Workers Compensation: Survival Analysis

Shannon Nicponski, Liz Riedell, Jerrick Zhang
Faculty Advisors: Ian Duncan, Roberto Molinari
Department of Statistics and Applied Probability, University of California, Santa Barbara

Abstract

The CSAC-EIA currently reserves for disabled worker Workers Compensation (WC) claims using an OSIP-prescribed methodology based on US population mortality. Using a sample of WC claims, we tested the accuracy of this method. We estimated claim closure rates using actuarial methods and compared these to the OSIP-prescribed closure rates. OSIP's reserving methodology was found to overestimate the time WC claims are open, thus overestimating the reserves needed for WC claims. To approximate the closure rate, we created multiple models such as Kaplan-Meier, polynomial, and Cox Proportional Hazard models, all of which more accurately fit the WC experience.

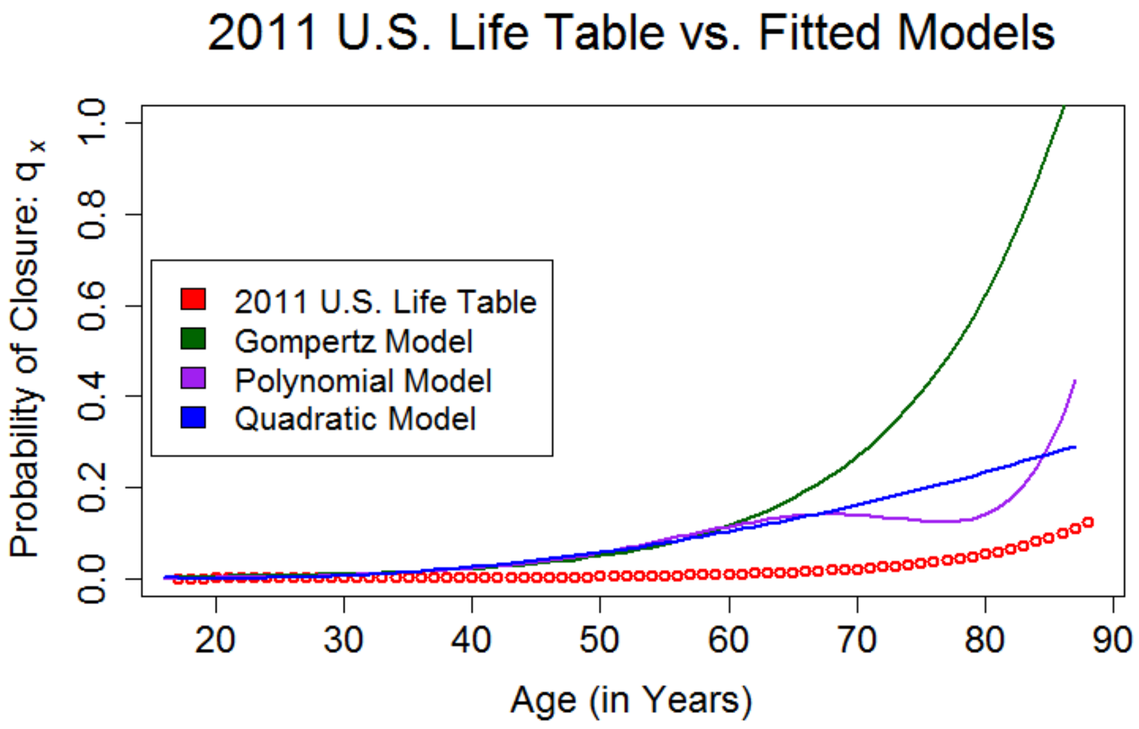
Objectives

- Test the accuracy of the survival portion of OSIP's current reserving method
- Approximate true claim closure rates using permanent disability claims data
- Establish an effective survival model for true claim closure rates using covariates as predictors

Data

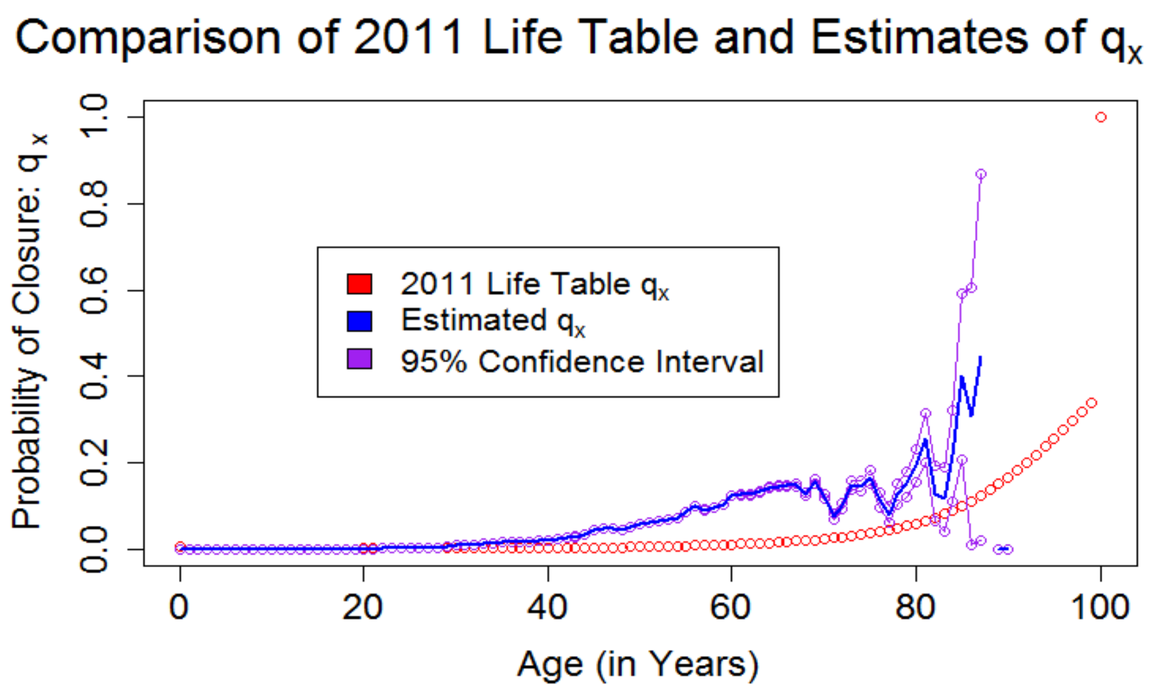
- Workers compensation claims from various CA public entities containing 1,124,473 data records[1]
- 21,110 unique claims reduced to 19,053 permanent disability claims
- Each claim re-evaluated every year on June 30th
- 126 columns describing each claim reduced to 7 predictors (in table below)
- Claim history from 1985 - 2016

Covariates	Description
Derived Entity Group	Categorical (17 Levels)
Age at Date of Loss (DOL)	Numeric
Years Employed at DOL	Numeric
Body Part Code	Numeric
Cause of Loss Code	Alpha-Numeric (19 Levels)
Severity	Numeric
Gender	Categorical (converted to Numeric)



Conclusion

The 2011 U.S. Life Table underestimates claim closure rates and we would suggest using a more accurate model to predict life expectancy of permanent disability claimants, such as our Cox PH model. This would imply overestimation of the reserves from the survival point of view; we can cannot make an overall conclusion about OSIP's FM reserving formula.



Methodology

Challenges

- Miscoding and inconsistencies among most variables and many missing values
- Needed to focus on permanent disability (PD) claims only
- Converting data to a comparable form to the 2011 U.S. Life Table

Solution

- Recoded data and created Severity and Duration variables
- Created indicator to filter data to PD only
- Imputed missing gender values using 'MICE' in R
- Derived $\hat{q}_x$ estimates using actuarial methods[2]:

$$\hat{q}_x = \frac{d_x}{l_x - .5w_x}$$

$\hat{q}_x$:= Rate of Mortality in Interval x to x + 1
d_x := Number of Deaths in Interval x to x + 1
l_x := Number Alive in Interval x to x + 1
w_x:=Number of Deaths + Number of Censored in Interval x to x+1

Modeling

- Cox Proportional Hazard Model: used to predict survival probabilities using covariates (in table)

$$h_{\text{No Imputation}}(t) = e^{\beta(\boldsymbol{Entity\ Group})+.000223(\boldsymbol{Severity})} * e^{-.00775(\boldsymbol{Years\ Employed\ at\ DOL})-.09736\,(\boldsymbol{Gender})} * e^{-.001989(\boldsymbol{Body\ Part\ Code})-.00381(\boldsymbol{Age\ at\ DOL})}$$

- Fitted 3 models using age (x) to predict claim closure rates shown in graph (to left)
- Ex: Gompertz Model

$$\hat{q}_x = e^{-7.19859+0.08404x}$$

Citations and Acknowledgements

[1] CDC/NCHS National Vital Statistics System <ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Publications/NVSR/64_11/Table02.xlsx>. Web.
[2] MacDonald, A.S. Richards, S.J. and Currie I.D., Modeling Mortality and Longevity with Actuarial Applications. Unpublished, 2017. Print.

We would like to thank our faculty advisors, Ian Duncan and Roberto Molinari for their assistance, guidance, and enthusiasm for this research