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Review

ON WHICH SOCIOECONOMIC GROUPS DO REVERSE MORTGAGES HAVE THE GREATEST IMPACT? EVIDENCE FROM SPAIN

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Abstract. Reverse mortgage is one of the products (perhaps the main one) that is good to obtain additional income by using the habitual residence as collateral. The main objective of this paper is to analyse the effects that reverse mortgage contracting has on household finances over the lifetime of a family according to the socioeconomic group to which it belongs in Spain. Four indicators are employed to measure the immediate and long-term effects. We use a stochastic model with a double source of randomness, survival and entry into dependency, and apply it to the three socioeconomic groups obtained with cluster methodology from the 2017 Spanish Household Financial Survey data. We conclude that the effects are very different depending on the group: regarding only the effects of hiring a reverse mortgage on the income of the family, widowed women aged between 81 and 85 years, with low income and expenses as well as little net wealth, and a habitual residence that represents half of her net wealth (Cluster 1) are the most benefited; considering that the highest impact indicators are on the probability of illiquidity and on the value of lack of liquidity, the use of reverse mortgages benefits more the families in Cluster 3 (high income and expenses and really high net wealth, head of household aged between 76 and 80 years) and less the families in Cluster 2 (medium income, net wealth and expenses, head of household aged between 65 and 75 years).

Keywords: long-term care, reverse mortgage, clustering, Markov process, simulation, Spanish Survey of Household Finances.

JEL Classification: G21, G51, D14, D15.

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1. Introduction

A reverse mortgage (RM) is a viable option, potentially the primary one, for generating extra income by leveraging your primary residence as collateral. It offers some comparative advantages over other products that can be used to liquefy wealth (see Reifner et al. (2009) for details on the differences/similarities with other products available in the European market with the same objective). One of the most notable is that the ownership of the property is maintained when the product is taken out and even the heirs, upon the death of the contracting party (or the last beneficiary of the RM), have the option of keeping the property after cancellation of the accumulated debt (Piggott & Woodland, 2016). However, depending on the evolution of the value of the property and the longevity of the contracting party/

beneficiaries, the heirs may find that the accumulated debt is very high or even higher than the value of the property. To prevent this situation, which is seen as a drawback by potential claimants of the product (Whait et al., 2019) in countries such as the United States and the United Kingdom (de la Fuente et al., 2021, 2018; Dowd et al., 2019; Li et al., 2010; Sharma et al., 2022; Tunaru & Quaye, 2019, among others), the inclusion of the No Negative Equity Guarantee (NNEG) clause guarantees that the property owner or their heirs can settle the entire debt by surrendering the property. In the US, it is implemented in most cases (Li et al., 2010; Simón, 2016) through public insurance against payment of premiums (Mortgage Insurance Premium). In the English market, bidding institutions cover this risk themselves, which is recognized as a quality aspect, so that the institution must include the NNEG in its RM (in addition to complying with other requirements) in order to be part of the Equity Release Council (Equity Release Council, 2018).

Despite the need to liquefy accumulated wealth and the usefulness of RMs for this purpose, in many countries this product has not been as successful as expected, both from the point of view of supply (few providers) and from the point of view of demand. Regarding the demand, among other reasons, family's financial literacy is found to be a crucial element (Duca & Kumar, 2014; Fornero et al., 2016; Fornero & Monticone, 2011; Leviton, 2002; Reed, 2009). Hanewald et al. (2020) highlight the technical complexity of the product in the Japanese market and conclude that a clear explanation aimed at clarifying the doubts of potential claimants and more abundant advertising would improve its marketability (see also Chatterjee (2016) and Jefferson et al. (2017) for the US and Australian markets, respectively). RM is also considered a risky product for providers (see Al-Umaray et al., 2018; Atance et al., 2024; Barrieu et al., 2012; de la Fuente et al., 2020; Megyeri, 2018; Overton & Fox, 2015 and Tsai et al., 2023, among others).

Several studies analyse the benefits of contracting an RM for families. Thus, specifically in Spain, Moscarola et al. (2015) conclude that RMs would reduce the vulnerability of families (the vulnerability index is defined on the basis of an income level equal to 60% of the average disposable income) over 65 years of age by 20.7%. Boj et al. (2022) conclude that the greatest effects would be observed on an increase in initial income, a decrease in probability of lack of liquidity and a decrease in the sum of the illiquidity of the different periods, and Martinez-Lacoba et al. (2021) estimate that, in a scenario with 8% of potential households opting for an RM, they would receive an extra mean annual income of EUR 32,243. However, few studies (Chatterjee, 2016; Michelangeli, 2008; Nakajima & Telyukova, 2017, 2019), all of them using data from the US, focus on the analysis of what type of households would benefit most from RMs. Nakajima and Telyukova (2017, 2019) indicate that RMs could be useful for households with only one member with modest savings and poor health, while Chatterjee (2016) suggests that those households with higher net worth and income (and better educational attainment) were more likely to have RMs. Boj et al. (2022) analyse the impact of RMs on the finances of Spanish families; the set of households under analysis was divided into two profiles, according to the number of members. One of the results of the study is that the impact of the RM is significantly different depending on the profile. This paper aims to contribute to this aspect, filling a gap in the literature, by systematizing the selection of different socioeconomic groups based on more variables than those used in existing studies to date and increasing the variety of tools to quantify the effects.

Then, the main objective of this paper is to look for specific families who would benefit more from RMs in Spain considering four different nature measures. With this purpose, we will perform a cluster analysis to create homogeneous profiles according to socioeconomic characteristics (some works that show the interest of establishing socioeconomic profiles include, among others, Boj et al., 2020; Fleishman et al., 2015; Balasankar et al., 2021, and Huang et al., 2021). The number of variables used and the cluster analysis carried out allow us to obtain richer conclusions than those existing in the literature to date and which we have cited in this section, with more details regarding the profile of the beneficiary families and the types of obtained benefits. One of the main conclusions is that immediate and long-term effects are different depending on the group, being higher for families that, a priori, would least need the monetary supplement provided by RMs, according to the indices indicated in this paper.

Following this introduction, the document is organized into five sections and concludes with the summarising remarks and bibliographical references. Section 2 provides an overview of the key features of the economic and financial model. Section 3 delves into the economic, financial, and actuarial attributes of the RM model applied in this study. Section 4 outlines the three data sources employed in the research and the methodology utilized, incorporating actuarial and statistical elements to model individual dependency and mortality through stochastic simulation. Section 5 presents the study's findings, encompassing the socioeconomic traits of the clusters and the outcomes derived from the model application. The ensuing discourse is found in Section 6, leading to the document's conclusion.

2. Economic and financial model

Henceforth, this section outlines an economic-financial model aimed at assessing the impact of RMs on the financial well-being of families. This model takes into account not only legal requirements but also factors dictated by the financial and insurance markets. Adherence to market conditions is crucial for bidders to manage the significant reputational risk associated with these transactions. According to Spanish Law 41/2007 (Ministerio de la Presidencia, Relaciones con las Cortes y Memoria Democrática, 2007), there are two eligible groups for RM applicants and beneficiaries: individuals aged 65 or older and those who are dependent or possess a recognized disability of 33% or more. Our analysis in this paper will focus on the first group, as our objective is to examine the effectiveness of RMs in addressing income loss or increased expenses resulting from aging.

The main variable of the model we used in this paper is the net balance of a family in each period (income minus expenses) until its extinction, symbolized by $S(t)$, $t = 0, 1, \ldots$ This model has been previously used by Boj et al. (2022), where it is explained in detail. The balance of a period is defined in Equations (1) and (2):

$$S(0) = INC(0) + RMD(0) - OEXP(0) - EXEXP(0), \tag{1}$$

$$S(t+1) = INC(t+1) + RMD(t+1) - OEXP(t+1) - EXEXP(t+1) + S(t)+,\ t = 0, 1, \ldots, \tag{2}$$

where $S(t)+ = \max(S(t),0)$ is the balance for period t if positive, INC is income, RMD is net income to be received as dispositions from an RM, $OEXP$ is ordinary expenses (i.e., not derived from dependency), and *EXEXP* is extraordinary expenses (derived from dependency). When $S(t) < 0$, the family is illiquid.

A double source of randomness (the year of death of each person is random as well as their entry into dependency) configures the balance sheet as a stochastic process. Thus, the income (and the rest of the variables included in Equation (1)) of the family at a given time is a random variable (r.v.) with different amounts depending on the status (alive-dead, active-dependent) of each of its members.

Additional working hypotheses are the same as in Boj et al. (2022) and the main of them are reproduced below to facilitate the understanding of this paper:

- The original family members persist within the family structure until their demise, and no new members are introduced. Conversely, the average age of emancipation is established at 30 years, see Eurostat (n.d.), ensuring that individuals initially aged 15 or older (excluding minors from the study) continue to be part of the family unit until they reach this specified age.
- A distinction has been drawn between income originating from employment and retirement pensions, calculated by summing up the constant income attributed to each family member, and other income sources unaffected by changes in family composition. The first category of income remains unchanged until a household member retires (commencing receipt of the retirement pension), passes away (potentially triggering the initiation of a widow/widower's pension), or becomes dependent (resulting in the loss of employment-derived income).
- Ordinary expenses consist of a fixed component and another portion that varies linearly with the number of family members.
- In the computation of extraordinary expenses arising from dependency, the benefits provided by the public system have been taken into account.

Four impact indicators are used to measure the effect of contracting an RM: income, probabilistic, temporal and financial indicators, corresponding to Equations (3) to (6).

The Income Indicator (*II*) is defined as the percentage represented by the periodic income to be received from the RM with respect to the family's income at the time it is contracted,

$$II = \frac{RMD(0)}{INC(0)}100. \tag{3}$$

This indicator only provides us with information on the effects of the RM at the time of contracting, but not during the period until the family's extinction. To quantify these effects, we will use the other three indicators.

The Probabilistic Indicator (*PI*) is defined as the percentage decrease in the probability of illiquidity that occurs when an RM is contracted,

$$PI = \frac{\left(1 - P(\text{YL} = FE)^{(without\ RM)}\right) - \left(1 - P(\text{YL} = FE)^{(with\ RM)}\right)}{1 - P(\text{YL} = FE)^{(without\ RM)}}100, \tag{4}$$

where *YL* is the r.v. "number of years of liquidity" (before a first period of illiquidity), which takes values from 0 to *FE*, and *FE* is the number of years until the family extinction. If a household never has liquidity problems, *YL* will take the value *FE*. The superscript indicates whether the calculation has been made considering that the household takes out an RM (*with RM*) or not (*without RM*).

The Temporal Indicator (*TI*) is defined as the percentage increase in the expected number of years without liquidity problems that occurs when the RM is contracted.

$$TI = \frac{E(\mathrm{YL})^{(with\,RM)} - E(\mathrm{YL})^{(without\,RM)}}{E(\mathrm{YL})^{(without\,RM)}} 100. \quad (5)$$

This indicator can be understood as the delay on the onset of illiquidity if it occurs.

The Financial Indicator (*FI*) is defined as the percentage reduction in the expected value of lack of liquidity.

$$\mathrm{FI} = \frac{E(VLL)^{(without\,RM)} - E(VLL)^{(with\,RM)}}{E(VLL)^{(without\,RM)}} 100. \quad (6)$$

VLL represents the value of lack of liquidity (according to a financial valuation at a zero-interest rate), that represents the sum of the illiquidity of the different periods, i.e. $\sum_{\forall t /\ S(t)<0} \left|S(t)\right|$. Therefore, if the household always has a positive balance, *VLL* takes a value of zero.

The distribution of the r.v. *YL* and *VLL* is obtained from the stochastic simulation of the possible trajectories of the stochastic net balance process (*S*).

In this paper, we assume that all eligible families opt to enter into an RM agreement if the anticipated income from the RM is positive.

3. Reverse mortgage

In this study, we examine RMs involving a single drawdown (*SDr*) and constant periodic withdrawals (*C*), continuing until a predetermined term that aligns with the expected remaining years of life for the mortgage contracting parties/beneficiaries. This term corresponds to the household's life expectancy, defined as the duration until the last family member's demise. Additionally, in accordance with the performance standards outlined for RM marketing in Europe by the European Pensions and Property Asset Release Group in July 2020, RMs will incorporate annuity insurance to ensure that families can sustain their income beyond the drawdown period. In this way, RMs are lifetime products that provide a constant income of amount *C* until the death of the last owner and beneficiary.

SDr is used exclusively to cover the initial expenses that the RM generates for the contracting party (ERM_0), the payment of a single premium of the annuity insurance ($C\times$P), as well as the cancellation of the outstanding debt (*OD*) if the property subject to the RM is already mortgaged; so $SDr = ERM_0 + C\times\mathrm{P} + OD$. Consequently, the net income to be received as dispositions from an RM at 0, *RMD*(0), equals to *C*.

The design of the RM includes considering that the accumulated debt at the end of the period in which drawdowns can be made -left-hand side of Equation (7) – is a percentage, the loan-to-value (*p*), of the appraised value of the property on the date of the contract (*AP*)

-right-hand side of Equation (7). This way, if any member of the family lives *esp* years more, the debt accumulated until then will be just $p \times AP$. If the family dies before *esp* years, the accumulated debt will be lower. Considering the RM interest rate, i, C can be obtained from

$$\left(ERM_0 + C \cdot \Pi + OD + C \cdot \ddot{a}_{\overline{esp+1}|i}\right) \cdot (1+i)^{esp} = p \cdot AP, \qquad (7)$$

being

$$\ddot{a}_{\overline{esp+1}|i} = \sum_{t=0}^{esp} (1+i)^{-t} \qquad (8)$$

and, if the RM has only one debtor and no additional beneficiaries,

$$\Pi = {}_{esp/}a_x = \sum_{t=esp+1}^{w-x} {}_t p_{x,g1} \cdot (1+I)^{-t}, \qquad (9)$$

where w is the last age at which a person can be alive following a life table, *esp* is the expected number of years (integer part formed by truncating the value) until the last family member dies, ${}_t p_{x,g1}$ is the probability that a person x years old from generation $g1$ is alive t years later and I is the technical interest rate of the insurance transaction. If there are two or more persons between debtors and beneficiaries, the formula for calculating the annuity premium is more complex, as it needs to consider the probabilities of survival of the group until its extinction (see Boj et al. (2022) and Alegre (2014) for further details).

It may happen that the initial expenses plus the outstanding debt from the previous mortgage are so high that, on their own, they produce a debt at the end of the period in which drawdowns can be made equal to or higher than that contemplated in the RM. In that case, the application of (7) would lead to negative C, which does not make sense. Therefore, those households whose economic data lead to this situation have been excluded from the study.

In the application to the Spanish case, the following values have been used for the different parameters, consistent with current practice in Spain: $p = 0.6$, $i = 6\%$, independent advisor's fee: 1.25% on the appraised value of the property, with a maximum of EUR 6,000, arrangement fee: 0.65% of the total amount of the loan, appraisal fee of EUR 350.

4. Sources and methodology

The data used in this article come from three sets of sources.

First, household economic and social data are from the 2017 Spanish Survey of Household Finances (Banco de España, 2019). Methodological details about that survey can be found in Barceló et al. (2020). From that survey, we have built the database we used in this paper, symbolised by DBRM, which includes only households that meet the economic and composition conditions. The economic conditions are 100% home ownership and being able to afford the RM; the composition conditions are: the head of household must be 65 years old or older and no members between 30 and 65 years old. Thus, the DBRM contains 1,617 surveys, which represent a total of 3,431,896 Spanish families. To learn more about the DBRM, see Boj et al. (2022).

Second, the data on the costs of dependency are those calculated in de Prada and Borge (2013), which, together with the rules for the participation of dependent persons in the financing of public benefits of the different services contained in the Dependency Act (Ministerio de la Presidencia, Relaciones con las Cortes y Memoria Democrática, 2006), allow us to obtain data on the costs of dependency net of public benefits.

Third, data on mortality/survival of individuals are those from the PERM/F 2020 generational mortality tables (Ministerio de Asuntos Económicos y Transformación Digital, 2020), while dependency incidence rates by age bracket are those contained in the monthly statistical report from the SAAD (Instituto de Mayores y Servicios Sociales, 2019) dated August 31, 2019. Employing a Makeham model for estimating prevalence rates at each age and adopting the method of converting these rates into transition probabilities between states proposed by Pitacco and Olivieri (1997), as detailed in Haberman and Pitacco (1999) and Pitacco (1999), along with a 10% overweight factor to derive probabilities of death for dependents relative to the general population, we generated the dependency tables utilized in this paper (previously applied in Boj et al., 2022). These tables enable the implementation of a non-homogeneous Markov chain with three states (autonomous, dependent, and deceased). The transition probabilities between states are contingent on age and year of birth, with the state of dependency being irreversible.

From a methodological point of view, in the actuarial aspects, in addition to the development of the dependency table mentioned in the previous paragraph, life expectancies and annuity premiums are calculated for individuals and groups by applying the usual actuarial methods for the survival probabilities of a group of insured persons until their extinction (for more information see, for example, Alegre (2014) among others).

From a statistical point of view, *k*-means cluster analysis is carried out for the development of homogeneous profiles. The method partitions the set of observations into a number of clusters in which the observations belong to the cluster with the closest mean value (see, e.g., Hennig et al., 2015). Since the 2017 Spanish Survey of Household Finances (Banco de España, 2019) contains five imputed datasets, an adaptation of the methodology has been used that accommodates this situation (Basagaña et al., 2013). To build the clusters, the R package *miclust* (Basagaña & Barrera-Gómez, 2021) has been used and, in particular, the *miclust* function, which performs *k*-means cluster analysis for data with multiple imputation as is the case of the 2017 Spanish Survey of Household Finances (Banco de España, 2019). The function incorporates optional procedures for choosing the cluster count and assessing variable significance, demonstrating the impact of imputations on result uncertainty.

The characteristics included in 2017 Spanish Survey of Household Finances (Banco de España, 2019), describing the households and used to form the homogeneous groups or clusters, are:

- Four household economic variables:
  # *renthog16_eur17*: Total combined income, including both labor and non-labor incomes, for all household members in the year 2016.
  # *riquezanet*: Net wealth determined through a comprehensive process involving intermediate variables related to real assets, financial assets, and debts.

expenses: Formed by aggregating three variables: alim (annual expenditure on food), nodur (annual expenditure on other non-durable goods), and gimpvehic (annual expenses for vehicle acquisition value).
p2_5: Present assessed value of the property in euros.

- Three variables describing the number and age of family members:
np_1: Number of household members.
nnumadtrab: The count of working adults in the household, ranging from 0 to 3 (representing none, one, two, or three or more).
esp: Life expectancy of the household, defined as the expected number of years until the last family member dies.

And, finally, three variables that reflect the age, sex and marital status of the head of household:

p1_2d_1: Age of head of household (years).
p1_1_1: Sex of head of household (Male, Female).
p1_4_1: The marital status of the head of the household, categorized as Single, Married, Domestic Partner, Separated, Divorced, or Widowed.

5. Results

5.1. Socioeconomic characteristics of clusters

Three clusters are obtained including 548, 983 and 86 surveys, respectively. The households represented by each cluster are 1,777,137 (Cluster 1), 1,645,558 (Cluster 2) and 9,201 (Cluster 3).

From Tables Table 1 to Table 7 encompass the explanations of the variables employed in generating clusters for both the overall database and each specific cluster.

Table 1. Description of continuous variables in clusters of DBRM (source: self-generated analysis based on Banco de España, 2019)

Description	Minimum	Maximum	Median	Mean	SD	1st Quartile	3rd Quartile
renthog16_eur17 (EUR)	0	576,327	18,402.02	25,486.78	27,009.65	11,475.99	576,327.00
riquezanet (EUR)	0	36,120,760	175,307.26	350,334.76	955,961.33	95,160	331,856
expenses (EUR)	768	83,000	9,000	10,944.49	7,259.02	6,312	13,200
p2_5 (EUR)	6,000	1,502,530	120,000	162,555.94	156,949.18	70,000	188,180
np1	1	4	1	1.51	0.56	1	2
nnumadtrab	0	2	0	0.03	0.17	0	0
esp	7.55	27.36	17.32	17.22	5.88	12.06	22.24
p1_2d_1	65	85	75	75.79	6.36	70	81

Table 2. Description of continuous variables in Cluster 1 (source: self-generated analysis based on Banco de España, 2019)

Description	Mini-mum	Maximum	Median	Mean	SD	1st Quartile	3rd Quartile
renthog16_eur17 (EUR)	0	531,703.11	13,048.77	18,351.96	24,738.55	9,908.78	21,245.23
riquezanet (EUR)	0	14,255,000	126,332.56	235,867.45	531,380.29	77,232	220,000
rxpenses (EUR)	1,200	68,676	7,200	8,241.49	4,842.78	5,160	9,828
p2_5 (EUR)	6,010	1,500,000	100,000	136,743.33	131,416.30	60,000	156,910
np1	1	3	1	1.07	0.27	1	1
nnumadtrab	0	1	0	0.03	0.16	0	0
esp	7.55	27.36	12.86	14.54	5.64	9.20	18.28
p1_2d_1	65	85	79	77.88	6.42	73	84

Table 3. Description of continuous variables in Cluster 2 (source: self-generated analysis based on Banco de España, 2019)

Description	Mini-mum	Maximum	Median	Mean	SD	1st Quartile	3rd Quartile
renthog16_e ur17 (EUR)	2,376.08	470,161.5	26,050.1	32,480.42	25,089.13	17,016.81	38,098.25
riquezanet (EUR)	6,651	31,159,967	240,443.96	420,012.56	631,715.66	135,338	470,455
expenses (EUR)	768	68,000	11,569.14	13,710.26	8,010.08	8,400	17,436
p2_5 (EUR)	6,000	1,500,000	140,000	186,895.16	170,007.94	85,639	230,000
np1	1	4	2	1.99	0.37	2	2
nnumadtrab	0	2	0	0.03	0.18	0	0
esp	8.05	27.36	20.23	20.1	4.65	16.38	23.25
p1_2d_1	65	85	73	73.55	5.48	69	77

Table 4. Description of continuous variables in Cluster 3 (source: self-generated analysis based on Banco de España, 2019)

Description	Mini-mum	Maximum	Median	Mean	SD	1st Quartile	3rd Quartile
renthog16_eur17 (EUR)	43,477.3	576,327	152,870.69	152,765.35	80,895.84	91,820.01	158,413.08
riquezanet (EUR)	1,318,913	36,120,760	4,196,930.5	9,997,364.22	10,885,582.93	1,418,462.8	23,304,236
expenses (EUR)	14,400	83,000	36,000	38,370.48	10,863.65	26,760	48,000
p2_5 (EUR)	270,455	1,502,530	695,183.19	795,181.12	219,683.05	600,000	1,000,000
np1	1	3	2	1.95	0.29	2	2
nnumadtrab	0	2	0	0.42	0.53	0	1
esp	9.2	27.36	19.93	19.36	3.88	15.46	23.25
p1_2d_1	65	85	75	74.19	5.21	70	78

Table 5. Age of head of household (source: self-generated analysis based on Banco de España, 2019)

	Cluster 1	Cluster 2	Cluster 3	DBRM
65–70 years	14.05%	27.88%	22.84%	20.71%
71–75 years	16.32%	34.54%	13.32%	25.05%
76–80 years	20.59%	19.81%	52.79%	20.31%
81–85 years	49.02%	17.75%	11.03%	33.92%

Table 6. Distribution of *p1_1_1* factor (source: self-generated analysis based on Banco de España, 2019)

	Cluster 1	Cluster 2	Cluster 3	DBRM
Male	24.61%	78.02%	95.73%	50.41%
Female	75.38%	21.97%	4.26%	49.58%

Table 7. Distribution of *p1_4_1* factor (source: self-generated analysis based on Banco de España, 2019)

	Cluster 1	Cluster 2	Cluster 3	DBRM
Single	14.01%	8.86%	0	11.50%
Married	3.71%	89.24%	91.68%	44.96%
Domestic Partner	0.13%	0.43%	1.44%	0.28%
Separated	2.76%	0.21%	0	1.53%
Divorced	4.89%	0.27%	1.70%	2.67%
Widowed	74.50%	0.98%	5.17%	39.06%

Once we have determined the clusters, we can calculate the average of the outstanding amounts to be amortized of the mortgages affecting the dwellings subject to the RM, variable *p2_12* of the 2017 Spanish Survey of Household Finances (Banco de España, 2019): EUR 8,905.46, EUR 16,020.50, EUR 42,455.00 for each cluster respectively.

Below, we discuss the defining characteristics of the families included in each cluster. The first cluster's household has a mean (standard deviation, or SD) annual income of EUR 18,351.96 (EUR 24,738.55), a mean (SD) net wealth of EUR 235,867.45 (EUR 531,380.29) and mean (SD) expenses of EUR 8,241.49 (EUR 4,842.78). The mean (SD) appraised value of the household's property is EUR 136,743.33 (EUR 131,416.30) that, considering an average amount of EUR 8,905.46 to be amortized, indicates that the property is really important for this household as it represents 54.20% of its net wealth. The household consists of between one and three members (with a mean of 1.07), none of whom are employed, and the mean expected number of years until the demise of the last family member is 14.54 years. The last group of characteristics refer to the head of the household: the average age is 77.88 years, although the majority is between 81 and 85 years old (49.02%), female (75.38%) and widowed (74.50%).

The second cluster's household has a mean (SD) annual income of EUR 32,480.42 (EUR 25,089.13), a mean (SD) net wealth of EUR 420,012.56 (EUR 631,715.66) and mean (SD) expenses of EUR 13,710.26 (EUR 8,010.08). The mean (SD) appraised value of the household's property is EUR 186,895.16 (EUR 170,007.94) that, considering an average amount of EUR 16,020.50 to be amortized, indicates that the property is also important for this household as it represents 40.68% of its net wealth. The household consists of between one and four members (with a mean of 1.99), none of whom are employed, and the mean expected number of years until the demise of the last family member is 20.1 years. Regarding the head of household, the average age is 73.55 years and the majority is between 65 and 75 years old (62.42%), male (78.02%) and married (89.24%).

The third cluster's household has a mean (SD) annual income of EUR 152,765.35 (EUR 80,895.84), a mean (SD) net wealth of EUR 9,997,364.22 (EUR 10,885,582.93) and mean (SD) expenses of EUR 38,370.48 (EUR 10,864). The mean (SD) appraised value of the household's property is EUR 795,181 (EUR 219,683.65) that, considering an average amount of EUR 42,455.00 to be amortized, indicates that the property is not relevant for this household as it only represents 7.53% of its net wealth. The household consists of between one and three members (with a mean of 1.95), practically none of them work, and the mean expected number of years until the demise of the last family member is 19.36 years. Regarding the head of household, the average age is 74.19 years and the majority is between 76 and 80 years old (52.79%), male (78.02%) and married (91.68%).

Therefore, the profiles of the three clusters are very different from each other: the typical family in Cluster 1 comprises a woman who is widowed and aged between 81 and 85 years, with low income and expenses as well as little net wealth, and her habitual residence that represents half of her net wealth; whereas the typical families in Clusters 2 and 3 are formed by a married couple, with the head of household being a man (aged between 65 and 75 years in Cluster 2, and between 76 and 80 years in Cluster 3). The typical family in Cluster 2 has twice the income, net wealth and expenses than that in Cluster 1, while in the typical family in Cluster 3 they are much higher (8 times the income, 42 times the net wealth and 4 times the expenses). It is also worth noting that, in Cluster 3, the main residence only represents 7.53% of net wealth.

5.2. Results of the model

This section provides the results of the model differentiating in all cases between the three groups described in the previous subsection. Initially, we present the yearly income to be obtained from RMs. Second, we present the probabilities of illiquidity and the *YL* and *VLL* statistics for the two situations we want to compare (without and with RM). Finally, we calculate and interpret the impact indices defined in Section 1.

All these results are obtained by carrying out simulations of the moments of death and of entry into dependency, if this occurs, for each of the members of the families that are part of our database. In particular, for every family, we conduct a total of simulations equivalent to 10% of the households represented by that family in the survey. Subsequently, we perform a collective treatment utilizing the first set of imputed data for each family unit.

Table 8 shows the descriptive statistics of the yearly income to be obtained from RM (*C*). Households in Cluster 3 have the highest additional income from the RM because, although the life expectancy of the household is high, the net value of the property is also high (4.4 times

[5.8] higher than that of a household in Cluster 2 [Cluster 1]). Cluster 1 households have the second highest additional income, even though the net worth of their homes is the lowest, mainly because the life expectancy of the household is also the lowest.

Table 8. Statistics of *C* (EUR) (source: self-generated analysis based on Banco de España, 2019)

Description	Cluster 1	Cluster 2	Cluster 3	Global
Minimum	119.62	53.74	1,906.34	53.74
Maximum	44,212.42	24,400.83	31,475.73	44,212.43
Median	2,803.76	2,379.76	8,501.22	2,666.86
Mean	4,909.64	3,332.96	9,968.41	4,231.53
SD	5,979.07	3,179.01	6,188.29	4,774.14
25% percentile	1,395.36	1,328.11	5,833.06	1,387.45
75% percentile	5,742.54	4,196.15	12,315.18	5,089.01

The contracting of an RM leaves the probability of lack of liquidity at almost zero for the families in Cluster 3 and at values below 4% for the families in the rest of the clusters (see Table 9). The strong effect on Cluster 3 households can be explained mainly by the high net worth of their homes.

Table 9. Lack of liquidity for a family. Probability (%) of illiquidity without RM and with RM (source: self-generated analysis)

Cluster 1		Cluster 2		Cluster 3		Global	
Without RM	With RM	Without RM	With RM	Without RM	With RM	Without RM	With RM
5.56%	2.85%	6.22%	3.83%	1.41%	0.049%	5.80%	3.23%

The average number of years during which a household experiences no liquidity issues is quite comparable in Clusters 2 and 3, but notably shorter in Cluster 1 (see Table 10).

Table 10. Statistics of *YL* (years) without and with RM (source: self-generated analysis)

	Cluster 1		Cluster 2		Cluster 3		Global	
	Without RM	With RM	Without RM	With RM	Without RM	With RM	Without RM	With RM
Mean	15.11	15.28	22.59	22.96	22.96	22.97	18.12	18.37
SD	10.61	9.86	10.24	9.68	8.60	8.57	11.09	10.489
1% percentile	0	0	0	0	4	4	0	0
5% percentile	1	2	5	7	9	9	1	2
50% percentile	14	14	23	23	23	23	18	18
95% percentile	32	32	37	37	37	37	35	35
99% percentile	39	39	42	42	41	41	41	41

From Table 11, we observe, first, that the mean values of *VLL* are small, although very unrepresentative, which is indicated by very high SDs from the means. Second, we see that families in Cluster 3 are the ones that have the lowest *VLL* on average (and are the more representative, as they have the lowest SDs), which is justified given the characteristics of these families. Third, as expected, in all clusters, hiring RMs reduces mean *VLL* values. Finally, as a side effect of RMs contracting, the first positive *VLL* value occupies a high percentile for all three clusters (94.43%, 93.77%, and 99.86% without RM; 97.15%, 96.16%, and 99.95% with RM for the three clusters, respectively).

Table 11. Statistics of *VLL* (EUR) without and with RM (source: self-generated analysis)

	Cluster 1		Cluster 2		Cluster 3		Global	
	Without RM	With RM	Without RM	With RM	Without RM	With RM	Without RM	With RM
Mean	5,302.58	2,594.87	9,176.17	5,959.63	245.45	57.88	6,830.09	3,928.25
SD	34,134.69	24,009.28	55,988.06	45,036.59	8,423.04	2,859.65	44,167.35	34,005.75
1% percentile	0	0	0	0	0	0	0	0
5% percentile	0	0	0	0	0	0	0	0
50% percentile	0	0	0	0	0	0	0	0
95% percentile	7,200	0	20,344.77	0	0	0	10,612.87	0
99% percentile	164,333.54	87,338.35	292,151.35	225,294.48	0	0	213,802.43	137,583.58

The impact indicators presented in Table 12 enable us to quantify and succinctly summarize the positive effects of engaging in an RM on the long-term financial well-being of households.

The largest effects consist of a reduction, for the overall households, of 44.31% in the probability of having a lack of liquidity and of 42.49% in the expected value of lack of liquidity. These effects are very pronounced in Cluster 3, medium in Cluster 1 and smaller in Cluster 2. Smaller effects are observed from the income and temporal indicators on the increase of income (9.65% for any given household) and delay of the first moment of illiquidity (1.37% for any given household). In contrast with the probabilistic and financial indicators, families in Cluster 3 show the lowest percentage increase in income and the lowest percentage delay of the first moment of illiquidity.

Table 12. Impact indicators (source: self-generated analysis)

Indicator	Cluster 1	Cluster 2	Cluster 3	Global
Income	14.89%	6.52%	6.11%	9.65%
Probabilistic	48.74%	38.42%	96.52%	44.31%
Temporal	1.12%	1.64%	0.04%	1.37%
Financial	51.06%	35.05%	76.42%	42.49%

6. Discussion

In this paper, we define a series of indices that allow us to analyse in depth the different effects of RMs according to the socioeconomic characteristics of the family that hires it. In this sense, our results complement those obtained by Moscarola et al. (2015) and Boj et al. (2022) and reinforce the conclusion that the most benefited profile is "house rich, cash rich" (Michelangeli, 2008), while other authors, like Case and Schnare (1994), maintain that "house rich, cash poor" is the most benefited profile. In addition, the number of used variables and the cluster analysis carried out allows us to obtain richer conclusions, with more details regarding the profile of the beneficiary families and the types of obtained benefits. In fact, regarding only the effects on the income of the family, widowed women aged between 81 and 85 years, with low income and expenses as well as little net wealth, and a habitual residence that represents half of her net wealth (Cluster 1) are the most benefited, a result consistent with Nakajima and Telyukova (2017).

The subsequent paragraphs address certain limitations of this paper. Initially, the assumption is made that all eligible families, capable of entering into an RM due to the prospect of gaining a positive supplementary annual income, opt to do so. Consequently, the analysis operates within a maximum scenario, assuming widespread utilization of RMs. A perhaps more realistic hypothesis to consider in future studies is that only a part of the families contracts an RM (Martinez-Lacoba et al., 2021) for reasons that may be very diverse.

Second, regarding mortality-dependency tables, we use generational mortality tables that consider the year of birth, sex and dependency status as risk factors, so that life expectancies are different according to these. However, it is known that socioeconomic status is another factor that influences the survival/mortality of individuals. However, the creation of mortality/dependency tables according to socioeconomic status requires very detailed data that are not yet available in Spain. Nevertheless, if we had mortality tables differentiated according to socioeconomic status, we conjecture that the differences between clusters would be more pronounced.

Third, the article implicitly assumes a zero-inflation assumption, consistent with the use of a zero-interest rate in the updates. Future work will include different scenarios, deterministic or stochastic, which will allow a sensitivity analysis of the results with respect to these variables.

As a last limitation, our model does not take care of how the lack of liquidity is covered. Then, the model will be extended in future works to consider the possibility of additional financial costs derived from the coverage of the lack of liquidity.

The results of the study highlight the importance of sex (of the head of household) in the impact of RMs, so that, in Cluster 1, families are made up of a widowed woman, while those in the other two clusters are married couples whose head of household is mainly a man. This element had also been highlighted, although in a more overlapping way, in Boj et al. (2022). Future work will analyse in depth the existence of a gender gap in RMs.

7. Conclusions

This paper employs a theoretical model that encompasses both the stochastic nature of mortality and dependency among family members, as well as the temporal evolution of family income and expenses. Utilizing data obtained from the 2017 Spanish Survey of Household Finances (Banco de España, 2019), the study quantifies the financial implications of engaging in an RM for Spanish families within each group identified through the application of cluster analysis techniques.

The main conclusion indicates that immediate and long-term effects are very different depending on the group, being higher for families that, a priori, would least need the monetary supplement provided by RMs, according to the indices defined in this paper. Specifically, considering that the highest impact indicators are on the probability of illiquidity and on the value of lack of liquidity, the use of RMs benefits more the families in Cluster 3 and less the families in Cluster 2. However, we must remember that Cluster 3 includes a small number of families, 0.27% of those represented in the study, and that the average value of their lack of liquidity without RM is only EUR 245.45. Thus, for families in Clusters 2 and 3, which are mostly married couples with the head of household being a man, we have the most significant favourable effects (Cluster 3: high income and expenses and really high net wealth, head of household aged between 76 and 80 years) and the least significant (Cluster 2: medium income and expenses as well as medium net wealth, head of household aged between 65 and 75 years) depending mainly on household income and net wealth. Another interesting conclusion is that widowed women aged between 81 and 85 years, with low income and expenses as well as little net wealth and a habitual residence that represents half of her net wealth (Cluster 1) have benefited the most in terms of percentage increase in income.

The findings presented in this paper serve as valuable insights for identifying market niches and can be utilized as an effective promotional tool for RMs. Our study offers compelling arguments to enhance the comprehension of the risk associated with facing liquidity challenges after the conclusion of one's working life, particularly heightened by factors such as increased life expectancy and the likelihood of entering a state of dependency. Public policies focused on enhancing the financial well-being of the elderly could benefit from optimizing their design and increasing their impact on the population, leveraging the research results outlining the financial effects of RM engagement based on the socioeconomic profile of families.

Author contributions

Conceptualization, M.M.C.; methodology, E.B., M.M.C. and X.V.; software, E.B.; validation, M.M.C. and X.V.; formal analysis, E.B., M.M.C. and X.V.; investigation, E.B., M.M.C. and X.V.; resources, X.V.; data curation, E.B. and X.V.; writing – original draft preparation, E.B., M.M.C. and X.V.; writing – review and editing, E.B., M.M.C. and X.V.

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