

Assignment: Mortality of Chilean Pensioners

ACTL3141/ACTL5104, T1 2024

Due time: Thursday 11th April 2024 11.55 am (sharp)

1 Skills developed

This assignment provides you with an opportunity to apply some of the techniques you have learned in the course lectures to a business task involving real data on the mortality of annuitants in Chile. In addition, the assignment aims to develop the course learning outcomes associated with the course aim “Understand and discuss ethical issues and implications of the modelling introduced in the course”, as well as all the UNSW Business School Program Goals but in particular “5. Responsible business practice” and “3. Business communication”.

2 Background

The Chilean Pension system is one of the pioneering pension systems being introduced in 1981. In Chile, when a retiree reaches retirement age they have the option of buying an annuity (Ferreiro Yazigi et al. 2003)¹. The current Chilean regulation introduced in February 2023² prescribes the use of the 2020 life tables for pricing and reserving life annuities. There are five life tables, to be used for different types of annuitant depending on their sex, disability status and type of pensioner:

- Life Table “CB-H-2020”: For all male annuitants who are not disabled.³
- Life Table “MI-H-2020”: For all male annuitants who are disabled.
- Life Table “RV-M-2020”: For female main annuitants who are not disabled.⁴
- Life Table “B-M-2020”: For female beneficiary annuitants who are not disabled.
- Life Table “MI-M-2020”: For all female annuitants who are disabled.

In Chile, insurance companies are still allowed to use the gender of the annuitant as a pricing variable. However, in other countries the use of gender in insurance pricing is not allowed. For example, in Europe since 2012 the European Court of Justice⁵ on grounds of gender equality prohibited the use of gender as a pricing variable effectively mandating the use of unisex life tables when pricing life annuities (European Union 2012).

3 Task

You work as an actuary for a Chilean insurance company who is revising the assumptions they use for pricing their annuities. In particular, given the precedent in other countries, your boss is foreseeing that there is a possibility that unisex life tables might be mandated to be used in the Chilean market.

¹<https://www.spensiones.cl/portal/institucional/594/w3-article-3523.html>

²https://www.cmfchile.cl/normativa/ncg_495_2023.pdf

³H in the table name stands for men as in Spanish the word for man is *hombre*.

⁴M in the table name stands for women as in Spanish the word for woman is *mujer*.

⁵See https://ec.europa.eu/commission/presscorner/detail/en/IP_12_1430

To inform decision making your boss has asked you to analyse the mortality of annuitants in Chile during the period 2014-2018. For this, they have forwarded you the dataset used in the construction of the five latest life tables used in Chile. Your boss is interested in:

- understanding whether the current use of five different life tables is justified and
- assessing how a unisex life table for Chilean annuitants might look like.

In particular, your boss has asked you to do the following tasks and write a short report to comment and summarise your results:

1. Perform a brief descriptive analysis of the mortality dataset of Chilean annuitants.
2. Using the methods learned in the course (e.g. KM, Cox regression), analyse the mortality and survival of annuitants in the given dataset. In particular, the study of differences in mortality by sex, disability status and type of annuitant.
3. Graduate a unisex period life table for the years 2014-2018 for non-disabled annuitants for the age range 60 to 99. For this, you should consider multiple graduation approaches including the Gompertz model, the Makeham model and splines. Furthermore, you should provide a recommendation on which approach is best for the data at hand.
4. Discuss from an ethical perspective whether insurers should use gender a rating factor for setting their annuity prices.

See more details on the tasks below.

4 Additional information and mark allocation

4.1 Data

For the assignment you have access to the data used in the construction of the current life tables used in Chile. You have access to a pre-processed file “ChileanMortality.csv”. This file contains data on 1,292,017 annuitants aged 60 or more who were part of the pension system between 1st January 2014 and 31st December 2018.

The data is described below:

Variable	Description
BIRTHDATE:	Date of birth of the person
DATE_START:	Date of start of the exposure
DATE_END:	Date of end of the exposure. For those who died this is the date of death and for the others the date of the end of observation
DEATH:	TRUE if the person died, ‘FALSE’ otherwise
SEX:	Sex of the person: ‘F’ for female and ‘M’ for male
HEALTH:	Categorical variable indicating whether the person is Healthy or Disabled
PERSON_TYPE:	Categorical variable indicating whether the person is the Main Annuitant or a Beneficiary (i.e. a dependent)

You also have access to the excel file “ChileanLifeTables.xlsx” containing the graduated q_x for 2020 for the five life tables currently being used in Chile.

4.2 Analysis, Modelling and Discussion [85 Marks]

Mark allocation for the assignment can be found in the rubric attached, refer as well to the below for more details on the tasks.

4.2.1 Descriptive analysis of the profile of annuitants in the data [10 Marks]

For this part you should use several summary metrics of the people in the data set including the distribution of the people by gender and health and, and others metrics of your choice.

Your calculations of the different metrics should be accompanied by a discussion of the insights you get from the summary metrics.

4.2.2 Survival analysis [30 Marks]

Your survival analysis should be accompanied by a discussion of the insights you get from each task. Provide the results and analysis associated with each of the estimation and modelling tasks in the technical appendix. Note that, when applicable, you should also provide in the main report the key assumptions, results and analysis for your selected modelling techniques, along with justification of why a particular modelling technique was chosen. Moreover, you should emphasise how your analysis supports or does not support the current use of 5 different life tables in Chile.

For this part, note that the data being used is **left truncated and right censored**. The `Surv` function in the **survival** package in R supports the creation survival object of this type using the syntax

```
Surv(left_truncation_time, right_censoring_time, event)
```

4.2.3 Graduation of unisex life table for healthy annuitants [30 Marks]

For this part you should consider only those individuals in the dataset who are **healthy**. For this subgroup of people graduate a mortality table for the age range 60 to 100. In doing so, consider several graduation methods such as the Gompertz model, the Makeham model and splines. Provide the results and analysis associated with each of these methods in the technical appendix. In the main report include graphs of the graduated unisex mortality rates (or mortality probabilities) along with justification of why the particular graduation method was chosen, and a comparison with the sex-specific life tables currently used in Chile for healthy annuitants (i.e., Tables “CB-H-2020”, “RV-M-2020” and “B-M-2020”).

4.2.4 Ethical implications of unisex annuity pricing [15 Marks]

In this part you should discuss from an ethical perspective whether insurers in Chile should continue to be allowed to use gender as a rating criteria for setting their annuity prices. This discussion should:

1. provide pros and cons of using gender as rating criterion and
2. formulate a recommendation based on the above.

To help complete this part of the assignment you should do the activities of week 7 and 8 which focus on ethical perspectives in actuarial work.

4.3 Presentation Format and Communication [15 Marks]

Communication of quantitative results in a concise and easy-to-read manner is a skill that is vital in practice. As such, marks will be given for the presentation of your results. In order to maximise your marks for presentation you may wish to consider issues such as: table size/readability, figure axis/formatting, ease of reading, grammar/spelling, and report structure. You may also wish to consider the use of executive summaries and appendices, where appropriate. Provide sufficient details in the main body of the report so that they can judge what you are doing, using appendices for non-essential but useful results as necessary.

Note that sufficient detail must be provided (in either the report body and/or appendices) so that the reviewer can follow all the steps and derivations required in your work.

Note that a **maximum page limit of 6 pages** (including tables and graphs but excluding references) is applicable to the main body of the report.⁶ You should also consider the rubric for the presentation component. There is no limit to the size of the appendix. Furthermore your answer should satisfy the following formatting requirements: (i) font: Times, 12 pt or equivalent size and (ii) margins: all four of at least 2cm.

4.4 Software

You may choose which software packages to use (e.g. R, Excel or other), however, most functions you will be required to use for this task are available in R. Note also that most of the code enabling you to perform the calculation and analysis are in the R tutorials.

4.5 Assignment submission procedure

4.5.1 Turnitin submission

Your assignment report must be uploaded as a **unique document**. As long as the due date is still future, you can resubmit your work; the previous version of your assignment will be replaced by the new version.

Assignments must be submitted via the Turnitin submission box that is available on the course Moodle website. Turnitin reports on any similarities between their own cohort's assignments, and also with regard to other sources (such as the internet or all assignments submitted all around the world via Turnitin). More information is available at: [click]. Please read this page, as we will assume that you are familiar with its content.

Please **also attach any programming code and/or sample spreadsheet output** used in your analysis as a separate file in the dedicated "code only submission" and "code or excel file submission" Moodle assignment boxes on the course webpage. These will be referred to by the marker only if needed, and in particular the **main assignment (with appendix) should be self contained**.

4.5.2 Late submission

Please note that it is School policy that late submission of assignments will incur in a penalty.

When an assessment item had to be submitted by a pre-specified submission date and time and was submitted late, the School of Risk and Actuarial Studies will apply the following policy. Late submission will incur a penalty of 5% per day or part thereof (including weekends) from the due date and time. An assessment will not be accepted after 5 days (120 hours) of the original deadline unless special consideration has been approved. An assignment is considered late if the requested format, such as hard copy or electronic copy, has not been submitted on time or where the 'wrong' assignment has been submitted. Students who are

⁶Please kindly note that this is a maximum - you should feel free to use less pages if it is sufficient!

late must still submit their assignment via Turnitin. The Turnitin date and time of submission of the main report determines the submission time for the purposes of calculating the penalty.

You need to check your document once it is submitted (check it on-screen). **We will not mark assignments that cannot be read on screen.**

Students are reminded of the risk that technical issues may delay or even prevent their submission (such as internet connection and/or computer breakdowns). Students should then consider either submitting their assignment from the university computer rooms or **allow enough time (at least 24 hours is recommended) between their submission and the due time.** The Turnitin module will not let you submit a late report. **No paper copy will be either accepted or graded.**

4.5.3 Plagiarism awareness

Students are reminded that the work they submit must be their own. While we have no problem with students working together on the assignment problems, the material students submit for assessment must be their own.

Students should make sure they understand what plagiarism is—cases of plagiarism have a very high probability of being discovered. For issues of collective work, having different persons marking the assignment does not decrease this probability.

4.5.4 Generative AI policy

You are allowed to use Generative AI to help you with editing, planning, idea generation, or coding. However, this must comply with the Generative AI Guidelines for the course available in Moodle/Assessment Hub/Generative AI/ Generative AI Guidelines ACTL3141-5104.

In addition, please include an Appendix in the report titled “**Generative AI usage**” explaining what you used AI for and outlining what prompts you used. **If you did not use Generative AI write in this Appendix that generative AI was not used.**

References

- European Union. 2012. “Guidelines on the Application of Council Directive 2004/113/EC to Insurance, in the Light of the Judgment of the Court of Justice of the European Union in Case c-236/09 (Test-achats).” *Official Journal of the European Union* 55: 1–11. [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012XC0113\(01\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012XC0113(01)&from=EN).
- Ferreiro Yazigi, Alejandro, Osvaldo Macías M., Jorge Mastrángelo, Marcia Miranda T., José Luis Ruiz V., Marcia Salinas B., and Dagoberto Valenzuela C. 2003. *The Chilean Pension System*. Translated by Linda Craddock. 4th ed. Santiago, Chile: Superintendency of Pension Fund Administrators. www.safp.cl.