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VALUATION OF REVERSE MORTGAGES IN THE SPANISH MARKET FOR FOREIGN RESIDENTS

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Abstract. The continuous growth in life expectancy, besides to the difficult economic and financial situation of the public pension system in Spain, makes reverse mortgages an attractive solution for providing additional income to retirees. However, despite being almost 20 years old, the Spanish market remains immature. Consequently, providers face significant risks, due to factors such as interest rates, housing prices, and longevity. Numerous tourists visit Spain, and many retire there, obtaining legal residence. Therefore, lenders could be interested in marketing reverse mortgages to foreign residents. Nevertheless, the longevity risk faced by these lenders may differ depending on the nationality of the borrower, and profits and losses could vary. Consequently, we propose a methodology for comparing the pricing of reverse mortgages in Spain by considering differences in longevity risk. Specifically, we calculate the amount offered by three types of reverse mortgages to customers of different nationalities, genders, and ages with contracts made in Spain. Our conclusions are pertinent to Spanish lenders since the results indicate that, in general, a Spanish lender would assume a slightly larger risk when lending reverse mortgages to borrowers of the selected nationalities, regardless of other considerations, such as legal issues, which are not addressed in this article.

Keywords: reverse mortgage, longevity risk, lump sum, income stream, Lee-Carter, foreign residents, mortality.

JEL Classification: D4, E27, G21, G22.

Introduction

At the beginning of 2018, 101.1 million people over the age of 65 lived in the European Union (Eurostat, 2019), constituting 19.7% of the total population. Additionally, the number of people over 65 in the European Union is expected to grow over the next three decades, reaching an estimated peak of 149 million in 2050, constituting 28.5% of the total population.

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Thus, with baby boomers retiring, low fertility rates, and an increasing proportion of people over 65, pension systems in different countries are facing an increasingly ageing population and significant future imbalances (Alai et al., 2014). Moreover, as Eurostat (2019) notes in 2016, the pension replacement rate relative to the last salary was 79% and will decline to 49% by 2050. Reverse mortgages are, therefore, a potential solution to have extra income to finance old age and maintain one's lifestyle (as noted by the studies by Mayer and Simons (1994), Hancock (1998a), and Hancock (1998b) show). In fact, retirees often use reverse mortgages to borrow against a home they own to obtain cash to supplement their pensions (de la Fuente et al., 2021).

A reverse mortgage is an insurance actuarial-financial product that enables retirees to convert a proportion of their home property into equity, while at the same time maintaining ownership of their residence until they die, sell, or leave their homes to live elsewhere (Banco de España, 2017). One of the main conditions for applying for a reverse mortgage is that the borrower must be over a certain age, typically over 55 in the United Kingdom and Canada, over 62 in the United States, and over 65 in Spain and Germany. The key elements of reverse mortgages are the home, which serves as collateral, and the purpose, which is to provide income until the death of the homeowner.

It is worth noting that the reverse mortgage began to be marketed in the United States in 1979 by the Federal Home Loan Bank Board (Chinloy & Megbolugbe, 1994), in Australia in the early 1990s (Wang et al., 2008), and in Spain in 2007 (Banco de España, 2017). While the market in several countries has not proven to be as active and viable as the industry had hoped, reverse mortgages have great potential for growth, as shown by the work of Reed and Gibler (2003), Chen et al. (2010), Shan (2011), and Costa-Font (2013). This low demand for the product is mainly due to low product awareness and a lack of financial knowledge in the general population (Dillingh et al., 2013; Davidoff et al., 2017; Whait et al., 2019; Choinière-Crèvecoeur & Michaud, 2023). Notably, the penetration of this product in Spain is relatively low compared to other countries, such as the USA and Australia. This fact is mainly attributed to the deep culture in favour of bequest, as noted by Costa-Font (2013) in a telephone survey. Other factors affecting the number of reverse mortgage contracts include the loss of house value, longevity risk resulting from people living longer than expected, high interest rates and expenses, risk aversion, and reputational risk, among others, as noted in different studies, see, for instance, Wang et al. (2008), Yang (2011), Barrieu et al. (2012), Fornero et al. (2016), and Boj et al. (2022).

In international reverse mortgage markets, there are four basic types of reverse mortgages depending on the form of payment. The first type is the lump sum, which is a cash payment of a fixed percentage of the future value of the property at the time of origination. Second, the income stream option offers periodic income payments from the initial time of the loan until the individual's death. The third option is the line of credit, allowing the borrower to make cash drawdowns up to a maximum amount. Finally, some plans combine aspects of the previous options. According to the Consumer Financial Protection Bureau (2012), the lump-sum payment is the easiest product for the customer to understand, as the complexity of these products is the main criticism of their commercialization (Cho et al., 2015). In addition, lump-sum is the most profitable product with the least risk for the lender, as Cho et al. (2015) demonstrated.

It should be noted that until now, the line of credit for reverse mortgages has not existed in Spain. Instead, income stream schemes have been the most widely used, with two types. The first type is the term reverse mortgage, which provides periodic income streams for a specific time period or until the individual's death if it occurs before such a time period has elapsed (this time coincides with the life expectancy of the borrower). The second type is the whole-life reverse mortgage, which provides periodic income streams until the individual's death.

These different forms of payment for a reverse mortgage have been examined and compared throughout the literature. Cho et al. (2015) compared lump-sum and annuity payment reverse mortgage types in the Australian market and determined that receiving a lump-sum has a higher expected return and lower value-at-risk (VaR) than receiving annuity payments. Alai et al. (2014) examined the return and risk profile of lump-sum, which is the most common type of reverse mortgage in Australia. Wang et al. (2016) presented a closed formula for calculating the loan-to-value (LTV) ratio for a lump-sum reverse mortgage. Lee et al. (2018) analysed the profitability and risk profile of both lump sum and annuity payment reverse mortgages. They showed that lenders prefer lump-sum products, which helps explain why this product dominates the market. de la Fuente et al. (2021) used a VaR process to analyse the risk faced by the provider of lump-sum reverse mortgages over time. The lump-sum product is most widely used when studying the performance of reverse mortgages. In addition, international comparisons (de la Fuente et al., 2021) have concluded that reverse mortgage providers in Spain face higher risks.

Clearly, the providers of a reverse mortgage are influenced by three main underlying risk factors, mortality/longevity, house price, and interest rates. The reductions in mortality and hence the improvements in longevity will delay the liquidation of reverse mortgages. A decline in the housing market will worsen the value of the property, while a higher interest rate will increase the rate at which the loan balance grows. Thus, of these three risk factors, Chinloy and Megbolugbe (1994) and Wang et al. (2008) believe that the mortality/longevity risk is the most important factor in reverse mortgage pricing and risk management.

The proposal of this paper is to set up a reverse mortgage sold to foreign borrowers living in Spain. Numerous tourists visit Spain throughout the year, and many of them choose to enjoy their retirement in this country. Therefore, Spanish reverse mortgage providers could be interested in marketing this product not only to Spaniards but also to foreign residents in Spain. Since the longevity risk that these companies face is different depending on the nationality and longevity of the individual, the profits and losses will vary.

Therefore, the main goal of this paper is to compare the amount offered by the providers of reverse mortgages in Spain to different customers and study which assumptions are more or less advantageous in terms of the longevity of foreign residents. To achieve this, we analyse the differences between the three types of reverse mortgages considering the nationalities, genders, and ages of the customers with contracts made in Spain. To estimate the price of reverse mortgages, we keep interest rate risk and house price constant, while we use a dynamic mortality model (Lee & Carter, 1992) to estimate longevity risk. This fact is due to longevity risk being the most important factor in pricing reverse mortgages, as previously highlighted. The contribution of this research is twofold. First, we propose a pricing approach to derive the actuarial-financial equilibrium in the three types of reverse mortgages. Second, we calculate the amount to be offered to different customers of these types of reverse mortgages in Spain by varying the ages, gender, and nationalities of the foreign residents that retire in Spain.

Furthermore, longevity heterogeneity refers to the socioeconomic differences observed among individuals within populations and/or socioeconomic groups. This heterogeneity in longevity is due to different factors, such as gender, age, race, education, geographic location, or marital status (Chetty et al., 2016; Ayuso et al., 2017b; Bravo et al., 2021). Such factors are highly correlated with income, which forms the basis for contributions and savings efforts that will lead to disbursement in the form of a pension. Therefore, longevity heterogeneity is positively linked to income throughout the individual's life cycle. Thus, the heterogeneity of longevity produces important biases in the price of life insurance contracts, public and private pension plans, and any financial product linked to longevity. This generates large differences between future and current generations, men and women, and different populations or countries (Ayuso et al., 2017a, 2021). It is worth remembering that many tourists of different nationalities enjoy retirement in Spain, and their longevity differs from that of a Spanish citizen. This heterogeneity can lead to large differences in the valuation process of reverse mortgages for different entities depending on the nationality, age, or sex of the individual. Thus, this article aims to study the impact that the heterogeneity of the longevity of foreign residents in Spain has on the valuation of reverse mortgages in Spain.

This paper is organized as follows. Section 1 provides a bibliographic review of how to address the different types of risk involved in reverse mortgages. Section 2 presents the Spanish reverse mortgage market. Then, in Section 3, the model for the construction of reverse mortgage calculation is described, and how each risk is captured is discussed. The data used are presented in Section 4. The application of the reverse mortgage methodology is shown in Section 5. Finally, the last Section presents the main conclusions.

1. Literature review

Reverse mortgages can be a valuable supplement to a modest pension of the elderly during retirement, but they also involve several risks to the provider. In this section, we will analyse these risks and provide a bibliographic review of the authors who have addressed them and their methodology, as shown in Table 1. Thus, Table 1 presents the primary papers in the first column, while Columns 2, 3, and 4 address how each paper models the three types of risks.

There are different approaches to modelling interest rate risk in reverse mortgages. One approach is to assume a fixed interest rate, which has been used by several authors, such as Chen et al. (2010), Yang (2011), Kogure et al. (2014), Shao et al. (2015), Sharma et al. (2022), de la Fuente et al. (2020), and Di Lorenzo et al. (2021). However, alternative models can be employed to capture the dynamics of interest rates. For instance, the Vasicek (1977) model is a good solution to describe the evolution of reverse mortgage interest rates, assuming constant volatility in a low or negative interest rate environment; for example, Wang et al. (2008) or de la Fuente et al. (2023). Alternatively, the CIR model (Cox et al., 1985), Cox-Ross-Rubinstein binomial tree model (Cox et al., 1979), Black process (Black et al., 1990), or pricing kernel can be used to assume a square root process or a log-normal process for the short-term interest rate, as detailed in Table 1. Moreover, in cases, such as during the Ukraine war, these assumptions may not be appropriate due to the significant fluctuations in short-term interest rates. Consequently, during periods with high volatility of the interest rate series, alternative approaches such as, the jump-diffusion process is a excellent solution to address this issue (Di Lorenzo et al., 2022).

Table 1. Review of the methodology used in the valuation of reverse mortgages

Paper	Interest Rate	Longevity Risk	Housing price model
Wang et al. (2008)	Vasicek (1977) model	Renshaw et al. (1996) model	Geometric Brownian process model
Chen et al. (2010)	Fixed	Lee and Carter (1992) model with asymmetric jumps	ARMA-GARCH process
Huang et al. (2011)	Log-normal process Black et al. (1990)	Lee and Carter (1992) model accompanied by the Wang (2000) transformation	Geometric brownian motion process
Yang (2011)	Fixed	Cairns et al. (2006) mode	ARMA-GARCH process
Lee et al. (2012)	Cox et al. (1985) model	Lee and Carter (1992) model accompanied by the Wang (2000) transformation	Log-normal diffusion process with jumps
Alai et al. (2014)	Pricing Kernel (Ang & Piazzesi, 2003)	Linear regression to central death rates and Poisson regression to death counts	Vector autoregressive model with 2 lags
Kogure et al. (2014)	Fixed	Joint distribution under a Bayesian setting	
Shao et al. (2015)	Fixed	Wills and Sherris (2008) stochastic mortality model	Vector-Auto-Regression
Wang et al. (2016)	Cox et al. (1985) model	Lee and Carter (1992) model	Geometric Brownian motion process
Lee et al. (2018)	Cox et al. (1985) model	Brouhns et al. (2002) model	Log-normal diffusion process with jumps
Sharma et al. (2022)	Fixed	Lee and Carter (1992) model	Factor-augmented vector autoregressive model
de la Fuente et al. (2020)	Fixed	Lee and Carter (1992) model	ARMA-EGARCH process
di Lorenzo et al. (2021)	Fixed	Lee and Carter (1992) model	Neural Network
di Lorenzo et al. (2022)	Jump-diffusion process	Lee and Carter (1992) model	Geometric Brownian motion process
Lee and Shi (2022)	Cox-Ross-Rubinstein binomial tree model (Cox et al., 1979)	Lee and Carter (1992) model	Geometric Brownian motion process
de la Fuente et al. (2023)	Vasicek (1977)	Lee and Carter (1992) model	ARMA-EGARCH process

The second risk is the housing price, which manages uncertainty in the real estate market. Geometric Brownian motion (GBM) is a popular option for describing the dynamics of the house price in the reverse mortgage literature; see, for instance, Wang et al. (2008), Huang et al. (2011), Wang et al. (2016), and Di Lorenzo et al. (2022). GBM is a random walk with constant drift and volatility. However, there are other approaches to consider, such as the ARMA-GARCH process (Chen et al., 2010; Yang, 2011) or ARMA-EGARCH process (de la Fuente et al., 2020, 2023). Alternatively, it is possible to model two risks simultaneously. The vector autoregressive (VAR) model can be used to capture the dynamic relationship between the house price index and interest rates; see Alai et al. (2014), Shao et al. (2015), and Sharma et al. (2022). However, if the market dynamic is expected to shift substantially, another approach may be needed, such as a jump-diffusion model (Lee et al., 2012, 2018). Even more sophisticated statistical techniques, such as neural networks, have been used to project the real estate market (di Lorenzo et al. 2021).

Additionally, the valuation of reverse mortgages also involves a third risk, the mortality/longevity risk, which assumes that individuals will live longer than expected (Debón et al., 2013). A wide range of mortality models has been employed in the literature to forecast the mortality process, with the Lee and Carter (1992) model being one of the most used. Indeed, this model has been employed by Chen et al. (2010), Huang et al. (2011), Lee et al. (2012), Wang et al. (2016), Sharma et al. (2022), de la Fuente et al. (2020), Di Lorenzo et al. (2021, 2022), Lee and Shi (2022) and de la Fuente et al. (2023). Other versions of the Lee and Carter (1992) model, such as the proposals by Cairns et al. (2006), Yang (2011), by Renshaw et al. (1996), Wang et al. (2008), or by Brouhns et al. (2002), Lee et al. (2018), can be employed to capture future mortality dynamics. Finally, other mortality models different from Lee-Carter have been applied to forecast mortality; for instance, Alai et al. (2014) and Shao et al. (2015), among others.

2. Reverse mortgages in Spain

The origin of the reverse mortgage market in Spain dates to the early 2000s, when the first banks, mainly savings banks, began to offer these products to their customers. However, this market had no regulation until 2007, when Law 41/2007, which established a generic regulatory framework for this product, was enacted (BOE España, 2007). Basically, Law 41/2007 defined the requirements for reverse mortgages to be eligible for tax incentives and be officially recognized.

The years immediately following the enactment of the law saw the greatest rise in reverse mortgages. The number of mortgages contracted peaked in 2009, when 780 mortgages were signed (Consejo General del Notariado, 2021), corresponding to an increase of 110.24% (Figure 1). In the following decade, the product suffered the consequences of the real estate crisis and the process of bank concentration, which reduced its contracting to residual levels. Despite being almost 20 years old, the Spanish reverse mortgage market is still not very mature. Since 2016, the number of reverse mortgages contracted in Spain has been growing progressively, with a considerable percentage growth in the latest available data from 2018 to 2019 (Figure 1).

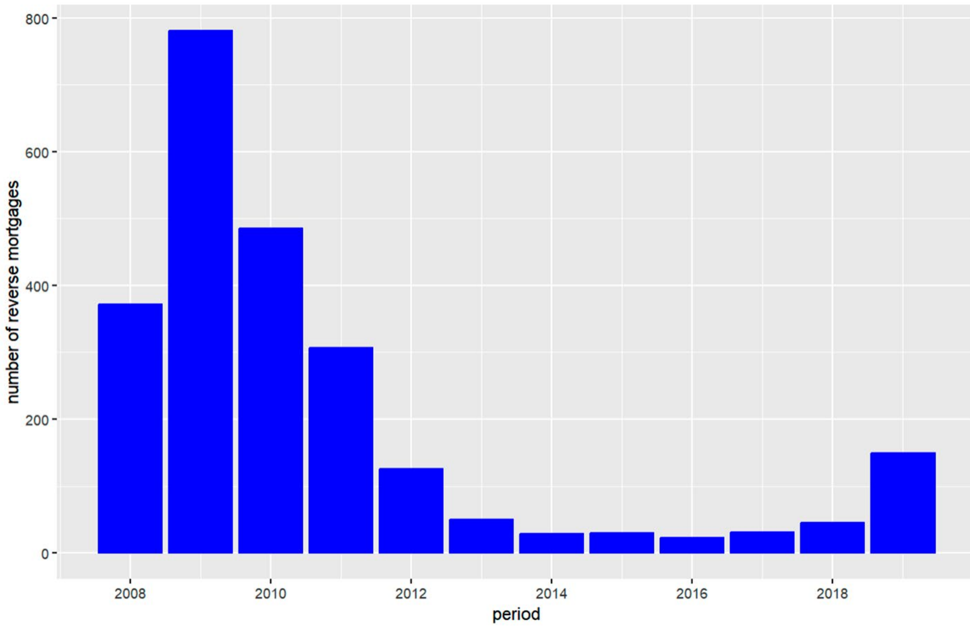

Figure 1. Evolution of the number of reverse mortgages taken out in Spain from 2008 to 2019 (source: Consejo General del Notariado, 2021)

In addition to the evolution of the market, it is worth highlighting some particularities that distinguish the Spanish reverse mortgage market from other more developed markets, such as the British or American markets, which are summarized below:

- First, in Spain, reverse mortgages only have to be repaid mandatorily when borrowers die. Thus, repayment is optional in other situations. However, in the United Kingdom and the United States, reverse mortgage loans must be repaid when borrowers die or when they leave their home permanently (Ji et al., 2012).
- Second, in the United Kingdom and the United States, the nonnegative-equity guarantee (NNEG) is included as a standard in reverse mortgages. This implies that although the accumulated debt exceeds the property's value, the loan is redeemed when the lender receives the real estate property. In Spain, the NNEG is not included; thus, in this situation, the borrower's inheritors respond with all the borrower's heritage assets, not only with the mortgaged property (de la Fuente et al., 2021).

Despite the low number of reverse mortgages contracted and the characteristics of the Spanish market, as in other European countries, different types of reverse mortgages have been marketed in Spain. This study focuses on the three most representative types of reverse mortgages in the Spanish market mentioned in the introduction: lump-sum, term, and whole-life reverse mortgages.

It should also be noted that the last reform in the Spanish pension systems that affected the retirement age was in 2013 (BOE España, 2013). This new law established two main reforms. First, there is an increase in retirement age. The Social Security System of Spain introduced a progressive increase in the retirement age, from 65 to 67 years old. Second, the introduction of a factor of financial sustainability will automatically link the starting salary of retirees to the evolution of life expectancy.

This reform aims to reduce the pension system's deficit, mainly due to demographic evolution and the problematic financial situation. Indeed, the increase in longevity and, consequently, in the proportion of the retirement-age population will generate significant upwards pressure on pension expenditure. Thus, reverse mortgages are a solution to provide additional income to finance retirement and maintain the standard of living.

3. Methodology

In this section, our interest focuses on dynamic life tables since all payments' correct valuation requires well-calibrated life tables. Additionally, the other two risks involved in the reverse mortgage calculations are presented later: interest rate and housing prices.

3.1. Projecting mortality rates

3.1.1. Coherent mortality extrapolation for ages above 85 years

To properly estimate longevity risk, we extrapolated the probabilities of death beyond the last observed age. It should be noted that reverse mortgages mainly focus on elderly people. Therefore, to obtain the right price, we need to extend the life tables to include a wide range of ages in the estimation process, even at the risk of appearing excessive.

In this paper, we use mortality data from the Human Mortality Database (2021) for the age range of 0–99. Although the database contains mortality information for ages up to 110, we refrain from using this last range of ages due to the low quality of data for ages above 99 years old, as mentioned by Barbieri et al. (2015) and Lima et al. (2017), among others.

Specifically, we opted to carry out a prior treatment of the probabilities of death at ages over 85 years following Booth et al. (2006), Cossette et al. (2007), and Debón et al. (2013), which included different proposals for completing the life tables at advanced ages (see, for example, the approaches by Coale and Guo (1989), Coale and Kisker (1990) or Thatcher et al. (1998)).

Thus, we decided to enlarge the mortality rates[1] until age 130 with a log-quadratic regression model, which was proposed by Denuit and Goderniaux (2005), and adapted the fitting method to Generalized Linear Models (GLM) with log link and binomial distribution by Debón et al. (2013),

$$\ln\left(q_{x,t}\right) = a_t + b_t x + c_t x^2 + \varepsilon_{x,t}, \tag{1}$$

where $\varepsilon_{x,t}$ are the independent and identically distributed errors, $N\left(0;\sigma^2\right)$. The model is calibrated separately for each calendar year t and for ages above 75 years to estimate the parameters a_t, b_t and c_t. In addition, it is necessary to impose two restrictions,

[1] The mortality rate $q_{x,t}$ is defined as the probability of an individual aged x in the calendar year t dying within one year (Pitacco et al. 2009). This term can also be called age-specific death probability or the probability of death.

1. $q_{130,t} = 1$.
2. $\frac{\partial q_x(t)}{\partial x}\Big|_{x=130} = 0$.

These two constraints yield the following relation between a_t, b_t and c_t for each calendar time (Denuit & Goderniaux, 2005):

$$a_t + b_t x + c_t x^2 + \varepsilon_{x,t} = c_t\left(130 - x\right)^2, \tag{2}$$

and by substituting Equation (2) in Equation (1),

$$\ln\left(q_{x,t}\right) = c_t\left(130 - x\right)^2. \tag{3}$$

This model extrapolates the crude probabilities from age 75 to age 130. The death probabilities to be used to fit the Lee and Carter (1992) model are the crude probabilities for $x = \{0, 1, \ldots, 85\}$ that will be downloaded from the Human Mortality Database (2021), and for $x = \{86, 87, \ldots, 125\}$[2], we use the extrapolated probabilities obtained using Equation (3). This procedure allows us to ensure that the age-specific probabilities of death at the end of the mortality curve do not have an abrupt change.

3.1.2. Modelling dynamic life tables

We fit the model that allows us to project the probabilities for future years. Many models have been proposed throughout the literature to model mortality dynamics. Among them, we chose the model of Lee and Carter (1992), following the research results by Chen et al. (2010), Debón et al. (2013), and Wang et al. (2016). This model was developed exclusively for the graduation of dynamic life tables. It has been widely accepted in the actuarial world due to its simplicity and the goodness of its results. and it has undergone many extensions. The model has been calibrated with more factors (Booth et al., 2002; Brouhns et al., 2002; Cairns et al., 2006, 2009), the cohort effect has been included (Hobcraft et al., 1985; Renshaw & Haberman, 2006; Haberman & Renshaw, 2009), and different methodologies have been proposed to fit the k_t time series (Doukhan et al., 2017; Nigri et al., 2019). In recent years, machine learning algorithms have been proposed to calibrate the model (Hainaut, 2018; Levantesi & Pizzorusso, 2019; Perla et al., 2021; Richman & Wüthrich, 2021; Hong et al., 2021).

The correct calibration of the probabilities of death and robust prediction are essential to calibrating longevity risk, as any deviation can lead to large losses for insurance companies. Atance et al. (2020) compared the predictive capacity of several versions of the model of Lee and Carter (1992). They found that the simplest version has the best forecasting ability for most European countries in the Human Mortality Database (2021). Furthermore, Debón et al. (2021) found that the life expectancy of this version of the model has a better response to the financial challenges posed by longevity risk. For these reasons, the model of Lee and Carter (1992) was used.

This model belongs to the category of age-period (AP) models (Villegas et al., 2018), as it describes the central mortality rate $m_{x,t}$ as a function of age x and period t,

[2] Age-specific probabilities of death for ages above 125 are not used because we consider that any individual arrives at that age.

$$m_{x,t} = \exp\left(a_x + b_x k_t + \varepsilon_{x,t}\right), \quad (4)$$

or equivalently,

$$\ln\left(m_{x,t}\right) = a_x + b_x k_t + \varepsilon_{x,t}, \quad (5)$$

In Equation (5), a_x and b_x depend on age, k_t is an index that captures the general trend in mortality over time, and $\varepsilon_{x,t}$ are error terms that are assumed to have zero mean and variance $\sigma^2_{x,t}$ and reflect the part of the central death rates that the model is not able to capture. This model is indeterminate since any given solution (a_x; b_x; k_t) is also a solution, any transformation (a_x; b_x/c; $c \times k_t$) or ($a_x + c \times b_x$; b_x; $k_t - c$), $\forall c$. To avoid this problem and obtain a single solution, Lee and Carter (1992) normalized the parameters $\sum_x b_x = 1$ and $\sum_x k_t = 0$. Furthermore, the model cannot be fitted by standard regression techniques since the values of the time index, k_t are not observable.

In this study, the model was applied to logit transformation of age-specific death probabilities, $q_{x,t}$ as Debón et al. (2008) proposed,

$$\operatorname{logit}\left(q_{x,t}\right) = \ln\left(\frac{q_{x,t}}{1 - q_{x,t}}\right) = a_x + b_x k_t + \varepsilon_{x,t}. \quad (6)$$

This transformation allows obtaining values of $q_{x,t}$ between 0 and 1 (Lee, 2000), a restriction not necessary for $m_{x,t}$ in Equation (5) from Equation (4). This also permits the maintenance of historical ties to the early actuarial work of Perks (1932), as noted by Haberman and Renshaw (2011).

The estimation of the model parameters was carried out using the maximum likelihood method and assuming a quasibinomial distribution for the number of deaths. For this purpose, the gnm library, published by Turner and Firth (2020) of the R Core Team (2020), was used. Implementation details in Debón et al. (2010).

Then, we needed to predict the future value of k_t assuming that it follows an ARIMA process (Renshaw & Haberman, 2006; Guillen & Vidiella-i Anguera, 2005; Debón et al., 2008; Hunt & Blake, 2020). In this case, we used the auto.arima function from the forecast R package by Hyndman and Khandakar (2008) and Hyndman et al. (2021). This function provides the ARIMA (p, d, q) model that gives the best results according to the AIC. Then, we are able to predict future death probabilities once the parameter k_t has been projected.

3.1.3. Monthly life tables

We use monthly life tables to calculate reverse mortgages, as reverse mortgage payments are similar to an annuity payable monthly (Bowers et al., 1987). These monthly cohort life tables show the mortality experience of a given birth cohort over its life course. Hence, we took the annual age-specific death probabilities, $q_{x,t}$, from previous subsubsection 3.1.2 to recursively obtain $l_{x,t}$, the number of individuals who reach the age of x,

$$l_{x+1,t} = l_{x,t} \cdot \left(1 - q_{x,t}\right), \quad (7)$$

from an initial cohort of $l_{0,t} = 100{,}000$ born individuals. Then, from the annual $l_{x,t}$, in each diagonal, we can obtain the monthly number of survivals, omitting the subscript t for the sake of simplicity of notation in the following formulas. Indeed, the forecast of the age-specific probabilities of death are made from the annual data using the Lee-Carter model. Once the out-of-sample mortality rates are projected, the monthly probabilities are estimated and used in the estimation process of the reverse mortgages.

Applying the uniform[3] distribution of deaths hypothesis (Bowers et al., 1987), to transform the annual life table into monthly tables, so

$$l_{x+\frac{s}{12}} = \left(1-\frac{s}{12}\right)\cdot l_x + \frac{s}{12}\cdot l_{x+1}, \text{ for } s=1,\ldots,12, \tag{8}$$

where $l_{x+\frac{s}{12}}$ symbolizes the number of people alive at age $x+\frac{s}{12}$.

Thus, we can calculate the number of monthly deaths and monthly probabilities of death to obtain the price of reverse mortgages following Bowers et al. (1987) and Pitacco et al. (2009),

$$d_{x+\frac{s}{12}} = l_{x+\frac{s}{12}} - l_{x+\frac{s+1}{12}}, \text{ for } s=1,\ldots,12, \tag{9}$$

$${}_{k+\frac{s-1}{12}}p_x = \frac{l_{x+k+\frac{s-1}{12}}}{l_x} \text{ for } s=1,\ldots,12, \tag{10}$$

$${}_{k+\frac{s}{12}}p_x = \frac{l_{x+k+\frac{s}{12}}}{l_x} \text{ for } s=1,\ldots,12, \tag{11}$$

$${}_{\frac{1}{12}}q_{x+k+\frac{s-1}{12}} = \frac{d_{x+k+\frac{s-1}{12}}}{l_{x+k+\frac{s-1}{12}}} = \frac{l_{x+k+\frac{s-1}{12}} - l_{x+k+\frac{s}{12}}}{l_{x+k+\frac{s-1}{12}}} \text{ for } s=1,\ldots,12, \tag{12}$$

where:

- $d_{x+\frac{s}{12}}$ denotes the number of deaths between age $x+\frac{s}{12}$ and age $x \quad \frac{s\quad 1}{12}$.
- ${}_{k+\frac{s-1}{12}}p_x$ denotes the probability that a life age x will attain age $x+k+\frac{s-1}{12}$.
- ${}_{k+\frac{s}{12}}p_x$ denotes the probability that a life age x will attain age $x+k+\frac{s}{12}$.
- ${}_{\frac{1}{12}}q_{x+k+\frac{s-1}{12}}$ denotes the probability that a life age $x+k+\frac{s-1}{12}$ will die within $\frac{1}{12}$ years.
- k represents the number of years considered by the provider to determine the amount of each type of reverse mortgage. Specifically, k can take the values $k = 0, 1, \ldots, \omega - x - 1$, where ω denotes the maximum age that an individual can reach (which is set at 125 for this paper), and x represents the age of the borrower who received the reverse mortgage.

[3] In actuarial literature, it is common to calculate fractional ages in intra-annual mortality studies using various fractional age assumptions (FAAs). The main alternatives for the distribution of deaths are the uniform distribution, the constant intra-age force of mortality, and the Balducci or hyperbolic assumption.

The uniform distribution assumes that the survival function of the age-at-death random variable is linear between integer ages (Jones & Mereu, 2000). The constant intra-age force of mortality is an actuarial assumption that imposes a constant force of mortality between integer ages (Jones & Mereu, 2000). Last, in the Balducci or hyperbolic assumption, the survival function is linear among the integer ages (Jones & Mereu, 2002; Pavía & Lledó, 2022).

Finally, the monthly remaining lifetime corresponding to age x, $e_x^{(12)}$, can be calculated as follows:

$$e_x^{(12)} = \frac{\sum_{k=x}^{\omega} \sum_{s=1}^{12} l_{k+\frac{s}{12}} + 1/2 \cdot d_{x+\frac{s}{12}}}{l_x}, \tag{13}$$

Once, we obtain the result $e_x^{(12)}$ from Equation (13), to obtain the life expectancy, e_x, in years we have to divide, $\frac{e_x^{(12)}}{12} \approx e_x$, rounded to the nearest whole year.

Although, using actual monthly data would provide a more precise estimate. However, not all countries considered in this paper have monthly information on the number of deaths; hence, we must make an assumption regarding the number of deaths that is quite usual in actuarial calculations.

3.2. Interest rate and housing price

Recall that the aim of the article is to obtain a first quantification of the mortality risk that a reverse mortgage provider in Spain would have when selling its product to foreign tourists. For this reason, other risk drivers, such as interest rates and housing prices, are fixed.

3.3. Reverse mortgage calculations

To calculate the amounts that a lender will pay to the borrower in various types of reverse mortgages, we employ a financial-actuarial approach for two primary reasons. First, the actuarial-financial equilibrium is consistent with the works by Wang et al. (2008), Huang et al. (2011) or Cho et al. (2015). Wang et al. (2008) define it as follows: "*the actuarial equivalence principle where the premium structure of reverse mortgages is determined according to when the present value of expected premiums is equal to the present value of expected losses*". Second, from a theoretical perspective, the reverse mortgage is a financial operation with random duration. Therefore, the actuarial approach is also an appropriate option, as suggested in the literature (Cho et al., 2015). Nevertheless, other ways of calculating reverse mortgages can be used, for example, from a financial point of view (Debón et al., 2013; Boj et al., 2022).

Thus, by equating, we apply the financial-actuarial balance at the initial time of the transaction, including the expected present value (EPV) of the borrower's drawdowns plus the expected present value of the expenses and the expected present value of the total debt accumulated at the time of loan repayment, as shown in the following expression:

$$EPV \text{ Dispositions} + EPV \text{ Expenses} = EPV \text{ Repayments}, \tag{14}$$

where *EPV* Dispositions are the expected present value of the payment that the provider of reverse mortgages pays to the borrower as financial compensation for the reverse mortgages; *EPV* Expenses are the expected present value of the expenses associated with the management of reverse mortgages; and *EPV* Repayments are the expected present value of the future liability that the provider of reverse mortgages will receive in with the death of the borrower. Indeed, this value represents a percentage of the home value.

From Equation (14) and rearranging the terms, expressions can be derived for obtaining the borrower's dispositions for each mortgage case, as shown in Table 2.

Table 2. Type of reverse mortgage and the corresponding formula

Type of reverse mortgage	Lump-sum or monthly income
Lump-sum reverse mortgage	$LS = LTV \cdot P \cdot (VA)_x^{(12)} - E_i$
Term reverse mortgage	$I_T = \frac{LTV \cdot P \cdot (VA)_x^{(12)} - E_i}{(Va)_{x:e_x}^{(12)}}$
Whole-life reverse mortgage	$I_W = \frac{LTV \cdot P \cdot (VA)_x^{(12)} - E_i}{(Va)_x^{(12)}}$

where:

- LS is the single amount to the borrower at the beginning of the reverse mortgage.
- IT is the monthly income to pay to the borrower in a term reverse mortgage.
- IW is the monthly income to pay to the borrower in a whole-life reverse mortgage.
- LTV is the percentage of loan to value that the lender lends to the borrower.
- P is the property value at the beginning of the mortgage.
- E_i are the initial expenses that the borrower has to pay and are included in the total debt of the mortgage.
- $(VA)_x^{(12)}$ is the expected present value of a monthly whole-life insurance benefit, which is variable in geometric progress. We can calculate it as follows:

$$(VA)_x^{(12)} = \sum_{k=0}^{\omega-x-1} \sum_{s=1}^{12} (1+\alpha)^k \cdot (1+i)^{-\left(k+\frac{s}{12}\right)} \cdot {}_{k+\frac{s-1}{12}}p_x \cdot {}_{\frac{1}{12}}q_{x+k+\frac{s-1}{12}}, \quad (15)$$

so:

- α represents the fixed percentage of increase in the future cash flows that the value of the home property will have for the k years of the transaction.
- i is the actual annual interest rate.
- $(Va)_{x:e_x}^{(12)}$ is the expected present value of a monthly immediate annuity, a variable in geometric progression. We can calculate it as follows:

$$(Va)_{x:e_x}^{(12)} = \sum_{k=0}^{e_x-1} \sum_{s=1}^{12} (1+\beta)^k \cdot (1+i)^{-\left(k+\frac{s}{12}\right)} \cdot {}_{k+\frac{s}{12}}p_x, \quad (16)$$

where:

- e_x is the expected years of remaining lifetime at age x, which is denoted by life expectancy.
- β is the common ratio of the geometric progression linked, in this case, to the annual increase in the elder borrower's incomes.
- $(Va)_x^{(12)}$ is the expected present value of a monthly whole-life immediate annuity, which is variable in geometric progression. We can calculate it as follows:

$$(Va)_x^{(12)} = \sum_{k=0}^{\omega-x-1} \sum_{s=1}^{12} (1+\beta)^k \cdot (1+i)^{-\left(k+\frac{s}{12}\right)} \cdot {}_{k+\frac{s}{12}}p_x. \quad (17)$$

4. Data

Once the procedure for calculating the different types of reverse mortgages has been established, we must set the main characteristics of the products, which are the following:

- Borrowers must be between 65 and 90 years of age[4] when the product is taken out. The probabilities of death for the populations of men and women have been estimated using $d_{x,t}$, the observed annual number of deaths in a population at age x, which is determined by the last birthday during calendar year t, and $E^0_{x,t}$, the corresponding initial exposure to risk. The probabilities of death[5] for an individual aged x according to their last birthday in period t are denoted by $q_{x,t}$ and can be estimated as $\hat{q}_{x,t} = d_{x,t} / E^0_{x,t}$. The data are downloaded from the Human Mortality Database (2021) for the period 1990–2018 and the age range 0–99 using the HMDHFDplus R package developed by Riffe (2015)[6].
- A distinction is made based on the gender of borrowers, although the European Council Directive (European Union, 2004) prohibits the marketing of financial products that discriminate based on gender. Nevertheless, lenders must analyse the risk of granting reverse mortgages according to all risk factors, gender being one of them, as there are considerable differences between the mortality rates of men and women. Although this paper aims to study the differences in the longevity risk taken by the reverse mortgage provider when lending to people from different countries, the lender should also consider different sexes for proper risk management. The countries were selected according to the number of tourists in Spain[7] in 2019. The data were obtained through the Spanish National Statistics Institute (INE), which provides the number of tourists according to their country or set of countries of residence. For 2019, as seen in Figure 2, the tourists who most visited Spain resided in the United Kingdom, Germany, France, Nordic countries (Denmark, Finland, Norway, and Sweden), Italy, and the Netherlands, and they are potential foreign residents in Spain. Thus, we decided to quantify the longevity risk that a reverse mortgage provider would assume based on the most well-represented nationalities among tourists in Spain but under the assumption that these persons are legally resident in Spain[8].
- All owners are considered to have a property in Spain of 120 m^2, valued at 194,352 €, according to the average appraised value of free housing in Spain at the end of the third quarter of 2020 (Ministerio de Fomento España, 2020).

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[4] Spanish regulations do not limit the maximum age of the reverse mortgage borrower. In the Spanish market, it is customary to find reverse mortgage borrowers over 90 years old. This is because when the borrower dies, and the debt exceeds the value of the home, in Spain, the entire estate is liable and not just the house, as in the United Kingdom or the United States.

[5] It should be mentioned that Human Mortality Database (2021) provide $E^c_{x,t}$, the central exposed to risk at age x and period t. Therefore, we need to approximate $E^0_{x,t}$, the initial exposed to risk by adding $a_{x,t}$, the matching reported number of deaths, so $E^0_{x,t} = E^c_{x,t} + \left(1 - a_{x,t}\right) \cdot d_{x,t}$.

[6] We used this R package because it allows obtaining the data in the form of a data frame using the function *readHMDweb*, which simplifies data processing.

[7] We have assumed that those most likely to buy their home are the main tourists coming to Spain, but these buyers may indeed differ because of issues such as visa requirements or tax laws.

[8] Granting reverse mortgages to nonresident foreigners may increase the lender's credit risk, as well as a significant moral hazard, as there is no legal obligation to inform the provider in the event of the borrower's death (Niepmann & Schmidt–Eisenlohr, 2022).

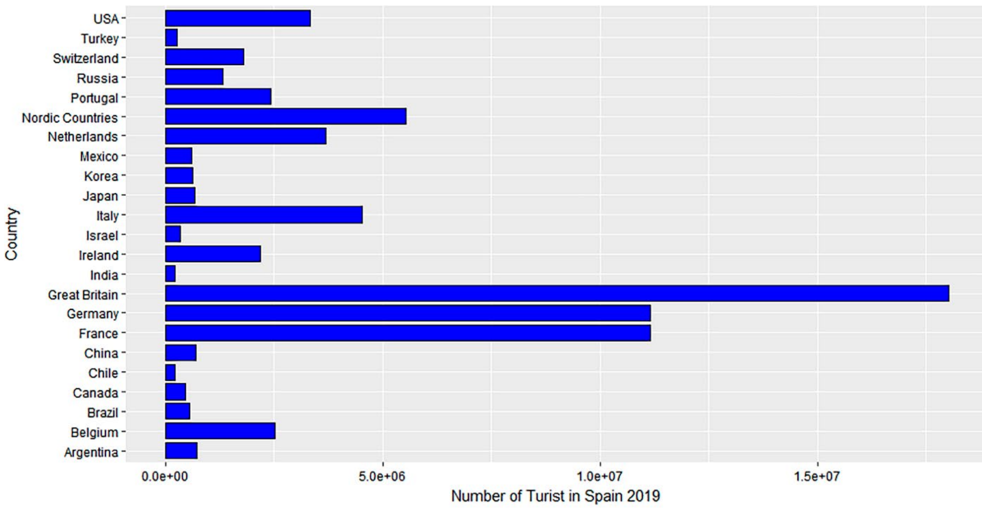

Figure 2. Number of tourists who visited Spain according to their country of residence

- The credit limit to the borrower's life expectancy is set at 70% of the current appraised value[9].
- The initial costs of the transaction to be borne by the borrower amount to 1.06% of the value of the property (Debón et al., 2013).
- The value of the property was estimated without any variation, assuming that the housing price is constant $\alpha = 0\%$.
- Rents were estimated to increase by $\beta = 0\%$ annually.
- The interest rate on mortgages is $i = 6\%$[10] annually.

As noted above, the purpose of this paper is to establish an objective criterion based on mortality to determine whether an institution operating in Spain would be interested in attracting customers of other nationalities. To this end, we compared the results of the amounts that could be offered to different customers by varying only the longevity risk, i.e., the nationality of origin. The mortality of foreigners in Spain will be similar to that of their country of origin since they have spent most of their lives in their home country. Migrants are formed with different social and cultural orientations, such as alcohol, diet, and social integration, provoking different mortality compared with the host population and more similarity to its home country (Kibele et al., 2008).

One of the weaknesses in the mortality projections is that we only consider the mortality of origin for foreign individuals, and therefore, we do not consider how factors of their residence in Spain (health care system, new lifestyles, new diets) will impact the longevity of these individuals and how it affects providers of reverse mortgages. Due to changes in the country of home residence, these habits could potentially modify mortality and result in different longevity risks than we have estimated.

[9] It should be noted that Spanish regulations do not limit credit based on age. All reverse mortgage borrowers will receive a fixed percentage of the home's value.

[10] In this paper, we have chosen to use a constant interest rate; however, we recognize that interest rate risk is volatile, and several alternatives exist to address this issue (Table 2).

5. Results

Table 3 in the Appendix shows the lump sum reverse mortgage initial amounts lent to men and women aged 65, 70, 75, 80, 85, and 90. There is a noticeable difference in performance between both genders. As with pure endowment insurance or survival annuities, the single amounts lent to females are consistently lower than those lent to male borrowers. These lower amounts correspond to the higher life expectancy of women, as lenders assume more longevity risk lending to female borrowers than to male borrowers. Women tend to live more than men, which implies a higher longevity risk for the provider of reverse mortgages in the case of supplying women. However, since the Law of Council Directive 2004/113/EC (European Union, 2004), there are no differences in terms of gender in pricing insurance products, although insurance companies should consider this gender difference in risk.

Similarly, but less markedly, when comparing nationalities, women's single dispositions lent to French women should be lower than those of Spanish women aged 69 and 90. This is due to longevity performance, as seen in Figure 3, where only France shows higher life expectancy values from 67 onwards. The lender would be disadvantaged for this age group and country of origin, as he assumes more risk lending to a French woman than lending the same initial amount to a Spanish woman. In practice, this would be equivalent to lending a higher loan-to-value percentage to French women. Thus, it is slightly less appealing for the lender to underwrite reverse mortgages with this age group and country of origin. To ease understanding, we have included Figure 5, which presents the differences in the initial amount of Spanish reverse mortgage Lump-Sum and the rest of the considered populations. The scale of colours indicates the degree of risk assumed by the provider of reverse mortgages for the corresponding population compared with Spaniards. Specifically, the red colour indicates that the initial reverse mortgage amount in this population is lower than in Spain, implying a higher longevity risk for the provider if they offer the product to this nationality. Conversely, as the colour shifts towards green, the risk assumed by the provider decreases, and therefore, it will make more money by offering this product to the corresponding populations. This analysis is made for both genders.

For men (Figure 4), most countries show a worse mortality performance than Spain for all ages. This situation is more favourable for the lender. The lender would only be assuming slightly higher risk when lending lump sum amounts to French borrowers of all ages and Norwegian, Swedish, and Italian borrowers of early ages than to Spanish borrowers. For countries that have a lower life expectancy, the lender could grant higher lump sum amounts than for Spanish men.

In addition, the differences between life expectancy for males in Figure 4 are lower than those for females in Figure 3. The lender can then charge similar lump sums, regardless of the country of origin, because of the similarity in male longevity performance for all countries included in this paper. The second remarkable fact is that life expectancy performance of French men follows a similar trend to that described previously for their female counterparts. However, for French men, life expectancy is higher for all ages than for Spanish men. Thus, as would be expected, the lump sum amounts lent are higher in the French case, regardless of age, which implies a higher risk for the lender. Earlier ages from 65 to 70, where the life

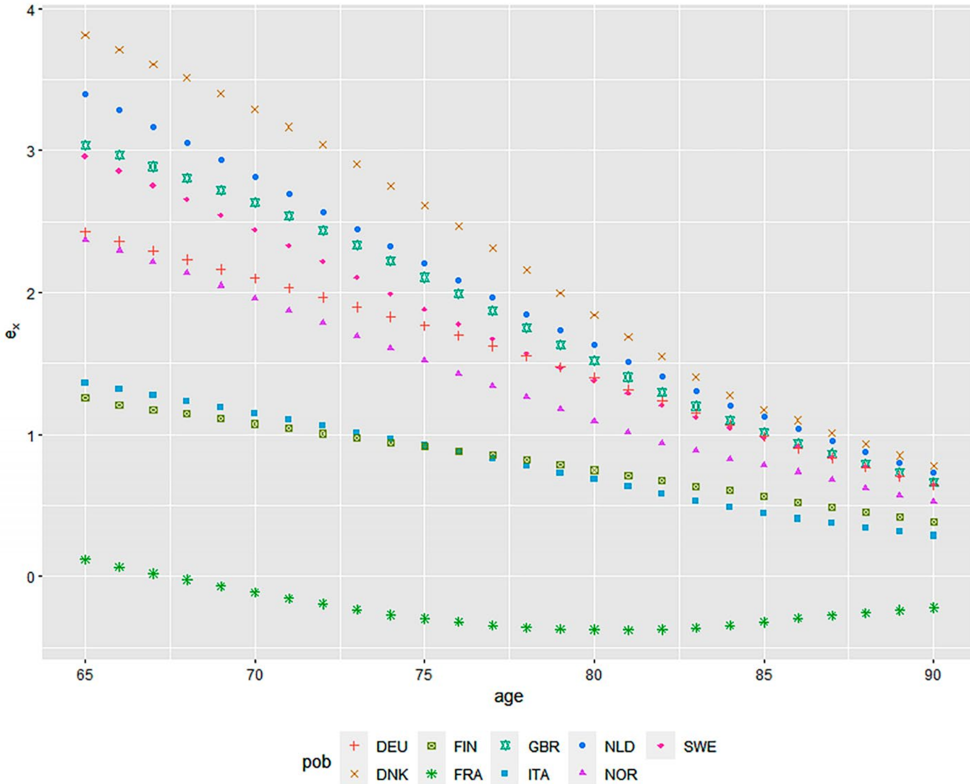

Figure 3. Life expectancy differences for each age group between Spanish women and the other countries under study

expectancy difference remains constant at approximately 0.5 years, are associated with more risk. After 70, life expectancy tends to reduce the difference, which is reflected in the amounts received by the borrower.

Regarding Italy, Sweden, and Norway, we can observe that for the early ages, which are up to 68 for Italians, 71 for Swedes, and 79 for Norwegians, these countries show lower lump sum amounts than in the Spanish case. This is explained by better mortality performance (higher life expectancy). For these countries, the situation remains favourable until ages 66, 68, and 75, respectively. From these ages onwards, the change in mortality performance implies a change in lump sum performance such that the lender would obtain higher benefits with borrowers from these countries.

The same pattern is repeated in the income stream products, such as in-term as well as whole-life reverse mortgages, with similar results to those highlighted in the earlier paragraphs and shown[11] in the Appendix Table 4 and Table 5. The difference in the moment that the lender grants dispositions (single at the beginning or annuities form) and the different

[11] We also have estimated the initial amount or monthly income with a confidence interval of 95%, which are available upon request to the authors.

evolution of the debt causes a slight difference between the two. Differences between nationalities were most pronounced for Term reverse mortgages. This pattern is based on the premise that annuities are paid for the duration of the life expectancy of a Spanish borrower, regardless of the country of origin, whereas this hypothesis is not assumed in other cases.

If we pay attention to the percentage differences, we can observe that, for men, despite the differences in longevity for each nationality, performance is fairly similar. In all cases, the amounts of different types of reverse mortgages are similar between Spanish and foreign borrowers due to the lack of significant differences in life expectancy. These minor differences could be determined by the socioeconomic factors that generate the heterogeneity of longevity. For example, a 65-year-old German male borrower is the most favourable for a Spanish lender (Table 3 in the Appendix), as he would only obtain a lump sum amount 6.22% greater than a Spanish borrower. Another similar example would be an 80-year-old Danish male borrower, whose whole-life reverse mortgage (Table 5 in the Appendix) would only pay him 11% more when Danish longevity is considered with respect to the Spanish borrower. However, a 76-year-old French male borrower should receive 4.24% less income on his term reverse mortgage than a Spanish man of the same age (Table 4).

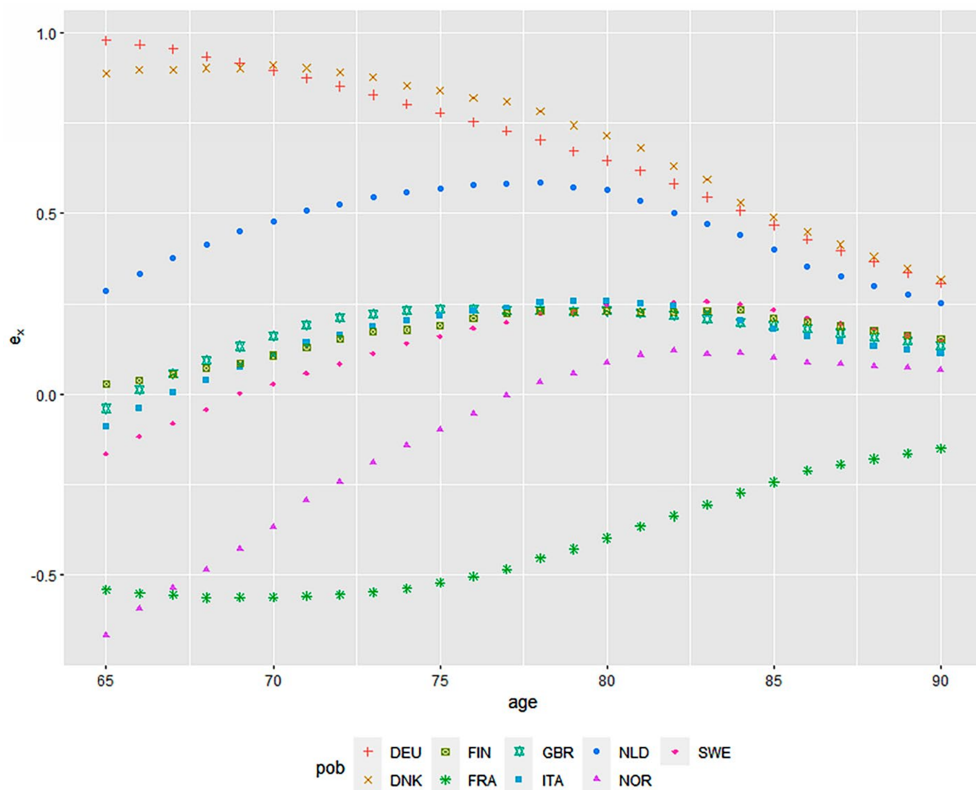

Figure 4. Life expectancy differences for each age group between Spanish men and the other countries under study

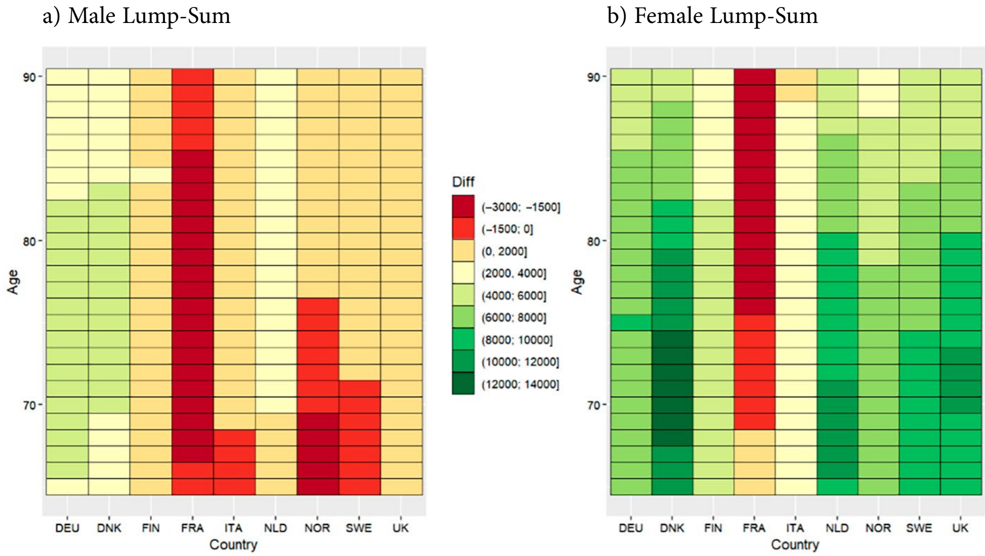

Figure 5. Differences in the initial amount of the Spanish Lump-Sum reverse mortgages and the rest of the countries studied. The scale of colours indicates which reverse mortgages assume higher or lower longevity risk for the corresponding country compared with Spain

On the other hand, among women, the differences between nationalities are much more significant due to the greater difference in life expectancy performance. For example, a 65-year-old Danish female borrower who takes out a whole-life reverse mortgage (Table 5) should receive 37.78% more than a Spanish female borrower. An 83-year-old French female borrower who takes out the same product should receive 5.44% less than her Spanish counterpart.

As explained in the previous paragraph, although gender is the main factor that explains differences in longevity performance, many other socioeconomic factors (lifestyle, geographic location, race, or education level) play an essential role. Countries such as Spain and France, which have an evident sociocultural and geographical link, show similar patterns compared to others such as Denmark or Germany, which have a closer relationship to each other. This similar longevity performance manifests in the reverse mortgage amounts. For example, if we pay attention to the female population in the Appendix Table 3, the difference in amounts between a Spanish borrower and a French borrower is the smallest, while the difference between a Spanish borrower and a Danish borrower is high. In general, similar results can be seen in all types of reverse mortgages for both genders.

Conclusions

Throughout this paper, we have estimated the longevity risk that a Spanish reverse mortgage lender (bank, insurance company, or other financial entity) would assume when lending reverse mortgages to Spanish borrowers and to foreign borrowers residing in Spain of the nine nationalities with the highest number of tourists to Spain. These potential residents in Spain are possible candidates to take out reverse mortgages with Spanish lenders since many already own real estate properties in Spain. Thus, they may need to access equity from their properties to maintain their standard of living.

Based on the data, the longevity risk associated with reverse mortgages depends on the following:

– the type of reverse mortgage,
– the age of the borrower,
– the gender of the borrower and
– the nationality of the borrower.

This paper compares the differences in the initial amount of each type of reverse mortgage offered to different customers, primarily based on longevity risk in Spain while keeping the dynamics of interest rates and housing prices constant. Indeed, the main contribution is to provide insights into the differences in the financial magnitudes involved in the valuations of reverse mortgages in Spain by varying the ages, gender, and nationalities of the borrowers. In this sense, the results indicate that, in general, a Spanish lender would only assume a slightly larger risk when lending reverse mortgages to borrowers of the selected nationalities. This finding is attributed to the slightly longer life expectancy of Spanish borrowers. Moreover, the study also analyses the impact of longevity risk based on gender and age.

Regarding gender, on the one hand, the risk of longevity is entirely different between men and women due to the significant differences in life expectancy. On the other hand, the difference between the life expectancy of a Spanish woman and a woman of any other nationality is greater than in the case of men. Then, the performance of female life expectancy implies that a Spanish lender would prefer to lend to men and female foreign borrowers. Only for French borrowers of either gender does the lender assume more risk in most age categories and for Italian, Norwegian, and Swedish men in the early ages.

These conclusions are essential for Spanish lenders since they illustrate that it is possible to lend reverse mortgages to both Spanish and foreign residents in Spain without assuming much higher risk, regardless of other considerations, such as legal problems, which are not analysed in this article.

In the same way, the heterogeneity of longevity revealed by the results is very interesting. Thus, countries with similar socioeconomic factors and lifestyles, such as Spain and France or Denmark and Germany, have similar longevity performance. For this reason, a detailed analysis of the influence of these factors on reverse mortgage conditions could be a future line of research.

This manuscript considers simple assumptions for interest rates and the housing market, and employing a model to calibrate interest rate dynamics or house price dynamics may lead to different pricing results for reverse mortgages. However, the conclusion of which country is more favourable for the reverse mortgage provider regarding longevity would still be valid because our calculations are with contracts made in Spain, thus with the same interest and home prices.

Finally, we calculated the reverse mortgage using an actuarial-financial equilibrium. However, there are other ways to estimate this product, such as a financial approach. Therefore, a future topic of research would be a comparative study of different equilibriums of reverse mortgages and a calculation of the differences in the initial reverse mortgage amount to be offered to different customers.

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APPENDIX

Initial reverse mortgage amount

Table 3. Initial amount for Lump sum reverse mortgages

Male Population										
Age	DEU	DNK	FIN	FRA	ITA	NLD	NOR	SWE	GBR	ESP
65	67411	66564	64439	**62190**	**62639**	64231	**61071**	**62358**	63886	63466
70	83544	83278	80485	**77252**	79462	81351	**77788**	**79070**	80666	79275
75	101775	101869	99058	**94940**	98394	100549	**97156**	98092	99272	97421
80	120791	121033	118502	**114311**	118088	120274	117463	118072	118475	116573
85	138101	138108	136496	**133069**	135855	137620	135620	136298	136314	134628
90	152027	152030	150960	**148435**	150333	151588	150216	150684	150814	149506
Female population										
65	54981	59208	51817	48393	51398	57591	54679	56160	57007	47637
70	70630	75243	67092	**62565**	66772	72886	69946	71439	72892	62820
75	89506	93387	85867	**80049**	85338	90991	88107	89437	91190	81499
80	110325	112412	106967	**100418**	106063	111022	108252	109573	110835	102711
85	129956	130752	127451	**121452**	126224	130384	128373	129427	129924	123756
90	145995	146703	144253	**139636**	143206	146311	144917	145649	146018	141407

Note: The bold number indicate a lower initial reverse mortgage amount compared to the Spanish ones.

Table 4. Monthly incomes for Term reverse mortgages

Male Population										
Age	DEU	DNK	FIN	FRA	ITA	NLD	NOR	SWE	GBR	ESP
65	486	476	457	**436**	**436**	452	**422**	**434**	451	447
70	728	723	688	**648**	**671**	696	**651**	**666**	691	671
75	1143	1143	1092	**1016**	1075	1117	**1052**	1067	1097	1060
80	1817	1825	1747	**1624**	1731	1802	1715	1728	1747	1688
85	3039	3036	2954	**2778**	2915	3014	2909	2939	2944	2853
90	4380	4378	4280	**4051**	4214	4336	4209	4247	4266	4140
Female population										
65	340	376	315	289	311	361	337	349	357	282
70	511	564	475	**432**	471	535	504	519	537	433
75	823	886	771	**693**	762	844	802	820	851	711
80	1366	1418	1289	**1152**	1267	1379	1314	1342	1379	1198
85	2250	2276	2152	**1935**	2100	2261	2181	2220	2245	2016
90	3512	3560	3390	**3091**	3311	3529	3429	3479	3511	3202

Note: The bold numbers indicate a lower monthly income of reverse mortgages compared to the Spanish ones.

Table 5. Monthly income reverse mortgages

Male Population										
Age	DEU	DNK	FIN	FRA	ITA	NLD	NOR	SWE	GBR	ESP
65	430	422	400	**377**	**383**	399	**368**	**380**	394	390
70	630	627	588	**545**	575	600	**553**	**570**	590	572
75	950	952	894	**816**	882	925	**858**	876	898	862
80	1468	1477	1391	**1263**	1378	1450	1358	1378	1390	1331
85	2276	2277	2179	**1992**	2143	2246	2129	2168	2168	2074
90	3458	3459	3338	**3080**	3272	3408	3259	3309	3322	3186
Female population										
65	314	351	287	260	284	337	311	324	331	255
70	469	522	430	**384**	427	494	461	478	494	387
75	724	789	668	**585**	660	749	702	724	752	605
80	1154	1210	1070	**925**	1049	1174	1102	1136	1168	973
85	1840	1879	1728	**1495**	1677	1861	1769	1817	1839	1579
90	2858	2921	2713	**2379**	2632	2886	2768	2829	2860	2499

Note: The bold numbers indicate a lower monthly income of reverse mortgages compared to the Spanish ones.