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Role of Private Long-Term Care Insurance in Financial Sustainability for an Aging Society

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Abstract: This work analyzes and quantifies the significance of private long-term care insurance for the elderly in protecting families from the increased expenses derived from dependency. We propose an economic and financial model for consumption and income deficit evolution. Survival/dependency are modeled by a Markov process with stochastic simulation techniques to obtain random variable distributions. Based on the Spanish survey of household finances data, Spanish families are classified using a cluster analysis for the wealth decumulation period. The conclusion is that, for a generic family, hiring long-term care insurance causes a significant reduction in the probability of lack of liquidity, the mean first time of lack of liquidity (if it occurs), and the mean present value of overall liquidity needs. It is also observed that there are important differences between these impacts on different groups of families. These results show that hiring long-term care insurance would considerably lower financial problems in the decumulation period.

Keywords: life cycle; cluster analysis; Markov process; survey of household finances; simulation; Spain

1. Introduction

Possible financial problems resulting from long-term care (LTC) for the elderly is one of the issues that worries people the most, especially when approaching the age of 60 or 65 years, and thereby retirement [1–7]. In addition, the way in which LTC is provided significantly affects the quality of life of older people [8].

Ageing and associated LTC is a challenge not only for governments, since healthcare systems' financial viability is affected, but also for all the people that have to adapt to a life cycle where childhood and old age (two economically dependent periods) have gained more significance [9]. One of the classic economic theories is the hypothesis of life cycle, defined in first instance by [10]. According to this economic model, individuals soften their consumption during life by borrowing in young adulthood, saving in intermediate ages, and then using those savings while ageing. Therefore, economic resources are obtained during the active period, basically between 30 and 60 years old. The life cycle deficit (LCD) precisely gathers the evolution of the difference between consumption and income from work throughout one person's life.

According to life-cycle models [11,12], this deficit resulting from early and old age is financed in three ways: public transfers (pensions and/or other social benefits); private transfers (such as parents paying for their children education), and a redistribution based on assets (savings made at an active age to be spent further on). Regarding LTC for the elderly, changes in family structure make informal care of elders impossible [3,13] and in-kind transfers difficult. Among asset redistribution mechanisms, products to make liquid savings, under the form of real state, stand out [14–16]. Private LTC insurance serves more as instruments for prevention and distribution of risk rather than for saving.

In Spain, the Promotion of Personal Autonomy and Assistance for Persons in a Situation of Dependency Act [17] (henceforth, the Dependency Act) has allowed to include dependency care as one more pillar of the welfare state. Dependency care is provided through a network of community centers and other services available in each one of the Autonomous Communities of Spain, while basic conditions' regulations ensuring equality among all citizens lies with the Ministry of Health, Consumption and Social Welfare through the Institute for the Elderly and Social Services (IMSERSO). Access priority to services is established through an evaluation of the applicant's degree of dependency and financial assets. The principle of inter-administrative cooperation that inspired the Dependency Act is mainly articulated through the Territorial Council of Social Services and the System for Autonomy and Care for Dependency (SAAD) (hereinafter, the Territorial Council). More information on its characteristics implemented in Spain since 2016 can be found in [3,18,19]. Various authors have categorized Spain's dependency public system coverage. For example, in [20], Spain is located next to Italy as a country with the worst care compared with the characteristics and evolution of dependency care systems of seven European countries. As shown in [9,21], Spain is at the bottom in the list of OECD countries concerning dependency public care, both in coverage rate (only 6.8% of people aged 65 years or older receive some kind of dependency public benefit) and in total expenditure (0.7% in terms of GDP). On the contrary, in [22], Spain is located in an intermediate position. Using two approaches, [22] provide a typology of existing systems of LTC in Europe based on the provision of care/organization and financing. Using the first approach, which focuses on the system characteristics (qualitative factors), Spain is included in a cluster characterized by medium organizational depth and medium financial generosity. According to the second approach, which focuses on use and financing of care (quantitative factors), Spain is included in a cluster (with Austria, Finland, France and England) characterized by moderate public spending on LTC, high private funding, high role of informal care, high support for informal caregivers, moderate formal care use, large role of cash benefits and high accessibility.

Depending on the welfare state characteristics of each country, the problems derived from financing dependency public coverage are acute and contribute differently to the development of dependency private coverage [23,24]. In the literature, we find several theoretical proposals combining LTC and retirement pensions in the public system. The idea of embedding a public LTC insurance scheme in a notional defined contribution (NDC) framework has been examined: for instance, [25] develops a Swedish-type financial reporting statement and [26] looked into introducing life care annuities (LCAs). The same authors have also assessed the cost of converting retirement benefits into an LCA with graded benefits using a pre-existing public pay-as-you-go (PAYG) pension scheme [27]. Finally, [28] analyze whether it would be possible and desirable to use an NDC scheme to provide retirement and graded LTC benefits so as to help pensioners cope with the cost of LTC.

In general, the private LTC insurance market is not highly developed [29,30], suffering problems derived from both offer and demand. In [31,32], factors for the low development of this type of insurance are explained. Regarding demand, private LTC insurance covers events with low probability and high loss, which are difficult to understand for consumers basically due to their limited consumer rationality. Regarding offer, transaction costs, imperfect competition, asymmetrical information and dynamic hiring problems are the four main market failures. Another market problem is its high inelasticity demand of prices. In [2], price elasticity is estimated for the first time.

Changes in family structure also have an impact on private LTC insurance demand. Thus, [33] concludes that the characteristics of the family structure of this generation, particularly regarding the spouse, come into play when deciding whether to hire insurance, and that, nevertheless, few attributes of the younger generation family structure intervene in such decisions. Family factors that allow for informal care (for example, having a son or daughter living with their parents or an active spouse) negatively affect private LTC insurance hiring.

This work contributes to the study of the role that private LTC insurance can play from the perspective of protection provided to families who face increased expenses derived from aging-related

dependency. Three indicators have been defined measuring the impact of hiring private LTC insurance on the following family economic magnitudes: lack of liquidity (difference between income and expenses), first time of lack of liquidity, and present value of overall liquidity needs. Impact indicators have been estimated using financial data from Spanish families whose head of household is retired and between 60 and 65 years old, for generic and specific types of families, and based on two different saving strategies after retirement of the head of household. One conclusion was that, for a generic family, hiring private LTC insurance reduces the probability of lack of liquidity in around 22%, the mean time of first lack of liquidity (if it occurs) in around 10%, and the mean of the present value of overall liquidity needs in around 35%. These percentages of reduction slightly changed when we introduced a different hypothesis regarding the financial behavior of the family. In addition, important differences were observed in impact indicators for different groups of families.

Therefore, we consider that this work is a contribution in three aspects. First, an impact measurement outline is designed for private LTC insurance that can be applied, with necessary adaptations, to any country or group, as long as there are enough data available. Second, the impact of private LTC insurance on Spanish families' finances is quantified. Third, the impact on different groups of families is analyzed.

After this introduction, the paper is structured in four sections and the bibliography is referenced. The characteristics and design of the economic and financial model used in this work are explained in Section 2. Section 3 details data sources used to characterize the Spanish population segment that is the object of this study, including financial and demographic data of the families, dependency-derived costs and main private LTC insurance characteristics. In addition, the methodology applied is explained, which mainly includes a cluster analysis that enables families' classification and a stochastic analysis of dependency and survival using stochastic simulation techniques. Results of the study are presented in Section 4, followed by a discussion in Section 5.

2. Model

This section defines an economic and financial model that allows to establish the impact of private LTC insurance on families' finances whose head of household is retired and aged 60–65 years old. It is an adaptation of the life-cycle model that considers the evolution of the deficit between consumption and labor-related income as a function of age. The central variable of our model is the net balance (income minus expenses) of a family in each period until its extinction, symbolized by $S(t)$, $t = 0, 1, \dots$. As it will be discussed in detail in the next section, the $S(0)$ value will be obtained from the Spanish survey of household finances for Spanish families.

Two scenarios are considered, each one corresponding to a different saving strategy for the family after retirement of the head of household.

In the first scenario (Scenario A), the family is willing to accumulate more wealth after retirement of the head of household, so that in a period with a positive annual income–expenses balance, this is accumulated to the initial wealth for the period and cannot be used to cover possible deficits in coming years. Equation (1) indicates the calculation of the balance in Scenario A:

$$S(t) = INC(t) + BLTCI(t) - OEXP(t) - EXEXP(t) - PREM(t), t = 0, 1, \dots, \quad (1)$$

where INC is income, $OEXP$ is ordinary expenses (i.e., not derived from dependency), $EXEXP$ is extraordinary expenses (derived from dependency), $BLTCI$ is monetary benefits received from private LTC insurance, and $PREM$ is the premium paid for private LTC insurance.

In the second scenario (Scenario B), the family does not accumulate more wealth; if the income–expenses balance of a period is positive, it will be used for expenses in future years. Equation (2) indicates the calculation of the balance in Scenario B:

$$S(t+1) = INC(t+1) + BLTCI(t+1) - OEXP(t+1) - EXEXP(t+1) - PREM(t+1) + S(t), t = 1, 2, \dots, \quad (2)$$

where $S(t)^+ = \max(S(t), 0)$ is the balance for period t if positive, considering that $S(0) = INC(0) + BLTCI(0) - OEXP(0) - EXEXP(0) - PREM(0)$.

Thus calculated, balance is a stochastic process, which includes a double source of randomness from mortality/survival and dependency for each member of the family. We consider that there is only one level of dependency, which in Spain's case corresponds to the most severe, i.e., after the age of 65. Therefore, individual's survival/dependency is described using a three-state stochastic model: autonomous (a), dependent (d), deceased (t). Mortality and dependency tables show the probabilities of transition from one state to another depending on the age reached. For instance, let us consider a two-member family aged 62 and 65 years. One simulated evolution of the states could be $(aa, aa, aa, aa, da, da, ta, ta, ta, tt)$, which indicates that the first member is active for three years, then becomes dependent and dies as dependent two years later, whereas the second member never becomes dependent and dies at the age of 73. Hence, considering incomes, ordinary and extraordinary expenses and benefits and premiums of private LTC insurance corresponding to each family member at each period depending on their state, a possible path of the stochastic process S is obtained for a specific evolution over time of the states of the family members until the extinction of the family due to death of all of them.

The model also considers that:

- Family composition remains stable until death of one of its members, except for children initially under 15, who are excluded from the study due to the impossibility to establish hypotheses for the future evolution of magnitudes related to them. The rest of the children under the average age of emancipation (fixed at 30 years in this study [34]) remain in the family unit until reaching that age.
- Within income, a distinction has been made between incomes derived from work and retirement pensions and incomes derived from the rest. Family salaries and pensions are calculated as the sum of incomes corresponding to each member, while the rest is assigned to the group and is not altered by the modification of the number of members. Family rents and pensions remain constant while no death occurs inside the group nor dependency or professional status is altered. When a working member of the family unit reaches the official retirement age, he/she shifts to retirement pension. Upon the death of one of its members, if any has the right, the corresponding widow's pension is collected provided that, adding other public pensions together, the amount does not exceed the legal maximum.
- Ordinary expenses remain constant as long as the number of members is unchanged. One part of ordinary expenses is independent from the number of family members, while the difference is linearly assigned to each member.
- Extraordinary expenses derived from dependency are net of the dependency benefits from the public system.
- Private LTC insurance benefits consist in a constant annual annuity starting at the end of the year in which the person begins dependency and ends at death.
- Private LTC insurance premiums are annual, constant, and payable at the beginning of the year. The family unit has hired or will hire private LTC insurance for each one of its members when reaching age 65.

From the balance stochastic process, three random variables are defined. The first one, symbolized by $FTLLP$, is the first time of the lack of liquidity period, when the use of wealth will be required. It corresponds to the first time when S is negative. The variable $FTLLP$ is defective, i.e., the sum of the probabilities that it takes finite values is less than one. When S never becomes negative, we will assume $FTLLP$ takes an infinite value (due to a similarity with the time of ruin of a portfolio in ruin theory models [35]) which indicates that the family unit always has liquidity and has been able to face expenses, including those derived from dependency. This event is associated with the probability $P(FTLLP = \infty)$. Hence, the probability that the family unit has at any given moment a problem of

liquidity is $1 - P(FTLLP = \infty)$. We must point out that, as it is a defective variable, its descriptive statistics cannot be calculated.

The second variable, $FTLLP_Def$, is the start of the lack of liquidity period (if it occurs):

$$FTLLP_Def = FTLLP | FTLLP < \infty \quad (3)$$

By construction, its probability mass function is

$$P(FTLLP_Def = x) = \frac{P(FTLLP = x)}{1 - P(FTLLP = \infty)}, \quad x = 0, 1, \dots \quad (4)$$

The study of the first time of lack of liquidity delivers one important temporal piece of information on lack of liquidity, assimilable to the time of ruin in ruin theory models in insurance. However, it is necessary to complement temporal personal information with that on lack of liquidity economic amounts. These economic amounts are measured using the third random variable, the present value of all liquidity needs (symbolized by VLN) that the family unit has during its existence (until its disappearance). In ruin theory models [36], such present value of an insurer's liquidity needs is known as the "area in red". Consistently with this scenario and with the working hypothesis explained in this section, we choose a zero-interest rate for financial valuation; due to this, the present value of all liquidity needs matches the sum of all negative balances that the family unit has until its extinction. If the family always has positive balances, such present value of overall liquidity needs takes a value of zero.

These three random variables are calibrated through stochastic simulation of the paths of the stochastic process S ; in each simulation, values of S are obtained for each period until family unit extinction due to death or emancipation of its members.

Finally, the model includes three indicators of diverse nature that allow to measure private LTC insurance impact on the elderly financial scheme: the Probabilistic Indicator (PI) shows the percentage of reduction of the probability of lack of liquidity resulting from hiring private LTC insurance:

$$PI = \frac{P(FTLLP = \infty)^{(with\ LTCI)} - P(FTLLP = \infty)^{(without\ LTCI)}}{1 - P(FTLLP = \infty)^{(without\ LTCI)}} 100, \quad (5)$$

where super indexes (*with LTCI*) and (*without LTCI*) indicate that their corresponding values have been calculated in the model with or without hiring a private LTC insurance.

The Temporal Indicator (TI) measures the starting time of lack of liquidity problems. It indicates the percentage of change in the expected value of the time of lack of liquidity (if it occurs) if the family unit hires private LTC insurance for its members:

$$TI = \frac{E(FTLLP_def)^{(with\ LTCI)} - E(FTLLP_def)^{(without\ LTCI)}}{E(FTLLP_def)^{(without\ LTCI)}} 100. \quad (6)$$

Due to indicator construction, if values are negative, it means that hiring private LTC insurance causes an anticipation of lack of liquidity (if it occurs). The Financial Indicator (FI) shows the percentage of reduction in the expected value of the present value of overall liquidity needs if the family hires private LTC insurance. FI quantifies the monetary amount of the lack of liquidity problems as follows:

$$FI = \frac{E(VLN)^{(without\ LTCI)} - E(VLN)^{(with\ LTCI)}}{E(VLN)^{(without\ LTCI)}} 100. \quad (7)$$

The model can be applied in two levels: the micro level (for a specific family) or the macro level (for a generic family representative of all or one part of a country). Its application to a specific family has academic interest but does not allow to extract global economic conclusions for a country or a

collective of families. In this work, a macroeconomic type application is carried out, without losing the rich data of the individual families that compose the collective or country in the process. The set of families analyzed in our case is that of Spanish families whose head of household is retired and 60–65 years old. The procedure carried out to apply the model in a macro level has two phases. The first phase consists in classifying the initial collective in sub-collectives that can be considered homogeneous enough and different from each other. The second phase consists in the selection of the family representative of each sub-collective and subsequently apply the model.

3. Materials and Methods

In this study, four sources of data have been used: the Spanish Survey of Household Finances 2014 (EFF, from its Spanish initials) [37] (most recent version available in Spain), Pociello and Varea dependency tables [38], de Prada and Borge dependency costs [39], and equations for cost distribution of public services (such as dependency) as provided in the Dependency Act.

3.1. The Spanish Survey of Household Finances and Its Use

EFF, which contains financial information about Spanish families, has been used as the basis. Specifically, the following files have been used: *databol1.xls*, *databol2.xls*, *databol3.xls*, *databol4.xls*, and *databol5.xls*, which include processing of missing data from the survey corresponding to unanswered questions or “I don’t know” answers. The multiple imputation technique has provided a total of five datasets corresponding to the abovementioned files [40]. The inclusion of imputed values allows to conduct an analysis using complete data methods; therefore, in all statistical analyses of this study, we will keep in mind previous imputations carried out.

In EFF, weights are given to each one of the surveyed families, using a variable named *facine3*, to compensate for: (i) unequal probability of the selected household in the sample, given oversampling and geographic stratification, and (ii) lack of response of the unit. The sum of the weights of all households in the sample is an estimation of the total number of households in the fourth quarter of 2014, i.e., the weights correspond to the inverse of the probability of one household to be part of the sample [40]. The sum of all weights of the first set of imputed data is 18,362,778 households. Previous data have been processed. Three sigma criteria were applied in outlier elimination for continuous variables used in the study. In total, 313 surveys were eliminated, leaving 5807 surveys representing a total of 18,112,864 households regarding the *facine3* weighting variable. For our database, we selected only those surveys from families with a head of household aged 60–65 years old resulting in 262 surveys, which, when extrapolated to national level, represents 696,719.4 households in Spain. This database is hereinafter referred to as DB60–65.

To obtain totals, means, and population participation from EFF data, it is critical to consider such weights. Nevertheless, some controversy exists about when regression weightings should be used [41,42]. Included weights must be assessed according to each situation and the analysis objective, as in our case, where a population subset (60–65 years old) was chosen. For this reason, the cluster analysis performed in this study has not taken weights into account, since they refer to the whole population; yet, they are used in the rest of the statistical analysis to be able to extrapolate results.

The family unit income initial value, as mentioned in the previous section, is obtained from EFF. As to its subsequent evolution if a family unit member who had earned income reaches age 67 (we are currently in a transitional period of increasing the legal retirement age from 65 to 67 years in 2027 [43]). However, there is no mandatory maximum retirement age. Thus, in the sample, many people are still working after 65 years old. To homogenize, it was decided to establish that retirement occurred at age 67 as a working hypothesis), we consider that, from then on, he/she will receive 78.7% of his/her salary as retirement pension [44], provided that it does not exceed the legal maximum of EUR 37,231.70 a year [45,46]. In the case of widows’ pensions, assuming death was due to non-labor causes, its amount is 60% of the salary or pension of the deceased person (value comprised between 52% and 70%, as legally established in [47] under certain conditions).

3.2. Dependency Tables

Survival and beginning of dependency randomness have been obtained from the tables created by [38] since they were adapted to the three-state model. This choice is mainly justified by the nonexistence of dependency tables based on the Spanish population for public use (each insurance company must use its own information and hypotheses for product pricing related to dependency). These tables are based on a combination of mortality tables GRM95 [48] and the incidence rate on dependency from the OARS-Vigo health survey [49]. For consistency, to simulate the mortality/survival of the autonomous collective, we have used the same mortality tables.

3.3. Dependency Costs

To determine the costs of dependency, only the costs of services included in the dependency benefits of the Dependency Act have been considered [17]: economic benefits for family care, telecare, home help, day/night centers and residential care. Although several studies have evaluated the costs associated with caring for the dependent population in Spain [39,50], the estimation made by [37] has been used to assess these costs, since it is the most recent version available in Spain.

In order to obtain the extraordinary expenses derived from a person's dependency, the public benefits included in the Dependency Act must be subtracted from the previously described costs, taking into account the provisions contained in Article 33, in which participation of the beneficiaries in the financing of the different services is determined. In this way, the extraordinary expenses derived from the dependency net of the public system dependency benefits (which in our model are included in the *EXEXP* variable) correspond to the annual financial participation of all beneficiaries there may be in a family in the cost of the different services, characterized as *PB1* (Participation of the Beneficiary) for Economic Benefits for Family Care Services, *PB2* for Telecare Services, *PB3* for Home Help Services, *PB4* for Day/Night Service Centers and *PB5* for Residential Care Services.

The overall cost of dependency is determined by the option chosen. In this study, we will consider that the person chooses between three options, with probabilities α , β and γ , $0 \leq \alpha, \beta, \gamma \leq 1$, $\alpha + \beta + \gamma = 1$:

- Option 1. Economic Benefits for Family Care + Telecare. In this case: $EXEXP = PB2$ and $\alpha = 0.3045$.
- Option 2. Residential Care Services. In this case: $EXEXP = PB5$ and $\beta = 0.1235$.
- Option 3. This includes all alternative benefits, that is, Telecare Services, Day/Night Service Centers and Home Help Services. In this case: $EXEXP = PB2 + PB3 + PB4$ and $\gamma = 0.5720$.

Probabilities have been estimated using the data from SAAD [51] Monthly Statistics as of August 31, 2019, corresponding to the distribution among the number of beneficiaries entitled to receive these benefits.

3.3.1. Economic Benefits for Family Care Services

We have assumed that the cost for the beneficiary is zero because they receive this benefit from the State, but this has an opportunity cost that we will consider as the same amount, which implies that $PB1 = 0$. For those people who choose this service, we will only compute the cost of Telecare Services that are compatible with them.

3.3.2. Telecare Services

These services are compatible with the other benefits, except for Residential Care. Their cost is EUR 20 per month for all beneficiaries, regardless of their degree of dependency. As agreed upon by the Territorial Council, *PB2* (Table 1) is determined based on the relationship between the economic capacity of the beneficiary (*ECB*) and the Multiple Effects Income Public Indicator (*IPREM*) that amounts to EUR 6454 per year for 2019 [52].

Table 1. Beneficiary's participation in the cost of Telecare Services.

<i>ECB</i>	<i>PB2</i>
$ECB \leq IPREM$	EUR 0
$IPREM < ECB \leq 1.5 \cdot IPREM$	EUR 120
$ECB > 1.5 \cdot IPREM$	EUR 216

Source: Own elaboration from [39].

3.3.3. Home Help Services

They are made up of a set of actions that aim to meet the needs derived from the situation of dependency within the home (including both personal care and housework). The Territorial Council establishes a service of 46–70, 21–45, and a maximum of 20 h/month for Grades III, II and I, respectively.

The beneficiary's participation (*PB3*) in the cost per hour (*PBH3*) of the service depends on the number of hours assigned and ECB:

- 21–45 h per month: $PBH3 = ([0.4 \cdot CH \cdot ECB]/IPREM) - (0.3 \cdot CH)$;
- 46–70 h per month: $PBH3 = ([0.3333 \cdot CH \cdot ECB]/IPREM) - (0.25 \cdot CH)$.

In all cases, the beneficiary would participate in the cost of the service with EUR 20 if the amount obtained when applying the equation is negative or less than this amount.

Table 2 details the annual cost of Home Help Services for each degree of dependency.

Table 2. Annual cost of Home Help Services for each grade of dependency.

Grade of Dependency	Hours/Month	<i>PB3</i>
Grade III	45.6	EUR 8211
Grade II	35.6	EUR 6411
Grade I	20.7	EUR 3726

Source: Own elaboration from [39].

The calculations consider a cost per hour for the Home Help Service of EUR 15.

In our study, we will consider that, for Grade III dependents, the annual cost of Home Help Services is equivalent to 45.6 h/month, even though said amount is 0.4 h less than the minimum established by the Territorial Council. However, to calculate *PBH3* of the service, we use the already established formula of 46–70 h/month, since it corresponds to Grade III dependents.

3.3.4. Day/Night Service Centers

The set of services offered by the Dependency Act distinguishes between day centers for the elderly, people under 65 years old, specialized care and, night centers. In addition, it also establishes that these centers may be public or private, the latter being duly accredited subsidized private centers. All this casuistry greatly complicates the determination of the cost of day service centers; therefore, and based on the hypotheses formulated by [39], for the purposes of our study we will establish the annual cost of the Day/Night Service Centers according to Table 3.

Table 3. Cost of Day/Night Service Centers according to center type.

Type of Center	Annual Cost
Centers for the elderly	EUR 8820
Disability centers	EUR 11,340

Source: Own elaboration from [39].

We will consider that Grade I and Grade II dependents are assigned in centers for the elderly and that Grade III dependents are assigned in disability centers.

The economic participation of the beneficiary is

$$PB4 = \max \{0, (0.4 \cdot ECB) - (IPREM/3.33)\}. \quad (8)$$

If the financial capacity of the beneficiary is equal to or lower than the monthly *IPREM*, the latter will not participate in the cost of the service and $PB4 = 0$.

3.3.5. Residential Care Services

We consider the estimated residential costs as shown in Table 4 by type of center.

Table 4. Cost of Residential Care Services according to center type.

Type of Center	Annual Cost
Disability	EUR 32,004
Disability special needs	EUR 43,200

Source: Own elaboration from [39].

The beneficiary's participation is

$$PB5 = ECB - MA, \quad (9)$$

where *MA* represents the minimum amount for personal expenses referenced to 19% of monthly *IPREM*.

3.4. Private Long-Term Care Insurance

Private LTC insurance can be paid by a single premium or in periodic premiums. Its benefits can be monetary (most usually) or service provision. At the same time, monetary benefits include the payment of a single capital at the beginning of the dependency or periodic payments of income from the beginning of dependency until death of the insured person.

Based on internal data provided to the ICEA association by the entities that sell private LTC insurance in Spain, for the period of 2008–2018, it can be seen that virtually all private LTC insurance contracts are based on periodic premiums. However, these data do not allow us to determine mean amounts of premiums or benefits. For this reason, to conduct this study and in order to use real data, the relationship between premiums and benefits has been obtained through the free simulations from different entities.

For this study, we considered private LTC insurance for continuous annual annuities and periodic premiums payable until the beginning of dependency and/or death (whichever occurred first). Based on annual annuity modules of EUR 6000 and a premium amounting to EUR 412.35, the distribution of premiums and benefits will be established for each member of the family units.

3.5. Methodology

From a methodological point of view, this study uses very diverse economic, statistical and actuarial modeling approaches to achieve its objectives. Regarding economic and financial modeling, and as already indicated in the previous point, this study uses an adaptation of the life cycle model, which considers the evolution of the deficit between consumption and labor-related income based on age.

Statistically speaking, the cluster analysis allows us to classify Spanish families in the period of decumulation of wealth (from 60–65 years old). The cluster methodology aims to identify homogeneous

groups of families that are different from other groups, so that each can be identified with a family profile during the period of decumulation. We worked at the family, rather than the individual, level for two reasons. First, available data are aggregated at the family level, although they are at the individual level for certain variables. Second, it seems reasonable to think that financial decisions and savings policies are made by and within the family.

The variables extracted from EFF are a set of characteristics that describe each family as a frame of reference to establish groupings or clusters:

renthog13_eur14: Sum of labor and non-labor incomes of all household members in 2013.

riquezamet: Net wealth calculated after a whole process of defining intermediate variables regarding real assets, financial assets and debts.

np2_1: Main housing tenure regime. It takes a value of 1 for ownership and of 0 for other tenure regimes.

neducdom: Level of education of the head of household. It takes a value of 1–3 (lower than high school, high school, university studies).

nnumadtrab: Number of adults in the household who are working. It takes a value of 0–3 (none, one, two, three or more).

np1: Number of household members.

expenses: Constructed as the sum of three variables: *alim* (annual expenditure on food), *nodur* (annual expenditure on other non-durable goods), and *gimpvehic* (annual expenses for vehicle acquisition value).

The cluster analysis method used was *k*-means, an iterative reassignment process in which the results of the previous partition are used to improve the next one. Unlike hierarchical cluster methods, it is necessary to specify groups formed a priori and work directly with the original data matrix instead of with the distance matrix (see [53] for more information).

The *R* *miclust* package was used to perform the clusters [6,54,55], specifically the *miclust* function, which implements the *k*-means cluster analysis, including optional procedures for the selection of the final number of clusters and variables. The function is designed to integrate the results of multiple imputed datasets and shows the uncertainty that imputations introduce in the result. Since EFF provides five files from a previous imputed data analysis, the package is perfect to classify families.

In stochastic and actuarial aspects, Markov processes and stochastic simulation techniques have been applied to obtain the probability mass function of various random variables used in the study. Individuals' survival/dependency has been analyzed with a stochastic three-state model (autonomous, dependent, and deceased). Considering the basic hypotheses of irreversible dependency and stationarity of the transition probabilities between states, the stochastic process is a time-homogeneous Markov process. For more information on the use of these processes to model individuals' survival/dependency, see [56–58].

4. Results

In this section, we will present the characteristics of each cluster obtained from EFF and define the profile type of each cluster, that is, the household that we consider representative of each one. Then we will describe the statistics for the first time of lack of liquidity, as well as its probability and the statistics for the present value of overall liquidity needs of one family in each cluster and for Scenarios A and B. In Section 4.2, data will be analyzed without including private LTC insurance, whereas in Section 4.3, the analysis will include private LTC insurance. Finally, in Section 4.4, the values obtained for the private LTC insurance impact indicators are presented.

4.1. Clusters and Profile Type

This subsection includes the characteristics of the clusters we have established. In order to facilitate the interpretation of each cluster, its profile type will be defined as the household that will be used to represent the entire cluster.

4.1.1. Clusters

Using the *R miclust* function, the 262 surveys have been divided in four clusters as follows: Cluster 1 = 167 surveys; Cluster 2 = 5 surveys; Cluster 3 = 75 surveys, and Cluster 4 = 15 surveys.

Extrapolated at a population level, each cluster represents the following of a total of 696,719.4 households: Cluster 1 = 523,588 households; Cluster 2 = 290 households; Cluster 3 = 140,395 households; and Cluster 4 = 32,449 households.

The descriptions of the variables included in the clusters of the entire DB60–65 and in each cluster obtained are presented in Tables 5–11.

Table 5. Description of the variables included in the clusters of DB60–65.

Description	<i>Renthog13_eur14</i> (EUR)	<i>Riquezanet</i> (EUR)	<i>Nnumadtrab</i>	<i>Np1</i>	<i>Expenses</i> (EUR)
Minimum	0	−9138	0	1	3000
Maximum	254,241.10	21,267,000	3	5	60,000
Median	29,688	330,531	0	2	14,400
Mean	38,926.86	483,315.26	0.36	2.1	15,712.79
SD	32,958.77	637,885.61	0.62	1.03	8903.37
1st Quartile	20,674.72	165,253	0	1	9000
3rd Quartile	50,964.40	537,455	1	3	19,200

Source: Own elaboration from [37].

Table 6. Description of continuous variables in Cluster 1.

Description	<i>Renthog13_eur14</i> (EUR)	<i>Riquezanet</i> (EUR)	<i>Nnumadtrab</i>	<i>Np1</i>	<i>Expenses</i> (EUR)
Minimum	0	−9138	0	1	3000
Maximum	77,470.84	1,510,354	2	5	42,000
Median	26,135.34	263,000	0	2	12,000
Mean	27,293.65	404,092.95	0.16	1.91	12,556.02
SD	13,738	443,301.65	0.37	0.93	5731.17
1st Quartile	18,010.72	120,000	0	1	8160
3rd Quartile	34,151.10	440,557	0	2	15,600

Source: Own elaboration from [37].

Table 7. Description of continuous variables in Cluster 2.

Description	<i>Renthog13_eur14</i> (EUR)	<i>Riquezanet</i> (EUR)	<i>Nnumadtrab</i>	<i>Np1</i>	<i>Expenses</i> (EUR)
Minimum	34,438.08	8,642,000	0	1	32,400
Maximum	213,753.6	21,267,000	0	3	36,500
Median	213,753.60	8,642,000	0	3	36,500
Mean	162,975.13	11,295,462.16	0	2.35	35,831.42
SD	74,679.68	3,650,569.10	0	0.76	1285.78
1st Quartile	97,399.40	8,642,000	0	2	36,000
3rd Quartile	213,753.60	12,070,000	0	3	36,500

Source: Own elaboration from [37].

Table 8. Description of continuous variables in Cluster 3.

Description	<i>Renthog13_eur14</i> (EUR)	<i>Riquezanet</i> (EUR)	<i>Nnumadtrab</i>	<i>Np1</i>	<i>Expenses</i> (EUR)
Minimum	18,178.95	91,800	0	1	7200
Maximum	204,114.90	5,614,016.50	2	5	60,000
Median	62,344.80	500,702.50	1	2	24,000
Mean	71,835.65	631,489.91	0.73	2.49	24,916.94
SD	36,362.89	612,350.47	0.61	1.08	10,171.05
1st Quartile	55,615.52	375,000.00	0	2	19,200
3rd Quartile	73,976.56	597,213.00	1	3	30,000

Source: Own elaboration from [37].

Table 9. Description of continuous variables in Cluster 4.

Description	<i>Renthog13_eur14</i> (EUR)	<i>Riquezanet</i> (EUR)	<i>Nnumadtrab</i>	<i>Np1</i>	<i>Expenses</i> (EUR)
Minimum	19,792	177,085	1	3	16,800
Maximum	254,241.10	5,202,176	3	5	45,600
Median	44,235.12	385,329	2	4	21,600
Mean	83,146.85	1,023,795.01	2.06	3.61	26,647.72
SD	74,469.01	1,513,324.89	0.41	0.65	8597.62
1st Quartile	40,078.80	385,329	2	3	21,600
3rd Quartile	80,256.56	660,860	2	4	27,000

Source: Own elaboration from [37].

Table 10. Distribution of np2_1 factor.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	DB60–65
Ownership	87.86%	99.95%	100.00%	100.00%	90.87%
Others	12.14%	0.05%	-	-	9.13%

Source: Own elaboration from [37].

Table 11. Distribution of neducdom factor.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	DB60–65
Lower than high school	54.67%	2.74%	0%	54.99%	44.20%
High school	21.24%	6.95%	0%	9.71%	17.81%
University studies	24.10%	90.31%	100%	35.30%	37.99%

Source: Own elaboration from [37].

We define the Spanish average family (hereinafter, Spanish Family, SF) as that corresponding to the mean values of the variables included in Table 5. SF represents any family whose head of household is retired and between 60 and 65 years old, regardless of the cluster to which it belongs.

4.1.2. Profile Types

Profile types were defined using the quantitative data describing each cluster.

Profile type of Cluster 1. This household is made up of between one and two members, none of whom work, has an annual income between EUR 18,010 and 34,151 (with a mean of EUR 27,293), a net wealth that varies between EUR 120,000 and 440,557 (with a mean of EUR 404,092), and spends between EUR 8160 and 15,600 a year (with a mean of EUR 12,556).

This household has a slightly lower income than the maximum retirement pension (this amounts to EUR 37,231.7 per year [45,46]), of which it spends 45% and has a net wealth that in 75% of cases includes the value of the average Spanish house in 2014 (this amounts to EUR 37,231.7 per year [45,46].) (fully paid). The head of household has an educational level lower than baccalaureate.

Profile type of Cluster 2. This household is made up of between two and three members, of whom at most one works, has an annual income between EUR 55,616 and EUR 73,977 (with a mean of EUR 71,836), a net wealth that varies between EUR 375,000 and 597,213 (with a mean of EUR 631,490), and spends between EUR 19,200 and 30,000 a year (with a mean of EUR 24,917).

This household has twice the income of SF (EUR 38,927) and expenses that represent 35% of their income. It has a mean net wealth 30% higher than that of the average family. The head of household has university studies.

Profile type of Cluster 3. This household is made up of between two and three members, none of whom work, has an annual income between EUR 97.400 and 213.754 (with a mean of EUR 162,975), a net wealth that varies between EUR 8,642,000 and 12,070,000 (with a mean of EUR 11,295,462), and annually spends a mean of EUR 35,831.42.

The distinctive feature of this household is the magnitude of its net wealth, which is 23 times that of SF (EUR 483,315). The mean annual income of this house is four times higher than that of SF (EUR 38,927), while expenses hardly double it and only represent 20% of its income. The head of household has university studies.

Profile type of Cluster 4. This household is made up of between three and four members, two of whom work, has an annual income between EUR 40,079 and EUR 80,257 (with a mean of EUR 83,147), a net wealth that varies between EUR 385,329 and EUR 660,860 (with a mean of EUR 1,023,795), and spends a mean of EUR 26,647.72 a year.

The high number of family members is one of the distinctive features of this household. Their income, 32% of which is spent, is twice the mean income of Spanish families. Net wealth is twice that of SF. The head of household has an educational level lower than baccalaureate.

4.2. Without Private Long-Term Care Insurance

This subsection presents the results of the model if families do not purchase private LTC insurance for their members. In this case, *BLTCI* and *PREM* always take a value of 0. First, results regarding the first time of lack of liquidity are presented and then those referring to the present value of overall liquidity needs.

To obtain the simulated values of the different random variables within each cluster, we will perform, for each family in the cluster, as many simulations as households it represents, except for Cluster 2, which, given the small number of households it contains, we will run simulations for all and multiply it by 100. A joint treatment of all simulations will be carried out for all family units included in each cluster using the first set of imputed data in all cases.

4.2.1. Determining the Beginning of the Period of Lack of Liquidity

The probabilities that the first time of lack of liquidity is finite will indicate, for each house and scenario, whether a family will have liquidity problems considering dependency and its coverage by the public system (Table 12).

Table 12. Probability (%) of lack of liquidity for a family according to the house and setting (without private LTC insurance).

Scenario	Cluster 1	Cluster 2	Cluster 3	Cluster 4
A	36.02%	27.71%	20.52%	53.94%
B	16.59%	7.98%	13.84%	18.11%

Source: Own elaboration.

The probability that SF has liquidity problems, taking dependency and only public coverage into account coverage, is 35.17% if the family accumulates an annual surplus of income with respect to expenses (Scenario A). If surpluses are used to offset future deficits (Scenario B), this probability is reduced to 14.92%.

In other words, one in three families may always be forced to use their accumulated wealth to mitigate their liquidity problems. In contrast, only one in seven families will not need to use their accumulated wealth until the beginning of the period of decumulation.

The probabilities of SF have been calculated as a weighted arithmetic mean of those corresponding to each house, using the number of families represented by each cluster as weights.

Looking at the houses, the probability of lack of liquidity is higher in Scenario A than in Scenario B. However, the probabilities of Clusters 1 and 4 are higher than those of SF, while those of the other two clusters are lower. These results are consistent with the mean annual income per member of the family unit corresponding to each cluster (see Tables 6–9).

Lastly, Table 13 describes statistics of *FTLLP_Def* resulting from the simulation process for both scenarios and for all the clusters.

Table 13. Statistics of *FTLLP_Def* without private LTC insurance (Scenarios A/B).

Statistic (Years)	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Mean	16.72/15.19	21.33/12.87	8.76/4.98	21.05/19.78
SD	11.48/12.78	14.81/13.34	10.08/8.48	12.50/10.70
50% percentile	15/13	19/8	1/1	18/19
90% percentile	33/33	41/32	25/19	38/33

Source: Own elaboration.

The mean of the first time of lack of liquidity (knowing that it has occurred) for SF is 17.85 years (Scenario A) and 14.93 years (Scenario B). That is, the problems of lack of liquidity appear earlier if positive surpluses of previous years are used. At first glance, this result (which, analyzing Table 13, is also repeated in all the clusters) appears to be contrary to reason; however, an exhaustive and reasoned analysis reveals that it is totally logical given data and working hypotheses. As an example, consider Cluster 2. Here (as in the others), a series of families already have liquidity problems at the initial time of analysis, so that the *FTLLP* variable takes a value of zero. The strategy chosen by the family to manage its positive surplus does not modify this fact (so that the probability that *FTLLP* takes a value of zero is the same in Scenario A and B), but it does affect the probability that there is less liquidity in Scenario B (see Table 12).

4.2.2. Financial-Actuarial Valuation of Overall Liquidity Needs

The statistics for the present value of overall liquidity needs (*VLN*) at a zero interest rate are shown in Table 14.

Table 14. *VLN* statistics without private LTC insurance (Scenarios A/B).

Statistic (EUR)	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Mean	70,816/42,935	61,004/24,152	37,163/32,211	112,423/51,515
SD	166,820/145,931	164,124/12,072	150,302/143,115	199,595/153,079
50% percentile	0/0	0/0	0/0	19,444/0
90% percentile	236,725/116,118	206,334/0	32,849/21,867	388,095/189,719

Source: Own elaboration.

The mean of the present value of overall liquidity needs for SF is EUR 70,763 (Scenario A) and EUR 39,545 (Scenario B). This result shows the total monetary effect of using positive liquidity surpluses to offset future liquidity problems.

If we looked at one family from each house, the mean of the present value of overall liquidity needs is higher in Scenario A than in Scenario B. However, the probabilities of Cluster 1 and Cluster 4 are higher than those of SF, while those of the other two clusters are lower.

4.3. With Private Long-Term Care Insurance

Table 15 includes the amounts of premiums and the annual annuity corresponding to private LTC insurance that each family will hire.

Table 15. Premiums and annual annuities of private LTC insurance per 65-year-old member of each family.

Amount (EUR)	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Premium	412.35	824.70	2,061.75	824.70
Annuity	6.000	12.000	30.000	12.000

Source: Own elaboration.

The income modules of the insurance hired are directly related to the initial mean income per family member of each cluster (see Tables 6–9).

4.3.1. Determining the Beginning of the Period of Lack of Liquidity

The probabilities that the first time of lack of liquidity is finite will indicate, for each house and scenario, whether a family will have liquidity problems considering dependency and its coverage by the public system and by the insurance (Table 16).

Table 16. Probability (%) of illiquidity for a family according to the cluster and scenario (with private LTC insurance).

Scenario	Cluster 1	Cluster 2	Cluster 3	Cluster 4
A	30.86%	8.31%	18.49%	51.34%
B	13.60%	4.62%	13.52%	15.50%

Source: Own elaboration.

The probability that SF has liquidity problems, taking dependency and its coverage by the public system and by private LTC insurance into account, is 27.26% in Scenario A and 11.88% in Scenario B.

Looking at the clusters, the same behavior is observed with respect to the scenarios. However, the probabilities of lack of liquidity of Cluster 1 and Cluster 4 are higher than those of SF, while those of Cluster 2 are lower. Cluster 3 is the only one with a probability that does not have the same relationship with that of SF in both scenarios.

Private LTC insurance reduces the probability of lack of liquidity in all scenarios regardless of the cluster the families belong to, as shown in Tables 12 and 16. Cluster 2 is the one in which this positive effect of private LTC insurance is the greatest.

Finally, Table 17 describes statistics of *FTLLP_Def* resulting from the simulation process for Scenarios A and B with private LTC insurance.

Table 17. Statistics of *FLLP_Def* with private LTC insurance (Scenarios A/B).

Statistic (Years)	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Mean	15.79/13.01	15.70/8.06	7.19/4.72	21.28/20.74
SD	11.82/13.49	14.40/12.53	8.97/8.27	12.78/9.46
50% percentile	14/9	12/1	1/1	18/21
90% percentile	32/32	34/28	22/18	38/33

Source: Own elaboration.

The mean of the first time of lack of liquidity (knowing that it has occurred) for an SF that has hired private LTC insurance is 16.02 years (Scenario A) and 12.37 years (Scenario B).

As without private LTC insurance, the problems of lack of liquidity appear earlier if positive surpluses of previous years are used. This result (which is also repeated in all the clusters) can be explained in the same way as in the case of not hiring private LTC insurance.

If we compare the mean of the first time of lack of liquidity (knowing that it has occurred) with and without private LTC insurance, we can observe that hiring private LTC insurance move the first time of lack of liquidity ahead, except in Cluster 4 in which it increases very slightly. This might be since the insurance makes periodic payments of premiums from the beginning, which in turn increases expenses, even if dependency does not occur. The final effect depends mainly on the family's work structure. The unique behavior of the families in Cluster 4 can be explained by the fact that half of its members are active, so that an increase in premium expenses does not affect them as much.

4.3.2. Financial-Actuarial Valuation of Overall Liquidity Needs

The statistics for *VLN* at a zero interest rate are shown in Table 18.

Table 18. *VLN* statistics with private LTC insurance (Scenarios A/B).

Statistic (EUR)	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Mean	49,462/30,920	9892/6321	26,392/22,908	65,500/23,464
SD	136,718/120,833	50,397/41,211	101,274/96,135	113,717/83,245
50% percentile	0/0	0/0	0/0	9980/0
80% percentile	40,465/0	0/0	0/0	111,116/0
90% percentile	157,262/43,906	0/0	48,655/38,536	206,475/63,419

Source: Own elaboration.

The mean of the present value of overall liquidity needs with private LTC insurance for SF is EUR 42,225 (Scenario A) and EUR 25,612 (Scenario B). If we looked at one family from each cluster, the same behavior can be observed with respect to the scenarios (the mean value of overall liquidity needs is higher in Scenario A than in Scenario B).

Hiring private LTC insurance has reduced the mean present value of overall liquidity needs of SF in approximately 40%. This reduction is not consistent among the clusters, varying between 30% for Clusters 1 and 3 and 84% for Cluster 2 in Scenario A.

4.4. Long-Term Care Insurance Impact Indicators

4.4.1. Probabilistic Indicator

Using data from Tables 12 and 16, Table 19 presents the results on this indicator.

Table 19. Probabilistic indicator (*PI*).

Scenario	Cluster 1	Cluster 2	Cluster 3	Cluster 4
A	14.33%	70.01%	9.89%	4.82%
B	18.02%	42.11%	2.31%	14.41%

Source: Own elaboration.

For SF, hiring private LTC insurance causes a reduction in the probability of lack of liquidity of 22.49% and 20.38% in Scenarios A and B, respectively, which is much more pronounced in Cluster 2.

4.4.2. Temporal Indicator: When Do Lack of Liquidity Problems Start?

By construction of the indicator, if it takes a negative value, this means that hiring private LTC insurance causes an anticipation of the mean time of lack of liquidity (if it occurs).

Using data from Table 13, Table 20 presents the values of these first four temporal indices for each cluster and scenario analyzed.

Table 20. Temporal indicator (*TI*).

Scenario	Cluster 1	Cluster 2	Cluster 3	Cluster 4
A	−5.56%	−26.40%	−17.90%	1%
B	−14.35%	−37.30%	−5.20%	4.80%

Source: Own elaboration.

For SF, *TI* takes a value of −10.22% and −17.16% for Scenarios A and B, respectively. Therefore, for any generic family, hiring private LTC insurance causes a reduction of between 10% and 17% in the mean time of lack of liquidity (if it occurs).

As previously mentioned, the periodic payment of premiums is one of the factors that explains the reduction of the first time of lack of liquidity (if it occurs). The final effect depends mainly on the family's work structure, so that, unlike the others, Cluster 4 shows a slight percentage increase in the mean of the first time of lack of liquidity (if it occurs).

4.4.3. Financial Indicator: How Much Do Overall Lack of Liquidity Problems Amount to?

Using the data from Tables 14 and 18, Table 21 presents the results on this indicator.

Table 21. Financial Indicator (*FI*).

Scenario	Cluster 1	Cluster 2	Cluster 3	Cluster 4
A	30.15%	83.80%	29%	41.80%
B	27.99%	73.80%	28.90%	54.50%

Source: Own elaboration.

For SF, hiring private LTC insurance represents a significant reduction of between 35% and 40%, depending on the scenario, in the mean of the present value of overall liquidity needs. If we break down the different clusters, Cluster 2 stands out with twice that percentage of reduction.

5. Discussion

Based on the economic data from Spanish families whose head of household is retired and between 60 and 65 years, three impact indicators have been estimated for a generic family and differentiated by

family types, and two scenarios have been considered, indicating different saving strategies depending on whether or not the family is willing to accumulate more wealth after retirement.

This study concludes that, for a generic family, hiring private LTC insurance causes a reduction of 22.49% in the probability of lack of liquidity in Scenario A and of 20.38% in Scenario B; a reduction of 10% in the mean time of first lack of liquidity (if it occurs) in Scenario A and of 17% in Scenario B; and a significant reduction of 35% in the mean of the present value of overall liquidity needs in Scenario A and of 40% in Scenario B. It has also been observed that there are important differences regarding these impact indicators between the groups of families.

Beyond their specific values, the results of these indices reflect that, if families take out private LTC insurance when they retire, they would considerably reduce their financial problems during the decumulation stage. This conclusion is valid regardless of the social stratum to which the family belongs. In the literature, the low demand for private LTC insurance is attributed to various factors, highlighting consumers' limited rationality, which makes it difficult for them to understand low probability, high-loss events [32] and the cost and complexity of private LTC insurance [5]. Furthermore, according to [2], this demand is inelastic in terms of prices, making it difficult to drive hiring an insurance policy that subsidizes part of the premium. Our study provides strong arguments to facilitate the understanding of the risk of falling into a situation of dependency and of the positive effects of hiring a private LTC insurance.

Our model, based on the Spanish structure for dependency contingency coverage, considers that private LTC insurance is complementary (never a substitute) to public coverage, unlike what happens in other markets where public coverage is opposite private insurance [1].

The results of this study are not directly transferable to other countries, although they can provide a reference point for societies with a welfare state like Spain's. In addition, the proposed model (with adaptations from the corresponding sources) does apply to the analysis of the effects that hiring private LTC insurance may have in each country.

In the model, we have made a series of working hypotheses that are susceptible to reflection. In order not to add unnecessary complexity to the analysis, we have used simple hypotheses regarding the future evolution of macroeconomic magnitudes (interest rates, consumer price index [CPI], evolution of pensions) and the evolution of the structure of families up to their extinction. Regarding the former, a future line of research will include a set of alternative scenarios in which the relationship of CPI's evolution with respect to the index used for pensions revaluation is modified.

The stochastic analysis of mortality has been based on GRM95 tables that can be considered as stationary tables in the sense that the mortality probabilities for a fixed age does not change as time goes on (and then the transition probabilities of the Markov process depend only on the attained age). Currently, in Spain, new generational mortality tables are being completed that would reflect future mortality in a more accurate way. In general, a generational table considers that the transition probabilities for a fixed age are no longer stationary but depend on the year of birth. The use of a generational table (or dynamic mortality table) would permit to include mortality improvements in the model. Likewise, concerning probabilistic tables, we have focused on analyzing only the effects of Grade III dependency on family finances due to the absence of information about the other grades recognized by the Spanish public system. However, in the future, the study could be expanded to include all three degrees of dependency, provided we have the corresponding tables. In this sense, if there are no dependency tables for the Spanish population, those published for other countries could be used (e.g., [59–61]) after making the appropriate adjustments.

In this study, private LTC insurance is set to provide a life annuity from the moment you enter dependency, since it is the type of insurance that currently prevails in the Spanish market. The annuities that this insurance provides for each cluster have been set based on the empirical market practice. A possible alternative would be to adjust the number of income modules taking into account each family profile instead of the cluster to which they belong, although we believe that the results obtained would not significantly differ from those obtained in this study.

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