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Household Refundable Utility by taking out refundable insurance: Empirical study in the Spanish auto insurance market

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ABSTRACT

This study investigates the expected benefits for Spanish households if they choose to purchase a refundable insurance policy that covers the deductible in the event of vehicle accidents. Using data obtained from the Spanish Survey of Household Finances alongside market data, this paper provides valuable empirical insights concerning the impact of refundable insurance policies on the overall expected utility of households (referred to as Household Refundable Utility) both from a technical-actuarial and a microeconomic point of view.

1. Introduction

In Spain, as reported in ICEA (2023), the total number of auto insurance policies covering compulsory civil liability was 24,095,486 in 2022, of which 10,035,500 policies extended coverage to own damage. Of these policies, 6,846,588 policies included an absolute per-claim deductible.[1] Notably, the auto insurance sector has recorded a premium volume exceeding 11.3 billion euros, representing a 28% market share, underlying its importance to the economy. Besides the macroeconomic implications, auto insurance contracts also contribute to improving household welfare, as measured through utility functions (Borch et al., 2014).

This paper defines and quantifies the increase in the expected utility of Spanish households derived from holding insurance policies that cover the deductible portions of claims. This is the first empirical study that endeavours to measure the impact of these policies, commonly known as refundable insurance (Claramunt and Marmol, 2021), on Spanish household welfare. Firstly, we gather data on households owning one or more vehicles from the Spanish Survey of Household Finances, specifically focusing on their wealth and level of risk aversion. Secondly, by employing the theoretical framework of collective models of risk theory and utility theory, we calculate the utility differential for each household with refundable insurance. Finally, we analyse the relationship between household refundable utility and the risk aversion.

2. Data and decision models in insurance

2.1. Data source

This study draws upon data from two sources: (1) the Spanish Survey of Household Finances 2020 (de España, 2022), known as EFF, a government-sanctioned survey that provides comprehensive economic and social data on Spanish households randomly selected from the various economic strata. From this dataset, we extract information concerning the number of vehicles, the disposable income and the levels of risk aversion of each household; and (2) the ICEA report (ICEA, 2023) that provides data offering insights into crucial aspects of the automobile insurance market.

2.2. Actuarial and decision model

Following the actuarial collective risk model theory (Kass et al., 2002), the aggregate claim amount random variable (r.v.) for a given portfolio of auto insurance over a year is defined as a random sum, $\sum_{i=1}^{N} X_i$, where $X_i, i = 1, \ldots, N$ is a non-negative r.v. representing the cost of the ith claim, N is a positive counting r.v. that represents the number of claims with expectation λ. X_i are independent and

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[1] These data are for first class vehicles including passenger cars and vans.

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identically distributed (i.i.d.) with common expectation μ and also independent from N.

When a per-claim absolute deductible is applied, the insured covers the initial a monetary units of each claim, and the insurer pays the excess over a, denoted as $X - a$ (Denuit and Charpentier, 2004). Let $A = min\{a, X\}$ represent the portion of the claim assumed by the insured.

A household with n vehicles covered by per-claim absolute deductibles in the own damage coverage should choose whether or not to take out a refundable deductible insurance. Following (Schoemaker, 1982), we presume that all such households are rational decision-makers. Consequently, we compare the expected utility of not taking out a refundable deductible with the utility of taking it out, allowing the corresponding Household Refundable Utility (HRU) to be calculated as:

$$HRU = U(W - n\Pi_D - n\Pi_R) - E\left[U\left(W - n\Pi_D - S\right)\right], \tag{1}$$

where $U(x)$ represent the utility function, W the initial wealth, Π_D the premium paid for a deductible insurance, Π_R the refundable deductible insurance premium and $S = \sum_{j=1}^{n}\sum_{i=1}^{N_j} A_{ij}$ the cost assumed by the household in the deductible insurance, being N_j the number of claims of jth vehicle and A_{ij} the portion of the ith claim of the jth vehicle assumed by the household. The literature on insurance decision-making based on the expected utility approach considers the question of how to measure initial wealth; an essential consideration particularly in empirical investigations that must be adapted to the specific decision under study. In this paper, initial wealth is defined as the year's disposable income plus liquid assets minus expenditure (food, non-durable goods and vehicle expenses). This metric is consistent with the decision whether or not to take out refundable own-damage insurance (Mossin, 1992). We assume that both insurers employ the mean criterion (Goovaerts et al., 1984) to calculate premiums with the same security surcharge δ. Thus, $\Pi_D = \lambda E(X - A)(1 + \delta)$ and $\Pi_R = \lambda E(A)(1 + \delta)$. If the insured opts for both a deductible insurance and a refundable deductible insurance, they pay both premiums, and the entire cost of claims is covered by the insurers. Alternatively, if the household does not have refundable deductible insurance, they pay the deductible premium and a portion of each claim. We apply the Constant Relative Risk Aversion (CRRA) utility function, $U(x) = x^{1-\alpha}$ (Holt and Laury, 2002), where α is the risk aversion coefficient, then

$$HRU = (W - n\Pi_D - n\Pi_R)^{1-\alpha} - E\left[\left(W - n\Pi_D - S\right)^{1-\alpha}\right]. \tag{2}$$

Assuming that all the households with own damage cover and per-claim absolute deductibles opt to take out refundable insurance, the total gain achieved by the Spanish households, HRU, can be calculated.

3. Empirical results

Some of the parameters utilised in our model can be obtained directly from (ICEA, 2023). For the remaining parameters, we require an additional hypothesis regarding to the distribution function of claim amounts. Table 1 includes the values of the parameters obtained directly from (ICEA, 2023), specifically: q the percentage of policies with deductible; λ the mean number of claims per policy; μ the mean of the individual claim amount and Π_D the premium in policies with deductibles. Regarding the distribution of the claim amounts, we select the distribution that provides us results that are most consistent with the market, considering that the tariff premium (market data) includes a positive margin or surcharge in comparison to the technical premium (which incorporates internal, external, security and safety surcharges, as well as profit margins). Additionally, given that we only have the average claim amount, we can only fit statistical distributions within one parameter. We choose the Lindley of parameter $\theta > 0$, (Ghitany et al., 2008), which leads to a positive surcharge, whereas the exponential distribution is disregarded because it leads to a negative surcharge.

Table 1
Parameters obtained directly from (ICEA, 2023).

q	λ	μ	Π_D
0.2841	0.2231	€852.73	€146.54

Table 2
Own calculated parameters from Table 1.

a	δ	Π_R
€358.22	0.2563	€92.34

As with claim amounts, only the average number of claims is available, limiting the possibilities for the choice of the distribution of the number of claims. In this paper, we apply the Poisson distribution, consistent with the usual assumption in actuarial science (Promislow, 2014). The process for calculating the absolute deductible, a, the surcharge, δ, and the refundable insurance premium, Π_R, is outlined in Appendix A with their respective values presented in Table 2.

From the EFF we have compiled a database that includes households with one or more cars and their initial wealth. Since the survey does not contain information on whether policies are franchised or not, a random selection has been made based on the percentage of policies with deductible (Table 1).

The value of the risk aversion coefficient, α, that we have assigned to each response option to the specific question included in EFF, is obtained from (Holt and Laury, 2002) and is outlined in Table 3. Specifically, by referencing Table 3 in Holt and Laury (2002), we have disregarded the first and the last open intervals and we have aligned the different response options offered by the EFF with the intermediate levels of risk aversion in that table, so that α corresponds to the mean value of each of the intervals.

The EFF includes five imputed datasets which are analysed for differences between them for the variables wealth (calculated after excluding outliers) and risk aversion. After analysis, no significant differences are observed, so it is decided to use the first imputed dataset. There are 6313 surveys (representing 18,821,645 households according to the weights) of which 5074 surveys (14,042,117 households) correspond to households that own a vehicle. We discard those households with negative or zero wealth, 413 surveys representing 1,398,145 households, since it is necessary for this variable to have a positive value in order to apply the formulations. We then generate a vector containing the total number of vehicles in the total population by multiplying the number of vehicles in each household in the survey by the household's weight. We obtain a total of 20,571,785 vehicles, of which we choose 28.41%, i.e. 5,844,444 vehicles, which are those to be franchised corresponding to vehicles from 984 different surveys. As some selected households have several vehicles, we end up with a selection of 873 surveys.

Subsequently, for each of these 873 households, we run 100,000 simulations of the number of claims, according to a Poisson distribution with parameter $\lambda = 0.2231$, for each vehicle/s selected. If the number of claims is greater than 0, the amount of each claim is simulated using a Lindley distribution with parameter $\theta = 0.002342$ (estimated with the method of moments, see Appendix A).

Once the claims amounts are obtained, the insured's payment is calculated as the minimum between the claim amount and the amount of the absolute deductible. Finally, the total cost to the insured can be calculated by adding up the amounts paid for the occurred claims.

Seventeen households are discarded from the analysis where HRU is calculated as a non-finite number. The resulting database contains 856 households, each representing a specific number of households in Spain according to the weights included in the EFF (4,712,025 households in the entire population). The results are obtained by statistical inference.

Table 3
Risk aversion coefficient α.

Response	α
Take on a lot of risk in the expectation of obtaining a lot of profit	−0.72
Take on a reasonable amount of risk in the expectation of obtaining an above-normal profit	−0.32
Take on a medium level of risk in the expectation of obtaining an average profit	0.13
Unwilling to take on financial risk	0.89

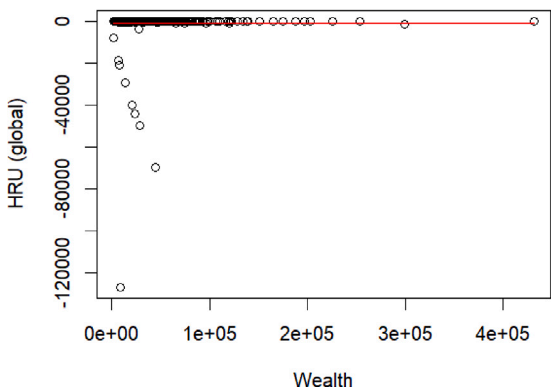

Fig. 1. HRU of each family.

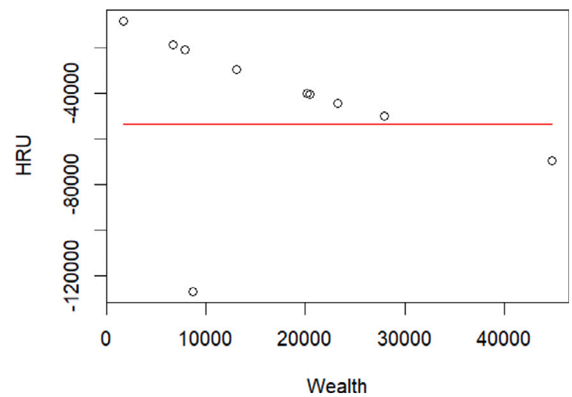

Fig. 2. HRU for households having $\alpha = -0.72$.

Fig. 1 illustrates the Household Refundable Utility of each family included in the constructed database according to their initial wealth levels.

HRU assumes zero values (79.64% of the households) or negative values, indicating that households obtain the same or lower utility if they opt for refundable insurance. This implies that for households with $HRU = 0$, the current market price represents the zero-utility premium (Kass et al., 2002), which consists of equating the expected utilities of taking out the insurance and not taking out the insurance.

The sensitivity of the percentage of households with $HRU = 0$ with respect to the premium is minimal (e.g. for a surcharge $\delta = 0$, the percentage only increases to 80.18%). However, a reduction in the premium significantly impacts the average HRU (further details are provided in Appendix B). Therefore, a reduction in the premium does not increase demand (price inelasticity of demand), as the percentage of households indifferent to the choice of whether or not to take out the product will remain constant and the other households will continue not to take out the product as the expected utility of taking out the product will remain lower.

We have also analysed the influence of the risk aversion levels on HRU. Figs. 2 to 5 display HRU values for the four groups of households categorised according to their risk aversion levels (the solid red line indicates the average HRU).

Household risk aversion strongly influences HRU, with the most risk-loving households exhibiting a highly negative average HRU ($-53,318$ in Fig. 2), while risk-averse households tend to have an almost zero HRU. From Figs. 4 to 5, within risk-averse households, it is clearly observed that higher wealth correlates with higher HRU, indicating a lower reluctance to opt for refundable insurance. This behaviour is more pronounced at higher levels of risk aversion. Conversely, in risk-loving households (Figs. 2 to 3), the opposite behaviour is observed.

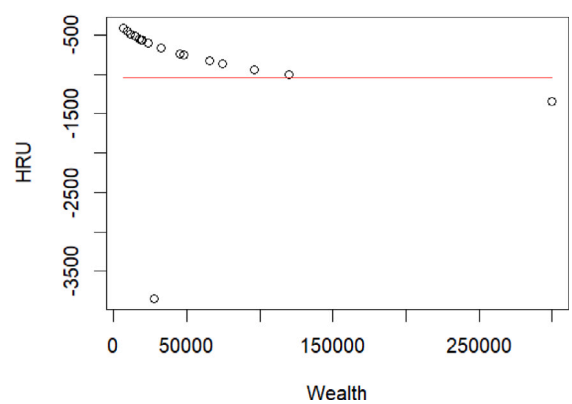

Fig. 3. HRU for households having $\alpha = -0.32$.

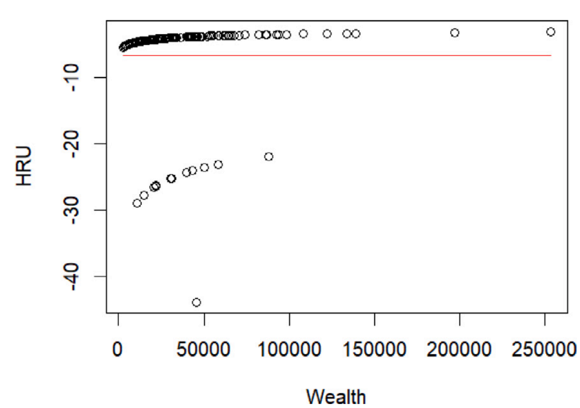

Fig. 4. HRU for households having $\alpha = 0.13$.

4. Conclusions

Spain's refundable insurance market has certain characteristics that differentiates it from other markets. Firstly, the data indicate that it offers a premium for the refundable that coincides, for 79.64% of households, with that which equals the profits of contracting the refundable with those of not contracting it. So, from a technical-actuarial

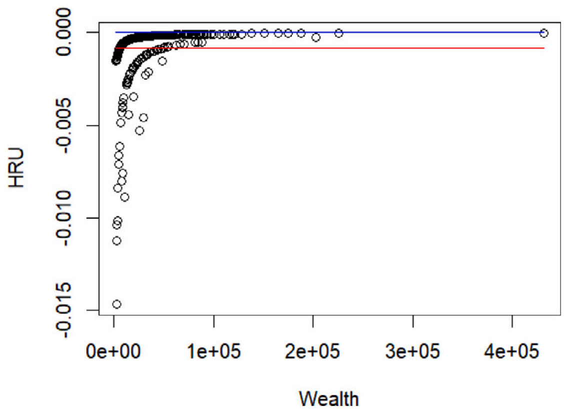

Fig. 5. HRU for households having $\alpha = 0.89$.

point of view, this premium is the one that would be obtained with the criterion of zero utility. Secondly, from a microeconomic perspective, this is a complicated market for insurance companies, given the price inelasticity of demand.

Therefore, an important conclusion for the management of insurance companies can be drawn from this research: since price is not the instrument, other instruments such as commercial campaigns to raise awareness of the product would be useful to increase market penetration.

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Declaration of competing interest

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

Data availability

All the data used are openly accessible. The Database can be obtained freely in the OPENICPSR repository, which is free with prior registration, with DOI reference: https://doi.org/10.3886/E198961V2.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.econlet.2024.111819.

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