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The Future Human Lifespan: A Study on Italian Population

Maria Russolillo

Department of Economics and Statistics, Campus di Fisciano, University of Salerno, Salerno, Italy
Email: mrussolillo@unisa.it

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Abstract

In the latter part of the 20th century, continued improvements in living standards, health behaviors, and medical care reduced mortality and produced amazing advances in life expectancy. These trends, followed by all industrial nations, decidedly affect the financial position of an insurance company, interested in the construction of updated life tables. The approach to this problem is faced in this paper by using the Lee-Carter methodology. In particular, in the present work, we are interested in modeling and forecasting mortality and life expectancy on a period basis through the use of a stochastic forecasting method which uses time-series models to make long-term forecasts.

Keywords

Lee Carter Model, Mortality Forecasting, Time Series, Survival Analysis

1. Introduction

In the twentieth century many industrialized countries have experimented downwards trends in mortality rates. A number of extremely important developments have contributed to this rapid mortality improvement. Among the others, we can highlight for example the improved healthcare provided to mothers and babies, improvements in motor vehicle safety, safer and more nutritious foods. Other factors are expected to contribute more to annual rates of mortality improvement in the future. We can highlight among the others an improvement in the education regarding health, the development and application of new diagnostic, surgical and life sustaining techniques and the general change in our conception of the value of life.

These improvements are undoubtedly favourable from our point of view, because we live longer than the past. Otherwise from the insurance companies' point of view, these changes clearly affect pricing and reserve allocation for life annuities. The financial position of an insurance company is indeed affected by the downwards

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trends in mortality. For this reason it is necessary to create updated life tables in order to produce financial estimates for an insurance company. A life table shows the probabilities of a member of a particular population living to or dying at a particular age. If the life tables do not take the trends into account, there is also the risk of underestimating the survival probability, thus determining inappropriate premiums by the insurance company. This risk is known in the actuarial literature as longevity risk.

In this study, we construct life tables in order to examine the mortality changes in the Italian population over time. In particular, starting from the Italian mortality experience of the past half-century, we extrapolate forecast for the future mortality. To consistently predict the trends [1], we have to use reasonable mortality forecasting techniques. Our analysis bases on the Lee Carter model [2], a milestone in the actuarial literature of mortality projections. Following the methodology of Renshaw and Haberman [3], we fit the Lee-Carter model and obtain forecasts of the time trend parameter. The main goal of this contribution is to construct life tables on a period basis for the Italian population by calendar year and gender.

The paper is organized as follows: in Section 2, we describe the mortality model; Section 3 refers to the SVD approximation technique; Section 4 is devoted to describe the modelling of the mortality index, used to generate associated life table values. Section 5 shows the findings of the empirical analysis on Italian population. Concluding remarks are presented in Section 6.

2. The Mortality Model

Among various forecasting methodologies, in this contribution we focus on the Lee Carter (LC) model which makes use of the past mortality experience in order to forecast future mortality. The authors described a methodology to forecast mortality which combines demographic model with statistical time series method. The model used for mortality bases on the central mortality rates $m_{x,t}$, for age *x* in year *t*, defined as the ratio between the number of deaths $D_{x,t}$, recorded during the calendar year *t* for people aged *x* and the exposure to risk $E_{x,t}$. The simple bilinear model was defined as:

$$\ln\left(m_{x,t}\right)=\alpha_x+\beta_x\kappa_t+\varepsilon_{x,t} \tag{1}$$

where on the right hand side of the equation, we find an age-specific component α_x, independent of time, another component given by the product of a time-varying parameter k_t and an age-specific component β_x. In particular, the k_t parameter is a time-trend index of the general mortality level and the component β_x indicates the pattern of deviations from the age profile when the general level of mortality changes. $\varepsilon_{x,t}$ is the residual term at age *x* and time *t*.

In their original paper, in order to fit the model, Lee and Carter [2], suggested a close approximation to the Singular Value Decomposition (SVD) method based on a two-stage estimation procedure. In the course of time, different alternative criteria have been proposed to overcome this method. Wilmoth [4], for example, developed two alternative one-stage estimation strategies, a weighted least square (WLS) and a maximum likelihood (MLE) technique. Nevertheless, there are still several advantages to use the SVD which has become, together with the WLS and the MLE, the most used method for estimating the model's parameters. In a study by Koissi, Shapiro and Högnäs [5], they compared these three methods and showed that SVD is the best alternative for the mortality index *k*. Moreover, another advantage of SVD is that can be easily represented by using the Biplot [6].

3. The SVD Approximation

In order to find a least squares solution to the Equation (1), we use a close approximation to the SVD method, assuming that the errors are homoscedastic. Following [2], the components β_x and k_t can be estimated according to the SVD [7] with proper normality constraints: we impose the sum of β_x coefficients equal to one and the sum of the k_t parameters equal to zero. Under these assumptions, we run the following steps:

- the α_x coefficients are the average values over time *t* of the $\ln\left(m_{x,t}\right)$ values for each *x*:

$$\alpha_x=\frac{1}{h}\sum_{t=t_1}^{tn}\ln m_{xt}=\ln\left[\prod_{t=t_1}^{tn}m_{xt}^{\frac{1}{h}}\right]$$

- k_t must equal the sum over age of $\left(\ln\left(m_{x,t}\right)-\alpha_x\right)$
- each β_x is estimated from $\left(\ln m_{xt}-\alpha_x\right)=\beta_x k_t^{(1)}+\varepsilon'_{xt}$ (where $k_t^{(1)}$ refers to the k_t estimated above) us-

ing the least squares estimation, *i.e.* choosing β_x to minimize

$$\sum_{x,t}\left(\ln m_{xt}-\alpha_x-\beta_x k_t^{(1)}\right)^2 \Rightarrow \beta_x=\frac{\sum_{t=t_1}^{tn} k_t^{(1)}\left(\ln m_{xt}-\alpha_x\right)}{\sum_{t=t_1}^{tn} k_t^{(1)2}}.$$

In Section 2, we stated that the approximation to the SVD method is built on a two-stage estimation procedure. This happens because the first stage estimation is based on logs of death rates rather than the death rates themselves, thus causing possible discrepancies between predicted and actual deaths. To guarantee that the fitted death rates will lead to the actual numbers of deaths, when applied to given population age distribution, we re-estimate k_t in a second step, taking the α_x and β_x estimates from the first step. To correct for this, we apply the methodology from Section 3 of [2]. We thereby find a new estimate for k_t by an iterative search, adjusting the estimated k_t so that the actual total observed deaths $\sum_{x=x_1}^{xk} d_{xt}$ equal the total expected deaths $\sum_{x=x_1}^{xk} e_{xt}\mathrm{e}^{(\alpha_x+\beta_x k_t)}$, for each year *t* (we remind the interested reader to [8] for a deeper insight in the iterative procedure). There are several advantages to make a second stage estimate of the k_t: it can be useful in the life table presentation of the data and especially in cases where only the total, rather than age-specific, death rates are known in certain years.

4. The Procedure

4.1. Modelling the Time-Varying Parameter

The mortality trend of a country is captured by the time-varying parameter k_t of the LC model. Once we fit the LC on a mortality dataset of a specific population, we obtain the k_t for the specific country. Then, we arrange the k_t time series in a vector in which the single units are represented by the time-varying parameter k_t in the different years. In this phase, the estimated time-dependent parameter k_t is modelled as a stochastic process. We use the standard Box and Jenkins methodology (identification-estimation-diagnosis) to generate an appropriate ARIMA (*p*, *d*, *q*) model for the mortality index k_t ([9] [10]). The ARIMA model is then used to generate forecasted mortality index k_t.

4.2. Projecting Life Tables

Once we have projected the index of mortality, we can generate associated life table values. Mortality experience is usually represented in the form of a life table. There are two basic type of life tables to be represented, period-based tables and cohort-based tables. In this study, we focus on period life table in order to analyse changes in the mortality experienced by a population through time. Let's start from the formula:

$$\mathring{m}_{x,t+s}=\hat{m}_{x,t}\exp\left\{\hat{\beta}_x\left(\mathring{k}_{t+s}-\hat{k}_t\right)\right\} \tag{2}$$

for computing forecasted mortality rates by alignment to the latest available empirical mortality rates $\hat{m}_{x,t}$. In the formula we inserted the projected k_{t+s}, $s=y,y+1,\cdots,y+T$, with *y* being the first time and *T* the length of the period considered for the projections.

A life table treats the mortality experience upon which it is based as though it represents the experience of a single birth cohort consisting of 100,000 births who experience, at each age *x* of their lives, the probability of death, denoted q_x [11]. Thus, we convert the life table death rates, m_x, into probabilities of death, q_x [12]. In particular, we compute q_x from m_x and f_x according to the formula:

$$q_x \cong \frac{w_x m_x}{1+f_x' w_x m_x},\ x=x_0,x_1,\cdots,x_{k-2}, \tag{3}$$

where f_x is the average number of years lived within the age interval $[x,x+1)$ for people dying at that age and $f_x'=1-f_x$. As in [3], we assume that $f_x=\frac{1}{2}$ for all age groups except age 0 (for $x=0$ we fix $f_x=0.15$

for males and $f_x = 0.16$ for females). For the sake of completeness, we formulate p_x, the probability of surviving from age *x* to $x+1$, as:

$$p_x = 1 - q_x \tag{4}$$

The entry l_x in the life table shows the number of survivors of that birth cohort at each succeeding exact integral age, while d_x shows the number of deaths that would occur between succeeding exact integral ages among members of the cohort. Thus we working down the column of *l*'s and *d*'s in the life tables, applying the recurrence equations:

$$l_{x+wx} = l_x\left(1-q_x\right), \quad x = x_0, x_1, \cdots, x_{k-2}, \tag{5}$$

$$d_x = l_x - l_{x+w_x} = l_x q_x, \quad x = x_0, x_1, \cdots, x_{k-2}, \tag{6}$$

where q_x is calculated as in (3) and l_0 is arbitrary (in our case is put equal to 100,000).

The number of person-years L_x lived between consecutive exact integral ages *x* and $x+1$ are:

$$L_x = w_x\left(l_x - f_x' d_x\right), \quad x = x_0, x_1, \cdots, x_{k-2}. \tag{7}$$

T_x gives the total number of person-years lived beyond each exact integral age *x*, by all members of the cohort, while the final entry in the life table, e_x, called life expectancy, represents the average number of years of life remaining for members of the cohort still alive at exact integral age *x*.

In this case, the person-years remaining for individuals of age *x* equal

$$T_{x_i} = \sum_{x=x_i}^{x_{k-1}} L_x \tag{8}$$

imply that life expectancy is given by

$$e_{x_i} = T_{x_i} / l_{x_i}. \tag{9}$$

5. Numerical Application

This study presents period life tables by gender from 2001 up to 2025 reflecting projected mortality. The fundamental step in constructing a life table from population data is that of developing probabilities of death q_x, that accurately reflect the underlying pattern of mortality experienced by the population [11]. In this contribution, the method used for developing the rates is based on the LC model and described in Section 3. Actual data permit the computation of central death rates, which are then converted into probabilities of death. Tabulations of death rates by age and gender are based on information supplied by the Human Mortality Database [13] available on the web at www.mortality.org or www.humanmortality.de). Deaths and exposure to risk for the Italian population are provided by five year age groups for ages 0 through 99 divided by gender. Death rates are calculated as the ratio between deaths and exposure to risk.

Usually the procedure for projecting mortality begins with an analysis of past trends. In this study, we fit the LC model to the matrix of Italian death rates from year 1950 to 2000, following the SVD approximation described in Section 3.

An accurate analysis of the autocorrelations and partial autocorrelations, together with related diagnostics, drive us to the choice of the ARIMA model for the re-estimated time-varying parameter k_t [8]. On the basis of this model, we generate the forecasted index of mortality for the 25 years onwards and produce associated life table values at five-year intervals from 2001 through 2025.

Tables 1-4 show values for the functions q_x, l_x, d_x, L_x by age and gender for quinquennial years 2010 through 2025. The method used to produce the values shown in these tables has been described in Section 4.1.

By looking at **Tables 1-4**, we notice that for each calendar year the probabilities of death q_x are relatively high at birth, decline to a low point until age-group 10 - 14, and thereafter rise up to age-group 95 - 99. Moreover, all of the four period tables show higher values of q_x for male than for female. It is relevant to notice also the drop of the probabilities of death as the calendar year increase, thus highlighting the improvement in the mortality, experienced by the industrialised countries.

Finally, in **Table 5** we have compared forecasted life expectancy at birth for male and female as well as life expectancy at 60. As regards life expectancy at age 0, by gender and calendar year, we can notice rapid gains in

Table 1. Period life tables for the Italian population by calendar year 2010 and gender.

Male					Female				
x	q_x	l_x	d_x	L_x	x	q_x	l_x	d_x	L_x
Calendar year 2010									
1 = 0	0.00261	100	261	99.778	1 = 0	0.00236	100	236	99.802
2 = 1 - 4	0.00038	99.73865	38	398.879	2 = 1 - 4	0.00041	99.76449	41	398.977
3 = 5 - 9	0.00045	99.70103	45	498.393	3 = 5 - 9	0.00034	99.72378	34	498.534
4 = 10 - 14	0.00061	99.65607	61	498.127	4 = 10 - 14	0.00045	99.6899	45	498.337
5 = 15 - 19	0.00250	99.59489	249	497.351	5 = 15 - 19	0.00089	99.64472	88	498.003
6 = 20 - 24	0.00410	99.34565	407	495.711	6 = 20 - 24	0.00106	99.55641	105	497.519
7 = 25 - 29	0.00428	98.93874	424	493.635	7 = 25 - 29	0.00118	99.45129	118	496.963
8 = 30 - 34	0.00427	98.51507	420	491.525	8 = 30 - 34	0.00152	99.33372	151	496.291
9 = 35 - 39	0.00542	98.09485	532	489.145	9 = 35 - 39	0.00231	99.18282	229	495.343
10 = 40 - 44	0.00700	97.56305	683	486.109	10 = 40 - 44	0.00382	98.9542	378	493.826
11 = 45 - 49	0.01110	96.88039	1075	481.714	11 = 45 - 49	0.00598	98.57635	589	491.409
12 = 50 - 54	0.01846	95.80514	1769	474.604	12 = 50 - 54	0.00968	97.98715	949	487.564
13 = 55 - 59	0.03166	94.03664	2977	462.741	13 = 55 - 59	0.01489	97.03859	1445	481.580
14 = 60 - 64	0.05119	91.05977	4661	443.647	14 = 60 - 64	0.02247	95.5936	2148	472.598
15 = 65 - 69	0.08696	86.39887	7513	413.211	15 = 65 - 69	0.03696	93.44565	3454	458.594
16 = 70 - 74	0.14148	78.88549	11161	366.526	16 = 70 - 74	0.06347	89.99179	5712	435.679
17 = 75 - 79	0.22335	67.72494	15126	300.810	17 = 75 - 79	0.11617	84.27969	9791	396.922
18 = 80 - 84	0.34416	52.5989	18103	217.738	18 = 80 - 84	0.21815	74.48917	16250	331.821
19 = 85 - 89	0.51581	34.4964	17794	127.998	19 = 85 - 89	0.38304	58.23911	22308	235.426
20 = 90 - 94	0.69975	16.70274	11688	54.294	20 = 90 - 94	0.59349	35.93131	21325	126.344
21 = 95 - 99	0.89195	5.01492	5015	12.537	21 = 95 - 99	0.81990	14.60633	14606	36.516

Table 2. Period life tables for the Italian population by calendar year 2015 and gender.

Male					Female				
x	q_x	l_x	d_x	L_x	*x*	q_x	l_x	d_x	L_x
Calendar year 2015									
1 = 0	0.00194	100	194	99.835	1 = 0	0.00176	100	176	99.852
2 = 1 - 4	0.00027	99.80634	27	399.171	2 = 1 - 4	0.00029	99.82375	29	399.236
3 = 5 - 9	0.00036	99.77924	36	498.806	3 = 5 - 9	0.00027	99.7944	27	498.904
4 = 10 - 14	0.00052	99.74323	52	498.586	4 = 10 - 14	0.00038	99.76709	38	498.740
5 = 15 - 19	0.00232	99.6913	231	497.879	5 = 15 - 19	0.00078	99.729	77	498.451
6 = 20 - 24	0.00387	99.4604	385	496.340	6 = 20 - 24	0.00091	99.6516	91	498.031
7 = 25 - 29	0.00403	99.07579	400	494.380	7 = 25 - 29	0.00102	99.56088	101	497.551
8 = 30 - 34	0.00400	98.6762	395	492.393	8 = 30 - 34	0.00132	99.45947	132	496.969
9 = 35 - 39	0.00500	98.28118	491	490.178	9 = 35 - 39	0.00202	99.32796	201	496.138
10 = 40 - 44	0.00638	97.78984	624	487.390	10 = 40 - 44	0.00339	99.12717	337	494.795
11 = 45 - 49	0.01012	97.16626	983	483.374	11 = 45 - 49	0.00538	98.79064	532	492.624
12 = 50 - 54	0.01696	96.18335	1631	476.838	12 = 50 - 54	0.00876	98.25896	861	489.143
13 = 55 - 59	0.02944	94.552	2783	465.801	13 = 55 - 59	0.01351	97.39829	1315	483.703
14 = 60 - 64	0.04817	91.76857	4421	447.791	14 = 60 - 64	0.02030	96.0829	1951	475.538
15 = 65 - 69	0.08269	87.34793	7223	418.683	15 = 65 - 69	0.03324	94.13214	3129	462.839
16 = 70 - 74	0.13489	80.12538	10809	373.606	16 = 70 - 74	0.05698	91.00326	5185	442.053
17 = 75 - 79	0.21309	69.31688	14771	309.658	17 = 75 - 79	0.10521	85.81784	9029	406.517
18 = 80 - 84	0.32940	54.54629	17967	227.813	18 = 80 - 84	0.20128	76.78903	15456	345.305
19 = 85 - 89	0.49662	36.57897	18166	137.480	19 = 85 - 89	0.36134	61.3329	22162	251.260
20 = 90 - 94	0.67957	18.41315	12513	60.783	20 = 90 - 94	0.57188	39.17099	22401	139.852
21 = 95 - 99	0.87242	5.900144	5900	14.750	21 = 95 - 99	0.80149	16.7699	16770	41.925

Table 3. Period life tables for the Italian population by calendar year 2020 and gender.

Male					Female				
x	q_x	l_x	d_x	L_x	x	q_x	l_x	d_x	L_x
Calendar year 2020									
1 = 0	0.00143	100	143	99.878	1 = 0	0.00132	100	132	99.889
2 = 1 - 4	0.00020	99.85653	20	399.387	2 = 1 - 4	0.00021	99.86811	21	399.430
3 = 5 - 9	0.00029	99.837	29	499.113	3 = 5 - 9	0.00022	99.84695	22	499.180
4 = 10 - 14	0.00044	99.80817	44	498.931	4 = 10 - 14	0.00032	99.82495	32	499.044
5 = 15 - 19	0.00214	99.76409	214	498.286	5 = 15 - 19	0.00068	99.79284	68	498.795
6 = 20 - 24	0.00365	99.55024	363	496.843	6 = 20 - 24	0.00078	99.72501	78	498.429
7 = 25 - 29	0.00380	99.1868	377	494.992	7 = 25 - 29	0.00088	99.64675	87	498.015
8 = 30 - 34	0.00376	98.81002	371	493.122	8 = 30 - 34	0.00115	99.5593	115	497.510
9 = 35 - 39	0.00461	98.4388	454	491.059	9 = 35 - 39	0.00177	99.44472	176	496.783
10 = 40 - 44	0.00581	97.98499	569	488.501	10 = 40 - 44	0.00302	99.26843	300	495.593
11 = 45 - 49	0.00922	97.41556	898	484.833	11 = 45 - 49	0.00485	98.9688	480	493.645
12 = 50 - 54	0.01558	96.51746	1504	478.827	12 = 50 - 54	0.00793	98.48921	781	490.495
13 = 55 - 59	0.02737	95.01342	2601	468.565	13 = 55 - 59	0.01225	97.70867	1197	485.552
14 = 60 - 64	0.04533	92.41262	4189	451.590	14 = 60 - 64	0.01834	96.51195	1770	478.134
15 = 65 - 69	0.07861	88.22343	6936	423.778	15 = 65 - 69	0.02989	94.74161	2831	466.629
16 = 70 - 74	0.12860	81.28782	10453	380.306	16 = 70 - 74	0.05113	91.91013	4700	447.801
17 = 75 - 79	0.20325	70.83445	14397	318.180	17 = 75 - 79	0.09523	87.21037	8305	415.289
18 = 80 - 84	0.31514	56.4375	17786	237.723	18 = 80 - 84	0.18558	78.90511	14643	357.918
19 = 85 - 89	0.47791	38.65159	18472	147.078	19 = 85 - 89	0.34061	64.26216	21888	266.590
20 = 90 - 94	0.65967	20.17959	13312	67.618	20 = 90 - 94	0.55074	42.37393	23337	153.527
21 = 95 - 99	0.85299	6.867716	6868	17.169	21 = 95 - 99	0.78322	19.0367	19037	47.592

Table 4. Period life tables for the Italian population by calendar year 2025 and gender.

Male					Female				
x	q_x	l_x	d_x	L_x	*x*	q_x	l_x	d_x	L_x
Calendar year 2025									
1 = 0	0.00106	100	106	99.910	1 = 0	0.00099	100	99	99.917
2 = 1 - 4	0.00014	99.89372	14	399.547	2 = 1 - 4	0.00015	99.90132	15	399.575
3 = 5 - 9	0.00023	99.87966	23	499.341	3 = 5 - 9	0.00018	99.88607	18	499.386
4 = 10 - 14	0.00037	99.85657	37	499.189	4 = 10 - 14	0.00027	99.86833	27	499.274
5 = 15 - 19	0.00198	99.81916	198	498.601	5 = 15 - 19	0.00060	99.84128	59	499.058
6 = 20 - 24	0.00345	99.62115	343	497.247	6 = 20 - 24	0.00068	99.78185	68	498.740
7 = 25 - 29	0.00358	99.27778	355	495.501	7 = 25 - 29	0.00076	99.71434	75	498.383
8 = 30 - 34	0.00353	98.92258	349	493.741	8 = 30 - 34	0.00100	99.63895	100	497.945
9 = 35 - 39	0.00425	98.5738	419	491.821	9 = 35 - 39	0.00155	99.53914	155	497.309
10 = 40 - 44	0.00530	98.15475	520	489.474	10 = 40 - 44	0.00268	99.38439	267	496.255
11 = 45 - 49	0.00840	97.63494	820	486.124	11 = 45 - 49	0.00436	99.11769	432	494.507
12 = 50 - 54	0.01432	96.81461	1386	480.608	12 = 50 - 54	0.00717	98.68524	708	491.657
13 = 55 - 59	0.02545	95.42857	2429	471.071	13 = 55 - 59	0.01111	97.97763	1088	487.168
14 = 60 - 64	0.04266	92.99983	3967	455.082	14 = 60 - 64	0.01657	96.88941	1606	480.433
15 = 65 - 69	0.07473	89.03293	6654	428.530	15 = 65 - 69	0.02687	95.28385	2560	470.019
16 = 70 - 74	0.12257	82.37913	10098	386.652	16 = 70 - 74	0.04587	92.72385	4254	452.985
17 = 75 - 79	0.19381	72.28161	14009	326.385	17 = 75 - 79	0.08616	88.47027	7622	423.295
18 = 80 - 84	0.30140	58.27251	17563	247.455	18 = 80 - 84	0.17098	80.84777	13823	369.680
19 = 85 - 89	0.45969	40.70937	18714	156.763	19 = 85 - 89	0.32084	67.02428	21504	281.362
20 = 90 - 94	0.64007	21.99563	14079	74.781	20 = 90 - 94	0.53010	45.52054	24131	167.276
21 = 95 - 99	0.83368	7.916855	7917	19.792	21 = 95 - 99	0.76509	21.39003	21390	53.475

Table 5. Forecasted life expectancy at birth and life expectancy at 60.

Male			Female		
Year	e0	e60	Year	e0	e60
2001	76.75	20.50844	2001	82.67	24.93699
2002	76.90	20.59296	2002	82.86	25.06818
2003	77.05	20.67749	2003	83.05	25.19859
2004	77.19	20.76202	2004	83.23	25.32819
2005	77.34	20.84655	2005	83.41	25.45699
2006	77.48	20.93109	2006	83.59	25.58497
2007	77.63	21.01561	2007	83.77	25.71213
2008	77.77	21.10013	2008	83.94	25.83845
2009	77.91	21.18463	2009	84.11	25.96393
2010	78.04	21.26912	2010	84.28	26.08856
2011	78.18	21.35358	2011	84.45	26.21233
2012	78.32	21.43802	2012	84.61	26.33524
2013	78.45	21.52243	2013	84.77	26.45727
2014	78.58	21.6068	2014	84.94	26.57842
2015	78.72	21.69114	2015	85.09	26.69869
2016	78.85	21.77544	2016	85.25	26.81807
2017	78.98	21.8597	2017	85.41	26.93655
2018	79.10	21.9439	2018	85.56	27.05413
2019	79.23	22.02806	2019	85.71	27.1708
2020	79.36	22.11215	2020	85.86	27.28657
2021	79.48	22.19619	2021	86.01	27.40142
2022	79.61	22.28016	2022	86.15	27.51535
2023	79.73	22.36406	2023	86.29	27.62836
2024	79.85	22.4479	2024	86.44	27.74045
2025	79.98	22.53165	2025	86.58	27.85161

life expectancy at age 0 from 2001 through 2025 more for female than for male. This trend is confirmed also for life expectancy at 60, even if the pace of improvement is lower than for life expectancy at birth. However, this gender gap diminished during the last decades, is projected to decrease only slightly in the future.

6. Concluding Remarks

Insurance companies often request mortality projections for forecasting and facing their financial position. With this study we suggest that relatively simple information can be used to make accurate risk assessments for the companies. In order to confirm risk specific premiums and to avoid acceptance at standard risk of persons with different life expectancy it is necessary to predict the risk. The paper deals with the projections of mortality for the Italian population. The analysis we propose bases on an application of the model underpinning the LC method for forecasting life table values. In the framework of the LC model, we consider a close approximation to the SVD method, in order to estimate the model's parameters. The objective of the research is in particular to forecast period life tables, by taking into account time-series-based forecast procedure. The results are life table values at five-year intervals from 2001 through 2025. Obviously, the difference in results is evident for both genders. Our results support the thesis that mortality predictions are necessary to estimate the costs of insurances and to calculate optimal premiums.

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