Free riding and rebates for residential energy efficiency upgrades: A multi-country contingent valuation experiment

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Overview

Subsidies to incentivize the adoption of energy efficient technologies are commonly used by governments and energy companies to reach energy savings or greenhouse gas emission goals (de la Rue du Can et al. 2011, 2014; Galleraga et al. 2013, 2016). The design and evaluation of such subsidy programs are generally complicated by self-selection, rebound effects, moral hazard (consumers deferring adoption to wait for a financial incentive program), and free riding (Hartman 1988; Gillingham et al. 2006; Alberini et al. 2014). Failure to account for these issues results in an overestimation of policy effectiveness (e.g. Joskow and Marron 1992). The overall objective of this paper is to do an ex ante assessment of the effects of free riding on the cost effectiveness of a rebate program incentivizing the premature adoption of energy-efficient heating systems. It uses contingent valuation choice experiments carried out through identical representative surveys in eight EU Members States. The analysis distinguishes between strong and weak free riders: strong free riders plan to adopt a new heating system in the next five years anyway; weak free riders decide to purchase once made aware of an attractive technology package (and therefore would not need a rebate to adopt).

Method

Our empirical analysis relies on contingent valuation choice experiments carried out through representative surveys of 15.000 households in eight EU Members States (France, Germany, Italy, Poland, Romania, Spain, Sweden, United Kingdom). Together, these eight countries account for about 80% of EU population, energy use, and greenhouse gas emissions. Experimental and econometric setups were adapted from Alberini and Bigano (2015). The structure of the choice experiment questions is shown in Figure 1.

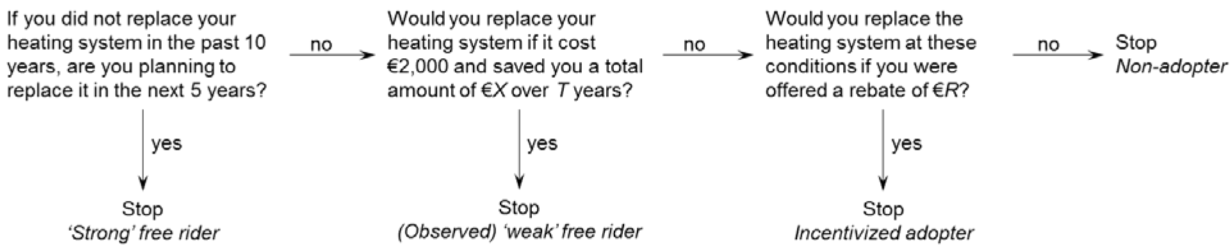

Figure 1 – Choice experiment question structure

We use an adapted double-bounded willingness-to-pay approach (Cameron and James 1986; Hanemann *et al.* 1991) to estimate the probability of adoption as a function of the rebate offered. We construct CO_2 abatement cost curves based on free rider shares, which are compared across countries.

Results

First, we estimate the mean and median reservation rebate level. Pooling data from all countries, the mean and median reservation rebate is 1064 euro. For the individual country models, which only use country-specific observations, we find the lowest mean and median reservation rebates for Romania and Poland, and the highest for France, Germany, and Sweden. In the *all countries* model and in most individual models, the mean and median reservation rebate corresponds to slightly more than half the heating system's purchasing price of 2000 euro, suggesting generally high opportunity costs for premature heating system replacement.
Second, we estimate the dependence of the reservation rebate on the technology package (total savings and savings period) and household characteristics (socio-demographic and attitudinal variables). As expected, the reservation rebate is higher when the *savings* offered are higher. On average, each additional euro of energy cost lifetime *savings* lowers the reservation rebate by about 0.14 euros. *Duration* exhibits the expected positive sign, but is not statistically significant at conventional levels. Regarding the household characteristics, we find significant positive (negative) correlations of the reservation rebate (predicted weak free ridership) with income and environmental

identity. Interestingly, and typically not considered in the extant literature, our results also suggest that risk and time preferences affect the reservation rebate. More risk-averse and less patient respondents require higher rebates and are thus less likely to be weak free riders.

Third, we perform simulations to gain insights into the role of weak and strong riders on cost effectiveness of the rebate and into differences across countries. For these simulations, we use the results of the interval data model. We find that raising a rebate by a given amount would lead to particularly large increases in the share of incentivized adopters in Italy, Romania, Poland, or the UK, and to relatively small increases in France, Germany, Spain, or Sweden. The increase in adoption probability varies between 3.4 percentage points in Sweden and 9 percentage points in Romania per €200 increase of the rebate (i.e. 10% of the proposed purchase price). Average weak free rider share is around 20 percent of the subsample, lowest for Sweden (11.70%), the UK (17.09%) and Germany (19.33%), and highest for Romania (28.30%), Poland (26.61%) and Italy (26.30%). The absolute number of weak and strong free riders does not vary with the rebate and the free rider share decreases as the rebate increases. However, even at a rebate of 1000 euro—which corresponds to half the purchase price of the heating system—the share of free riders remains around 50 percent in most countries, and is even higher in Italy and Romania. For a rebate of 1000 euro, the specific rebate costs (rebate expenditure per ton of CO_2 abated) for most countries are just above 500 €/tCO_2. At a rebate of 1000 euro (in most countries) at least half of the subpopulation would replace its heating system. Due to a high share of strong free riders, the specific rebate costs are particularly high for Romania (even though the mean reservation rebate was low). In comparison, for some countries (e.g. Sweden) that exhibit relatively high levels of the mean rebate, the specific rebate costs may be rather low if the shares for weak and strong free riders in these countries are low. Differneces in CO_2 abatement cost curves across countries suggests that cooperation among countries to achieve a given aggregate CO_2 emission level would yield sizeable efficiency gains. Depending on the aggregate target, it would only be efficient to implement the rebate program in the UK, Sweden, and Poland.

Conclusions

Relying on contingent valuation choice experiments in eight EU Members States, we ex ante assess the effects of free riding on the cost effectiveness of a rebate program that incentivizes the adoption of energy-efficient heating systems in these countries. Conceptually and empirically, we distinguish between what we name strong and weak free riders: strong free riders plan to adopt a new heating system in the next five years anyway; weak free riders decide to purchase once made aware of an attractive technology package (and therefore would not need a rebate to adopt).

We find substantial differences across countries in the median reservation rebate, weak free ridership, and the sensititivity of adoption to the rebate level. Rebates for heating system upgrades appear to be an effective means for governments or energy companies to reach energy and emission targets but rather costly, because of high shares of free riders. At a rebate level that corresponds to half the purchase price of the offered heating system, the share of free riders was estimated at 50 percent for most countries, with the share of weak free riders typically higher than that of strong free riders. Specific abatement costs differ considerably across countries, suggesting efficiency gains from cooperation, but they only appear justifiable for high social costs of carbon. Interestingly, and typically not considered in the extant literature, our results also suggest that risk and time preferences affect the reservation rebate.

Our findings on weak free ridership attest to the role of attention-getting efforts in increasing program participation. While a combination of policies may increase adoption compared to a single policy, the cost effectiveness of a non-discriminatory subsidy policy suffers from a parallel instrument's effectiveness.

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