OFFER II:

ENERGY EFFICIENT HEATING SYSTEM

Fr. xx increase in monthly rents

Fr. 130 monthly heating costs

SELECT II

Besides the the attributes described, these two appliances are again exactly similar and the change of appliance will again take place in 2017. All decisions have the same format.

Please consider your choices carefully, and remember that expenses for your dwelling will not be available for other things. It is important that your choices reflect your preferred situation, as this research will contribute to inform energy policy in Switzerland. The only right answer is what you would choose in reality.

Figure A18: Instructions for endline MPL with heating costs and CO_2 tax, A^+ lower tax (T_{iF})

tmpl_tf_ec_i2. You will now be asked to make further choices between pairs of offers. In addition, for each offer we now report approximate total heating and warm water cost, as well as the associated CO_2 tax for an average Swiss household:

OFFER I:	OFFER II:
STANDARD HEATING SYSTEM	**ENERGY EFFICIENT HEATING SYSTEM**
	
NO change in rents	**Fr. xx increase in monthly rents**
Fr. 170 monthly heating costs	**Fr. 130 monthly heating costs**
(incl. Fr. 55 CO_2 tax)	**(incl. Fr. 42 CO_2 tax)**
SELECT I	SELECT II

Besides the the attributes described, these two appliances are again exactly similar and the change of appliance will again take place in 2017. All decisions have the same format.

Please consider your choices carefully, and remember that expenses for your dwelling will not be available for other things. It is important that your choices reflect your preferred situation, as this research will contribute to inform energy policy in Switzerland. The only right answer is what you would choose in reality.

Figure A19: Instructions for endline MPL with heating cost and CO_2 tax, A^+ no tax (T_{iG})

tmpl_tg_ec_i2. You will now be asked to make further choices between pairs of offers. In addition, for each offer we now report approximate total heating and warm water cost, as well as the associated CO_2 tax for an average Swiss household:

OFFER I:

STANDARD HEATING SYSTEM

NO change in rents

Fr. 170 monthly heating costs

(incl. Fr. 55 CO_2 tax)

SELECT I

OFFER II:

ENERGY EFFICIENT HEATING SYSTEM

Fr. xx increase in monthly rents

Fr. 130 monthly heating costs

(no CO_2 tax)

SELECT II

Besides the the attributes described, these two appliances are again exactly similar and the change of appliance will again take place in 2017. All decisions have the same format.

Please consider your choices carefully, and remember that expenses for your dwelling will not be available for other things. It is important that your choices reflect your preferred situation, as this research will contribute to inform energy policy in Switzerland. The only right answer is what you would choose in reality.

Figure A20: First endline MPL choice task - Heating cost (T_{iC} and T_{iD})

tmpl_tc_ec1. Please make your choice below.

OFFER I:

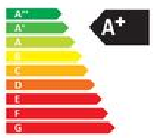
STANDARD HEATING SYSTEM

NO change in rents
Fr. 170 monthly heating costs

SELECT I

OFFER II:

ENERGY EFFICIENT HEATING SYSTEM



NO change in rents
Fr. 130 monthly heating costs

SELECT II

Figure A21: First endline MPL choice task - Heating cost and CO_2 tax (A^+ lower tax, T_{iF})

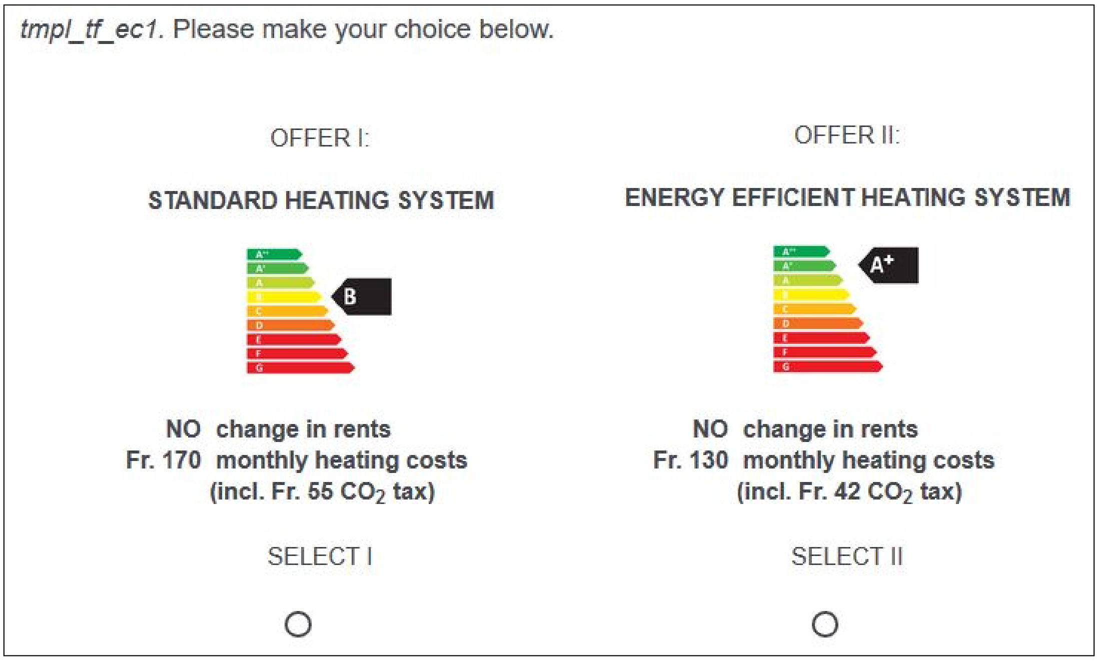
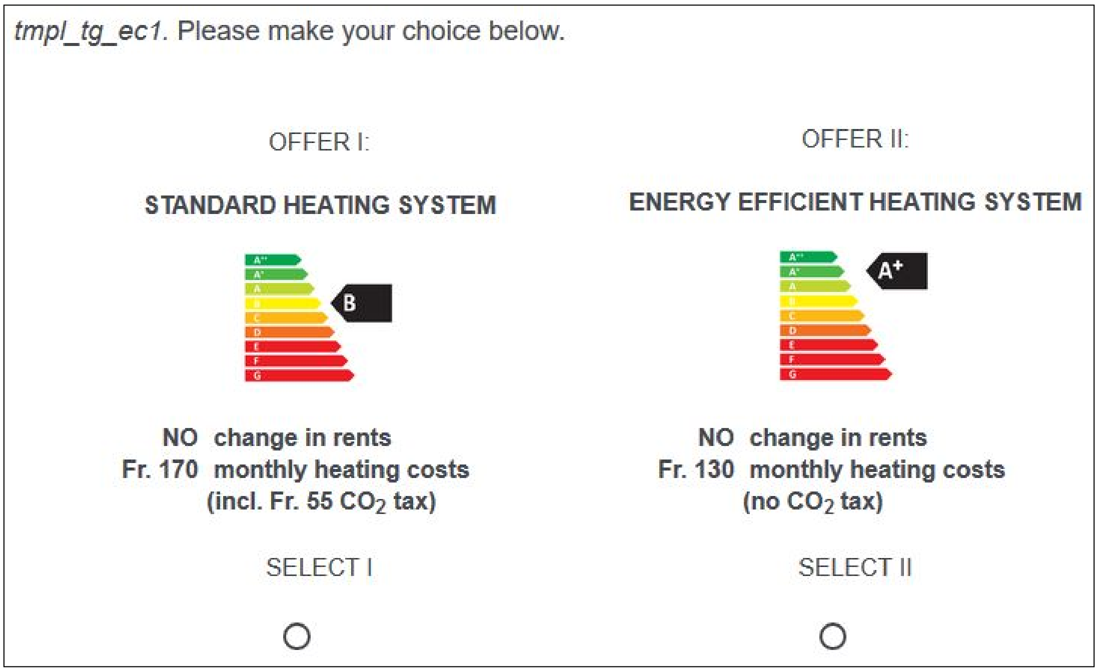


Figure A22: First endline MPL choice task - Heating cost and CO_2 tax (A^+ no tax, T_{iG})



Appendix B Sample Composition *(for online publication)*

Table B1: Summary statistics for the sample of tenants

	N	Mean	Std.-dev.	Min	Max
Female indicator	406	0.53	0.50	0	1
Age (in years)	406	43.38	15.01	20	85
University indicator	406	0.47	0.50	0	1
Household income[a]	340	3.74	1.41	1	6
Dwelling size (in m^2)	406	92.00	45.16	2	500
Multifamily house indicator	406	0.84	0.37	0	1
Oil heating indicator	406	0.37	0.48	0	1
Individual meter for heating	406	0.40	0.49	0	1
Annual heating costs (in CHF)[b]	124	1174.62	888.69	20	4692

Notes: [a]Monthly gross household income is coded as: 1 – CHF 3,000 or less; 2 – CHF 3,000-4,459; 3 – CHF 4,500-5,999; 4 – CHF 6,000-8,999; 5 – CHF 9,000-12,000; 6 – CHF 12,000 or more. [b]Annual household expenditures for heating, as per the latest energy bill available.

Table B2: Treatment randomization and observable characteristics

Treatment condition	A	B	C	D	E	F	G
Baseline WTP (wtp_i^0)[a]	31.55	38.33	42.37	36.23	38.42	38.89	36.98
Female indicator	0.50	0.41	0.51	0.51	0.60	0.65	0.55
Age (in years)	43.76	42.79	43.42	44.57	44.39	43.62	41.14
University indicator	0.48	0.56	0.51	0.44	0.49	0.42	0.38
Household income[b]	3.48	3.63	3.92	4.08	3.85	3.70	3.50
Dwelling size (in m^2)	81.71	89.90	88.79	96.54	96.91	96.19	94.36
Multifamily house indicator	0.90	0.83	0.91	0.77	0.88	0.87	0.74
Oil heating indicator	0.34	0.38	0.33	0.44	0.33	0.44	0.33
Individual meter for heating	0.38	0.38	0.37	0.39	0.42	0.37	0.48
Observations	58	63	57	61	57	52	58

Notes: [a]Acceptable rent increases as measured in the stated choice MPL *before* treatment, in CHF per month. [b]Monthly gross household income is coded as: 1 – CHF 3,000 or less; 2 – CHF 3,000-4,459; 3 – CHF 4,500-5,999; 4 – CHF 6,000-8,999; 5 – CHF 9,000-12,000; 6 – CHF 12,000 or more.

Appendix C Additional regression results *(for online publication)*

Table C1: Regressions with control variables and interaction terms

	(1) Endline WTP wtp_i^1	(2) Endline WTP (Control set a)	(3) Endline WTP (Control set b)	(4) Endline WTP (Interactions)
Heating cost screen	1.19	1.35	1.04	2.11
	(5.02)	(5.00)	(5.02)	(5.18)
Cost MPL task	16.89**	15.61**	15.53**	33.86**
	(6.66)	(6.62)	(6.72)	(13.69)
Cost variability screen	-6.96	-5.84	-5.65	-5.68
	(6.76)	(6.61)	(6.74)	(6.85)
CO_2 tax screen	-1.08	-1.79	-1.36	-3.59
	(5.25)	(5.23)	(5.24)	(5.36)
CO_2 tax MPL task	-1.35	-1.27	-0.95	0.39
	(8.19)	(8.17)	(8.30)	(8.52)
Baseline WTP (wtp_i^0)	0.75***	0.75***	0.75***	0.72***
	(0.06)	(0.05)	(0.05)	(0.06)
Female indicator	–	6.59**	6.93**	4.71
		(3.27)	(3.27)	(3.96)
Age (in years)[a]	–	-0.19	-0.19	0.04
		(0.12)	(0.12)	(0.15)
University indicator	–	4.69	4.25	10.53**
		(3.15)	(3.10)	(4.26)
High income indicator[b]	–	–	-0.06	13.89**
			(0.05)	(6.65)
Dwelling size (in m^2)[a]	–	–	–	0.05
				(0.04)
Multifamily house indicator	–	–	–	1.13
				(5.07)
Cost MPL task X Female indicator	–	–	–	2.90
				(6.30)
Cost MPL task X Age (in years)[a]	–	–	–	-0.32
				(0.22)
Cost MPL task X University indicator	–	–	–	-11.13*
				(6.30)
Cost MPL task X High income indicator[b]	–	–	–	-8.18
				(9.17)
Cost MPL task X Dwelling size (in m^2)[a]	–	–	–	-0.09
				(0.06)
Cost MPL task X Multifamily house indicator	–	–	–	-5.67
				(9.36)
Constant	15.14***	11.93***	12.90***	1.41
	(3.41)	(4.38)	(4.23)	(6.34)
Observations	406	403	403	403
Adjusted R^2	0.50	0.51	0.51	0.52

Notes: [a]Normalized to mean zero for ease of interpretation. [b]Monthly gross household income of CHF 9,000 or more (above sample median). Robust standard errors are reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% respectively.

References

Achtnicht, M. and R. Madlener (2014) "Factors influencing German house owners' preferences on energy retrofits," *Energy Policy*, 68, pp. 254–263.

Allcott, H. and M. Greenstone (2012) "Is there an energy efficiency gap?" *The Journal of Economic Perspectives*, 26, 1, pp. 3–28.

Allcott, H. and C. Knittel (2019) "Are consumers poorly informed about fuel economy? Evidence from two experiments," *American Economic Journal: Economic Policy*, 11, 1, pp. 1–37.

Allcott, H. and D. Taubinsky (2015) "Evaluating behaviorally motivated policy: Experimental evidence from the lightbulb market," *The American Economic Review*, 105, 8, pp. 2501–2538.

Allcott, H. and N. Wozny (2014) "Gasoline prices, fuel economy, and the energy paradox," *Review of Economics and Statistics*, 95 (5), pp. 779–795.

Andersen, S., G. W. Harrison, M. I. Lau, and E. E. Rutström (2006) "Elicitation using multiple price list formats," *Experimental Economics*, 9, 4, pp. 383–405.

Anderson, S., G. W. Harrison, M. I. Lau, and E. E. Rutstrom (2007) "Valuation using multiple price list formats," *Applied Economics*, 39, 6, pp. 675–682.

Banfi, S., M. Farsi, M. Filippini, and M. Jakob (2008) "Willingness to pay for energy-saving measures in residential buildings," *Energy economics*, 30, 2, pp. 503–516.

Bateman, I. J., I. H. Langford, A. P. Jones, and G. N. Kerr (2001) "Bound and path effects in double and triple bounded dichotomous choice contingent valuation," *Resource and Energy Economics*, 23, 3, pp. 191 – 213.

Bird, S. and D. Hernandez (2012) "Policy options for the split incentive: Increasing energy efficiency for low-income renters," *Energy Policy*, 48, pp. 506–514.

Blasch, J., M. Filippini, and N. Kumar (2017) "Boundedly rational consumers, energy and investment literacy, and the display of information on household appliances," *Resource and Energy Economics*, in press.

Brent, D. and M. Ward (2018) "Energy efficiency and financial literacy," *Journal of Environmental Economics and Management*, 90, pp. 181 – 216.

Burlig, F., C. Knittel, D. Rapson, M. Reguant, and C. Wolfram (2017) "Machine learning from schools about energy efficiency." NBER Working Paper No. 23908.

Cameron, T. (1988) "A new paradigm for valuing non-market goods using referendum data: Maximum likelihood estimation by censored logistic regression," *Journal of Environmental Economics and Management*, 15, pp. 355 – 379.

Carroll, J., C. Aravena, and E. Denny (2016) "Low energy efficiency in rental properties: Asymmetric information or low willingness-to-pay?" *Energy Policy*, 96, pp. 617–629.

Charlier, D. (2015) "Energy efficiency investments in the context of split incentives among french households," *Energy Policy*, 87(C), pp. 465–479.

Council of European Union (2013) "Commission delegated regulation (EU) no 811/2013." Brussels, Belgium.

Davis, L. (2012) "Evaluating the slow adoption of energy efficient investments: Are renters less likely to have energy efficient appliances?" in D. Fullerton and C. Wolfram eds. *The Design and Implementation of U.S. Climate Policy*: University of Chicago Press, USA.

Eurostat (2017) "Europe in figures: Housing statistics." Luxembourg, Luxembourg.

Fowlie, M., M. Greenstone, and C. Wolfram (2015) "Are the non-monetary costs of energy efficiency investments large? understanding low take-up of a free energy efficiency program," *American Economic Review*, 105, 5, pp. 201–04.

——— (2018) "Do energy efficiency investments deliver? evidence from the weatherization assistance program," *The Quarterly Journal of Economics*, 133, 3, pp. 1597–1644.

FSO (2017) "Die bevoelkerung der schweiz 2017." Swiss Federal Statistical Office (FSO), Neuchâtel, Switzerland.

——— (2018a) "Construction and housing dataset." Swiss Federal Statistical Office (FSO), Neuchâtel, Switzerland.

——— (2018b) "Durchschnittsalter der staendigen wohnbevoelkerung nach staatsangehoerigkeitskategorie, geschlecht und kanton, 2010-2017." Swiss Federal Statistical Office (FSO), Neuchâtel, Switzerland.

——— (2018c) "Haushaltseinkommen und -ausgaben saemtlicher haushalte nach jahr." Bern, Switzerland.

——— (2019a) "Bildungsstand der bevoelkerung - daten des indikators." Swiss Federal Statistical Office (FSO), Neuchâtel, Switzerland.

——— (2019b) "Construction and housing." Swiss Federal Statistical Office (FSO), Neuchâtel, Switzerland.

Gerarden, T. D., R. G. Newell, and R. N. Stavins (2017) "Assessing the energy-efficiency gap," *Journal of Economic Literature*, 55, 4, pp. 1486–1525.

Gillingham, K., M. Harding, and D. Rapson (2012) "Split incentives in residential energy consumption," *The Energy Journal*, 33 (2), pp. 37–62.

Gillingham, K. and K. Palmer (2014) "Bridging the energy efficiency gap: Policy insights from economic theory and empirical evidence," *Review of Environmental Economics and Policy*, 8, 1, pp. 18–38.

Glumac, B., S. Reuvekamp, Q. Han, and W. Schaefer (2013) "Tenant participation in sustainable renovation projects: Using AHP and case studies," *Journal of Energy Technologies and Policy*, 3, 11, p. 16.

Hoppe, T. (2012) "Adoption of innovative energy systems in social housing: Lessons from eight large-scale renovation projects in The Netherlands," *Energy policy*, 51, pp. 791–801.

Houde, S. and J. E. Aldy (2017) "The efficiency consequences of heterogeneous behavioral responses to energy fiscal policies." NBER Working Paper No. 17282.

IEA (2011) "Technology roadmap energy-efficient buildings: Heating and cooling equipment." International Energy Agency (IEA), Paris, France.

IPCC (2014) "Climate change 2014: Mitigation of climate change." Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jacobsen, G. D. (2015) "Do energy prices influence investment in energy efficiency? evidence from energy star appliances," *Journal of Environmental Economics and Management*, 74, pp. 94–106.

Jakob, M. (2007) "The drivers of and barriers to energy efficiency in renovation decisions of single-family home-owners." Center for Energy Policy and Economics, CEPE Working Paper No. 56.

Johnston, R. J., K. J. Boyle, W. Adamowicz, J. Bennett, R. Brouwer, T. A. Cameron, W. M. Hanemann, N. Hanley, M. Ryan, R. Scarpa, R. Tourangeau, and C. A. Vossler (2017) "Contemporary guidance for stated preference studies," *Journal of the Association of Environmental and Resource Economists*, 4, 2, pp. 319–405.

Lang, G. and B. Lanz (2020) "Climate policy without a price signal: Evidence on the implicit carbon price of energy efficiency in buildings." IRENE Working paper 20-03.

Lanz, B., J.-D. Wurlod, L. Panzone, and T. Swanson (2018) "The behavioral effect of pigovian regulation: Evidence from a field experiment," *Journal of Environmental Economics and Management*, 87, pp. 190–205.

Li, S., J. Linn, and E. Muehlegger (2014) "Gasoline taxes and consumer behavior," *American Economic Journal: Economic Policy*, 6, 4, pp. 302–42.

Liang, J., Y. Qui, T. James, B. Ruddell, M. Dalrymple, S. Earl, and A. Castelazo (2018) "Do energy retrofits work? evidence from commercial and residential buildings in Phoenix," *Journal of Environmental Economics and Management*, 92, pp. 726–743.

Melvin, J. (2018) "The split incentives energy efficiency problem: Evidence of underinvestment by landlords," *Energy Policy*, 115, pp. 342–352.

Myers, E. (2020) "Asymmetric information in residential rental markets: Implications for the energy efficiency gap," *Journal of Public Economics*, 190, p. 104251.

NDRC (2017) "13th five-year plan for economic and social developmentof the Peoples Republic of China (2016-2020)." National Development and Reform Commission (NDRC), Beijing, China.

Newell, R. G. and J. Siikamäki (2014) "Nudging energy efficiency behavior: The role of information labels," *Journal of the Association of Environmental and Resource Economists*, 1, 4, pp. 555–598.

Perino, G., L. Panzone, and T. Swanson (2014) "Motivation crowding in real consumption decisions: Who is messing with my groceries?" *Economic Inquiry*, 57(2), pp. 592–560.

Phillips, Y. (2012) "Landlords versus tenants: Information asymmetry and mismatched preferences for home energy efficiency," *Energy Policy*, 45, pp. 112–121.

Rapson, D. (2014) "Durable goods and long-run electricity demand: Evidence from air conditioner purchase behavior," *Journal of Environmental Economics and Management*, 68 (1), pp. 141 – 160.

Seiders, D., G. Ahluwalia, S. Melman, R. Quint, A. Chaluvadi, M. Liang, A. Silverberg, and C. Bechler (2007) "Study of life expectancy of home components." National Association of Home Builders and Bank of America Home Equity.

The Swiss Federal Council (2012) "Ordinance on the reduction of CO2 emissions (CO2 ordinance)." Bern, Switzerland.

——— (2016) "Imposition of the CO2 levy on heating and process fuels." Bern, Switzerland.

U.S. Census Bureau (2016) "Tenure Universe: Occupied housing units - 2016 American Community Survey 1-Year Estimates." Suitland, MD, USA.

U.S. Department of Energy (2015) "2016-2020 strategic plan and implementing framework." Office of Energy Efficiency and Renewable Energy, Washington, D. C., USA.

Vossler, C., M. Doyon, and D. Rondeau (2012) "Truth in consequentiality: Theory and field evidence on discrete choice experiments," *American Economic Journals: Microeconomics*, 4(4), pp. 145–171.

Weber, S., P. Burger, M. Farsi, A. L. Martinez-Cruz, M. Puntiroli, I. Schubert, B. Volland et al. (2017) "Swiss household energy demand survey (SHEDS): Objectives, design, and implementation." IRENE Working paper 17-14.

Yang, Z. and J. Chen (2014) *Housing affordability and housing policy in urban China*: Springer Science & Business Media, The Netherlands.

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