Energy Efficiency Investments in the Building Sector:
The Impact of Information on the Discount Rate

The Case of Swiss Home Owners

By

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Extended Summary

Investments in energy efficiency are important determinants to reduce the demand for energy in the building sector, to meet climate and environmental targets, and to lower dependence on fossil fuels. For these reasons, energy efficiency investments are targeted by numerous government incentive programs. Many of these incentives apply to homeowners. Nonetheless, rates of energy efficiency renovations are still quite low although many of these renovations are economically interesting.

According to economic theory, homeowners will undertake energy efficiency investments in the home if their benefits are greater than their costs. However, it seems that the cost-value ratio of energy efficiency investments in the building envelope is not perceived as being positive by many homeowners and rates of energy efficiency renovations are still quite low in Switzerland: a large energy-saving potential, which has not been completely exploited yet, has been identified in the building sector of Switzerland (BFE 2003; BFE 2011). Jakob and Madlener (2004) found out that energy-efficiency retrofitting has a high potential for energy savings, especially an improved insulation of walls, floor, roof, (façade) and windows. Renovation is a key factor towards energy-efficient buildings (Jakob 2007).

Much research has been concerned with the so-called “energy efficiency paradox”, whereby individuals pass up opportunities to purchase highly efficient, but somewhat more expensive, equipment or energy efficiency investments that result in energy savings in the future. This reluctance to invest in energy efficiency is similarly observed in many apparently cost-effective technologies. This paradox is commonly referred to as the ‘energy-efficiency gap’ (Jaffe & Stavins 1994; Brown 2001; Thompson 2002) and is in general used to describe the difference in the observed and the optimal use of energy. The energy efficiency gap can be interpreted as a potential for energy savings that can be realized through investments in the most effective technologies that are currently available commercially and are cost-effective under prevailing energy prices.

Possible explanations for such underinvestments in energy efficiency include information gaps, transaction costs, and uncertainty about energy prices. Adverse incentives for owners and renters and other institutional barriers, and limited access to credit are other reasons (Clinch & Healy 2000). Substantial investments may be required to retrofit the existing housing stock. An explanation for this behavior might also be found in high discount rates for money and impatience (see Golove & Eto 1996, for a review) for the return on investment. The discount rate reflects the rate at which people are willing to exchange present and future economic benefits (Howarth 2004).

Empirical evidence is published in a number of studies using a variety of methodologies (Sanstad et al. 2006; Train 1985; Ruderman et al. 1984; Hausman 1979): Train (1985) reports
estimated discount rates implicit in homeowners’ energy efficiency retrofit decisions or appliance purchases and between 2 and 37%, varying with the type of investment or appliance. Ruderman et al. (1984) even pointed to the existence of implicit discount rates ranging from 17% up to 243% for refrigerators, heating and cooling systems, building shell improvements, and a variety of other technologies. Hausman (1979) estimated an average personal discount rate of 25%. Sadler (2003) found a mean discount rate of 20.8% for energy efficiency renovations in a stated preference study. These figures, however, rely on different studies with different methodologies employed.

We ask three questions in this paper: What is the discount rate implicit in the respondents’ choices for energy efficiency retrofit scenarios; how does this discount rate compare with the discount rate exhibited in a “money now vs. money later” trade-off by the same individuals in the same survey; what is the impact of information on the discount rate.

To answer these questions we conducted a survey about energy efficiency retrofits of building envelopes by Swiss homeowners. 473 homeowners of five cantons in German-speaking Switzerland (AG, BE, BL, TG, and ZH) responded to the online questionnaire in May 2010.

The survey gathers data on the characteristics of the buildings, the motivation for energy efficiency renovations and characteristics of the owners. It includes two stated preference experiments to gather the necessary data needed to calculate discount rates. In the main part of the questionnaire, we conducted a choice experiment on energy efficiency decisions. Second, we additionally included a more general so-called “money vs. money” trade-off question to get supplementary information on intertemporal preferences of the respondents. The main focus of the questionnaire lies on the choice experiment, the “money now - money later” question is seen as an additional exercise to get supplementary information on intertemporal preferences of the respondents in the sample. The two stated preference approaches are different and the discount rates exhibited in both experiments are not necessarily comparable.

In the choice experiment, respondents were asked to choose the alternative they prefer the most from three hypothetical home renovation scenarios. Specifically, the respondents were asked to choose between two alternatives of energy efficient retrofits of the building envelope or to perform neither of the two alternatives. Each respondent was shown a total of 6 pairs of hypothetical renovation alternatives. Alternative A and B in each pair represent an energy efficiency renovation project which is characterized by five attributes, namely 1) the upfront cost of the investment, 2) the subsidy paid by the government, 3) the savings in energy costs, 4) whether thermal comfort in the home would be improved as a result of the investment, and 5) the time horizon over which such savings would be realized (i.e., the lifetime of the investment). For each of the six pairs, the respondent was to indicate which alternative he preferred between alternative A, alternative B, and neither one (the status quo). The setup is particularly suited to calculate the discount rate implicit in the people’s
choices because it provides data on choices, investments and savings under varying time horizons. The estimation of the discount rate is achieved through the formulation of the utility function used to econometrically analyze the choice experiment. The choice experiment is characterized by:

- Trade-offs between hypothetical energy efficiency retrofitting alternatives;
- Large time horizons;
- A broad range of upfront costs, ranging from medium to rather large investment sums;
- Ample information and clearly defined scenarios (investment costs, subsidies, and savings are presented in monetary units).

As predicted by economic theory, the results of the econometric model used to analyze the choice experiment show that homeowners are responsive to the upfront costs of the energy efficiency renovation projects and that they do pay attention to the savings in energy expenses, the time horizon over which such savings would be realized, and the thermal comfort improvement afforded by such renovations.

Within the same survey, we asked people to imagine that they just won in a lottery. The respondent is given two options to receive the price: either he could choose to accept 10’000 CHF now or accept annual payments over T years. An implicit discount rate making the annual payment equivalent to the present value of 10’000 CHF is used to calculate the annual payments. The discount rate \( \delta \) and the years T are varied across people and assigned randomly to the respondents. Using a latent regression approach, the experiment allows to infer the mean discount rate of the survey population within the specific framework of this supplementary experiment. The “money now – money later” trade-off question differs from the choice experiment in the following manner:

- It is presented as a lottery;
- It comprises short to long time horizons;
- It fixes the present value to 10’000 CHF, which is at the lower end of the upfront costs presented in the choice experiment,
- The situation is characterized by little information. How reliable is it that the payments will be affected as promised?

In the choice experiment, we were able to estimate the rate at which people discount the future savings in energy bills. This rate of 2.9% is astonishingly low. This is a surprising result, since reluctance to undertake energy efficiency renovations in the home (or other buildings) is often interpreted as implying high discount rates. This figure falls on the lower end of the range (2-37%) of the discount rates in Train’s 1985 review of the literature on energy
efficiency. It is also much lower than the discount rate exhibited in the accompanying analysis of the “money now - money later” trade-offs, where the discount rate is 19.8%.

We conjecture that there might be two possible reasons for the finding of the 2.9% discount rate in the choice experiment. First, all attributes of the alternatives in the choice experiment were expressed in CHF, rather than in physical units (e.g., “number of windows replaced” and “liters of oil saved per year” or “kWh reduced per year”), and earlier studies where the attributes were cast in relatively abstract terms do likewise report lower estimated discount rates (Train 1985). Second, the lifetime of the investment, and hence the period over which the savings in the energy bills would be realized, was long: It ranged from 20 to 40 years, depending on the variant of the conjoint choice questions, and this precludes us from observing higher discount rates, which are typical for short investment horizons if discounting is hyperbolic.

It is important to note that the discount rate implicit in the respondent’s decisions in the conjoint choice question specifically apply to the conditions of the choice experiment. In general, the choice experiment was characterized by little uncertainty and ample information. Particularly with regard to information, the energy efficiency renovation scenarios presented in the choice experiment were clearly defined. Respondents were provided information on the exact upfront costs of the energy efficiency renovation, and also the savings on the energy bill that would be realized over a certain time horizon.

The results indicate that it seems conceivable that respondents do have lower discount rates when provided with extensive information. Since one explanation for underinvestments in energy efficiency are high discount rates, it is desirable to improve the level of information of homeowners. Potential policy measures to achieve this purpose include: provision of information about the technologies and the energy savings they realize, financial incentives that lower the up-front cost of the investments, and regulations such as mandatory energy efficiency standards.

In future research, it would be interesting to test whether wider time horizons and/or attributes described in a physical manner, rather than in monetary units, would confirm or refute the low discount rates we found in the present study.

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