Unifying the Public Pension Plans A Case Study in Taiwan

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Contents

- Introduction
- Methodology
- Empirical study
- Conclusion

Introduction-Mortality

- Zhu et al. (2015) proposed the following three aspects are equally important in insured mortality studies:
  - Mortality trend
  - Mortality slope
  - Mortality differential
- The PIWG and MWG of the IAA hosted a seminar on Current Developments in Aging and Mortality on April 2017.
  - whether current levels of mortality improvements are slackening off
  - whether we have the right assumptions regarding mortality at high ages
  - how mortality is likely to change in the future and what might drive these changes

Introduction – Villegas and Haberman (2014)

- With higher socioeconomic subgroups(e.g. educational attainment, occupation, income, or area deprivation) having **lower mortality rates** and also experiencing **faster mortality improvements** than lower socioeconomic subgroups.
- These socioeconomic differences in mortality pose significant challenges.
  - For the design of pension systems.
  - The management of longevity risk in pension funds and annuity portfolios.
- The ignorance of mortality heterogeneity could result in an **inadequate funding of annuity and pension**.

Introduction – Jeffrey R. Brown (2002)

- Ignoring individual or group characteristics in mortality will result in expected transfers away **from high-mortality risk groups to low-mortality risk groups**.
- Mortality rates differ substantially across these groups(e.g. gender, race, Hispanic status, and level of education) leading to very different valuations of annuities.
- Transfers from shorter-lived to longer-lived individuals should not, in and of themselves, be considered “redistribution.”
- If everyone experienced the same risk of dying at each age, then every individual would have an equal chance of being the survivor, and thus an annuity would not redistribute in expectation.

Introduction – Annuity Revolution

- Annuity Revolution in Taiwan
  - Aggregate social insurances, e.g. National Pension Insurance and Farmers' Health Insurance, to be a basic annuity insurance
  - Neglecting mortality differential may lead to deterioration of the financial position of insurance fund
- This research uses data of National Pension Insurance and Farmers' Health Insurance
  - Assess mortality differential of each insurance above
  - Consider various risk factors'(e.g. gender, age, salary) impact to mortality in order to decrease anti-selection

Introduction - Risk Factors

References	Risk Factors	Purposes
Madrigal et al. (2011)	Age, gender, health condition at retirement, salary before retirement, pension amount, and residence area	Take mortality factors into consideration in calculating actuarial liability, in order to revise current mortality assumptions, so that pension fund is stable
Villegas and Haberman (2014)	Include social status like salary, employment status, health, education, crime, residence	Considering the impact of socioeconomic status on mortality make the model more suitable for analyzing differences and future prediction.
Zhu et al.(2015)	Age, time, smoker or not, insurance category	Considering the impact of socioeconomic status on mortality make the model more suitable for analyzing differences and future prediction.

Methodology

- Calculate basic mortality $q'_{x,t}$ based on overall population (National Pension Insurance and Farmers' Health Insurance)
- Take the error terms $(D_{i,t})$ between the original $q_{i,x,t}$ and basic mortalities $q'_{x,t}$ to analyze the impact of mortality differentials.
- $D_{i,t} = \sum_x (q_{x,t,i} - q'_{x,t}) \times \frac{exp_{i,x,t}}{\sum_x exp_{i,x,t}}$

$$= \beta_0 + \beta_1 z_{i,type} + \beta_2 z_{i,weak} + \beta_3 z_{i,type} z_{i,weak} + \sum_{k:area} \beta_k z_{i,k} + \varepsilon_i$$

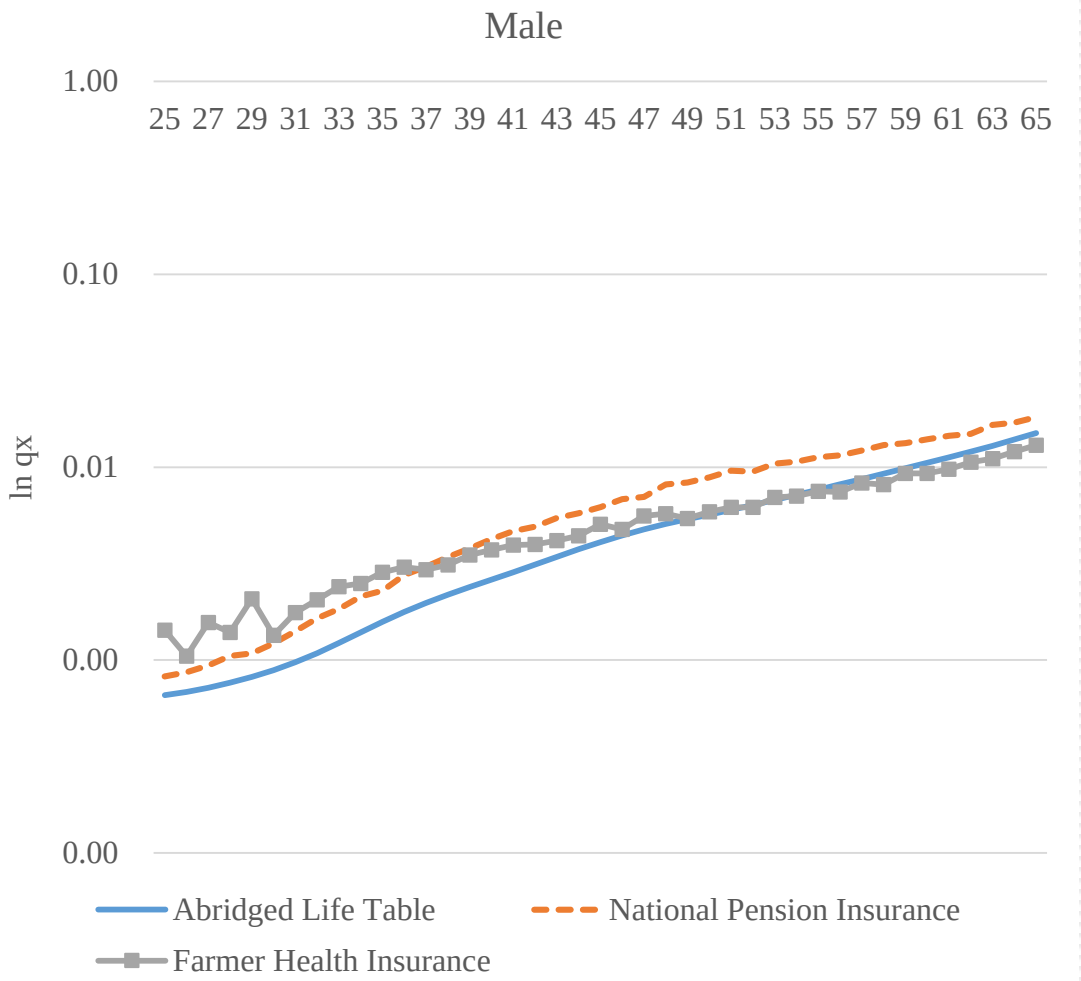
Variable	Description
i	Risk category
t	Year
x	Age
exp	Exposure
type	The insured that is identify by National Pension Insurance or Farmer Health Insurance
weak	the underprivileged groups (vulnerable and non-vulnerable)
area	the residence city

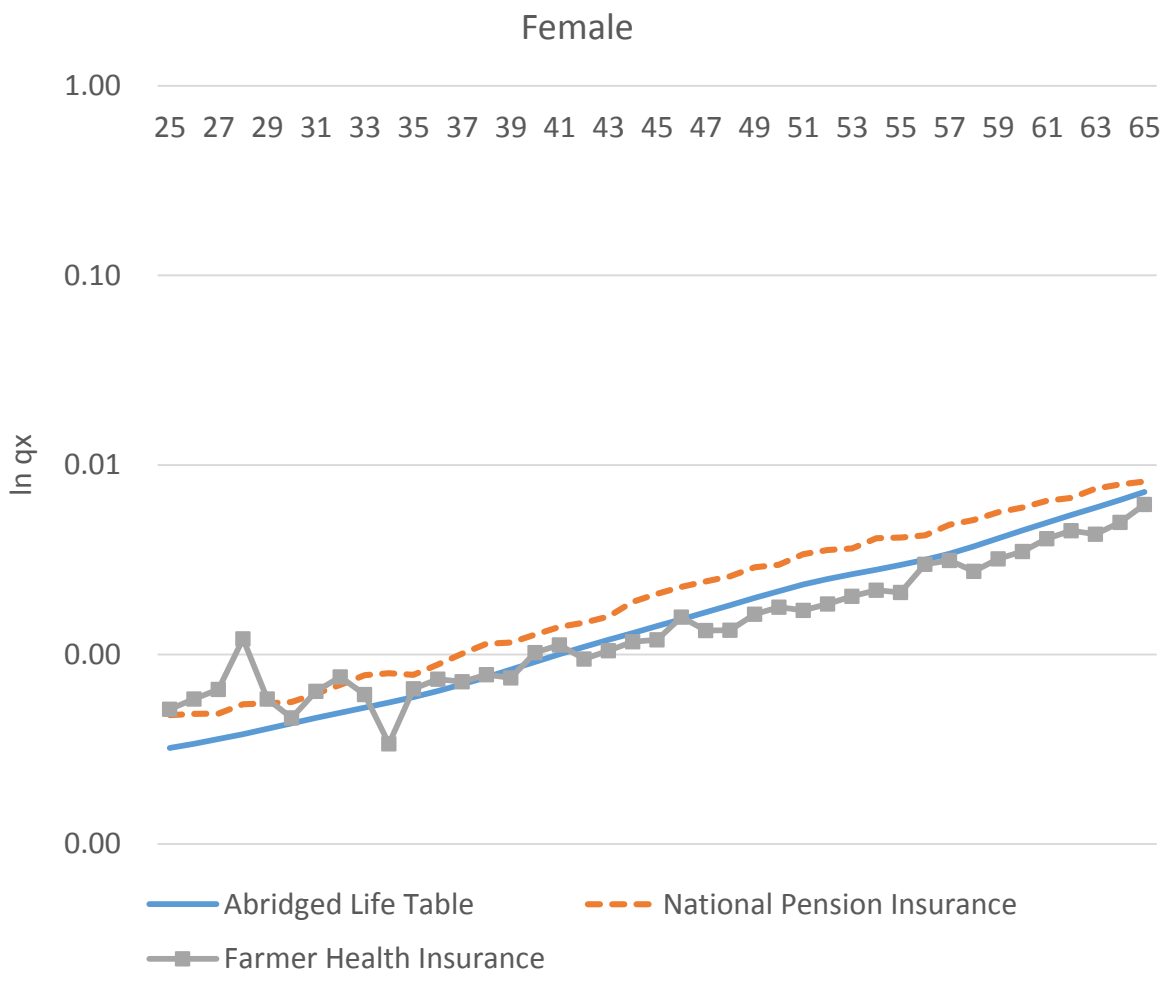
Empirical Study – Data Description

- Duration: 2008/10 to 2015/09
- Insured age: 25-65 years old

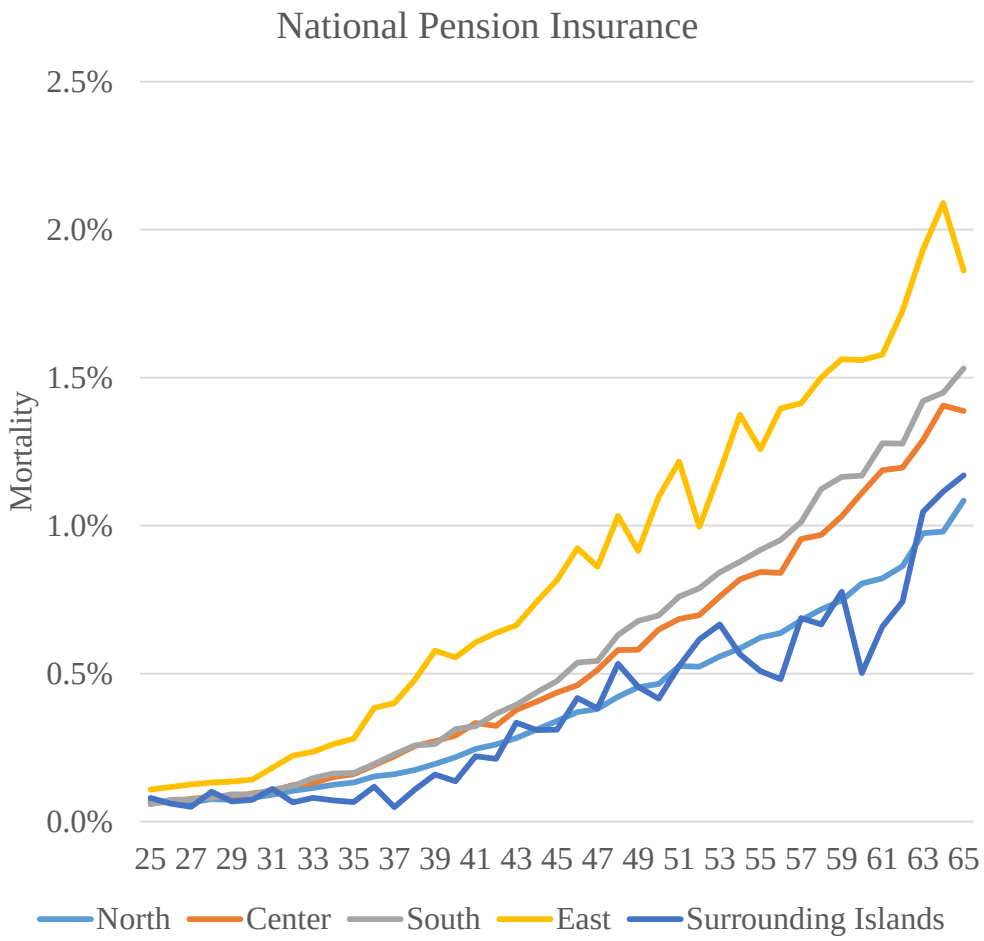
Category		National Pension Insurance	Farmers' Health Insurance
Insured proportion to national population (2015/09)		35.7%	5.6%
Male : Female (%)		49：51	51：49
Age (2015)	25-44	54.6%	9.6%
	45-64	36.5%	36.6%
	≥ 65	8.9%	53.8%
Average age		44 - 45	62 - 65
Population ratio (%)		North：34.4；Center：23.4 South：14.3；East：2.4 Outside Island：0.4	North：9.5；Center：42 South：30.5；East：4.2 Outside Island：0.4
Non-vulnerable：Vulnerable (%)		93：7	90：10

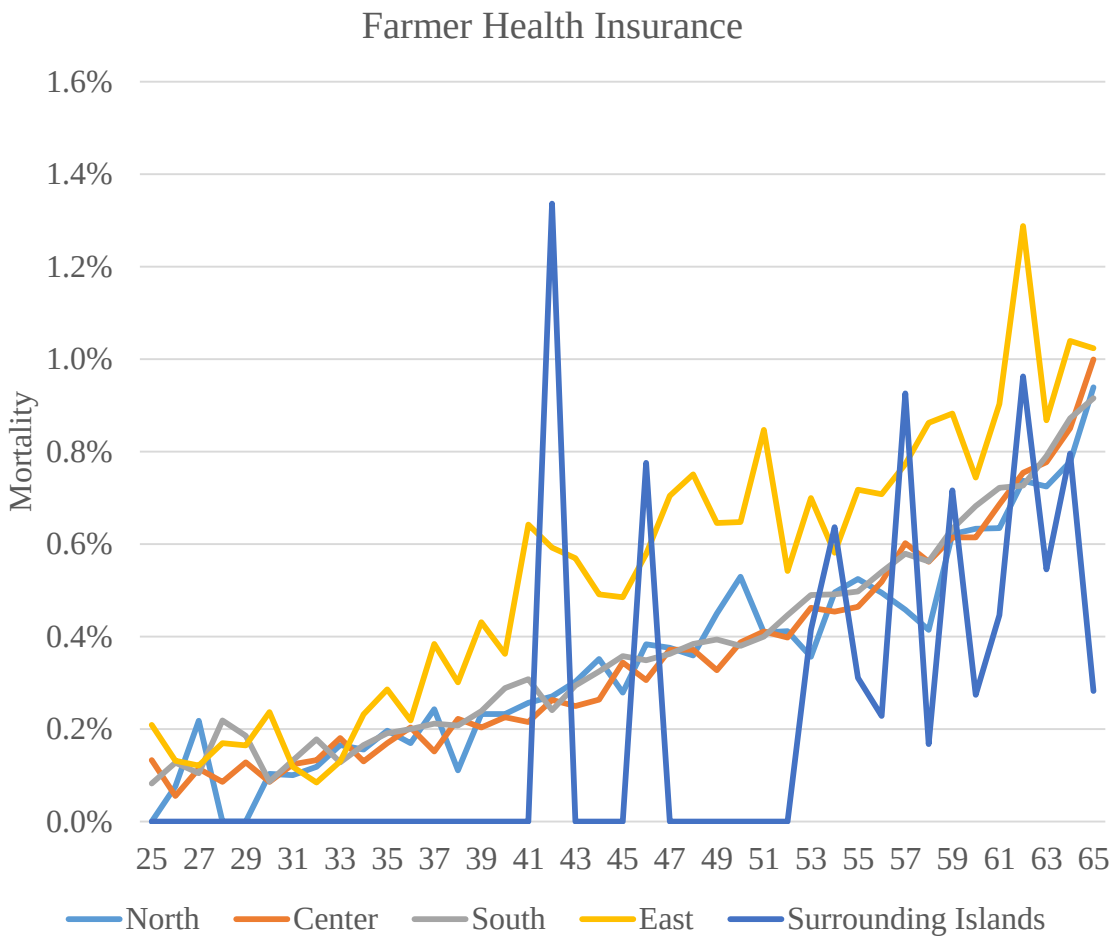
Data Description – Mortality Differential



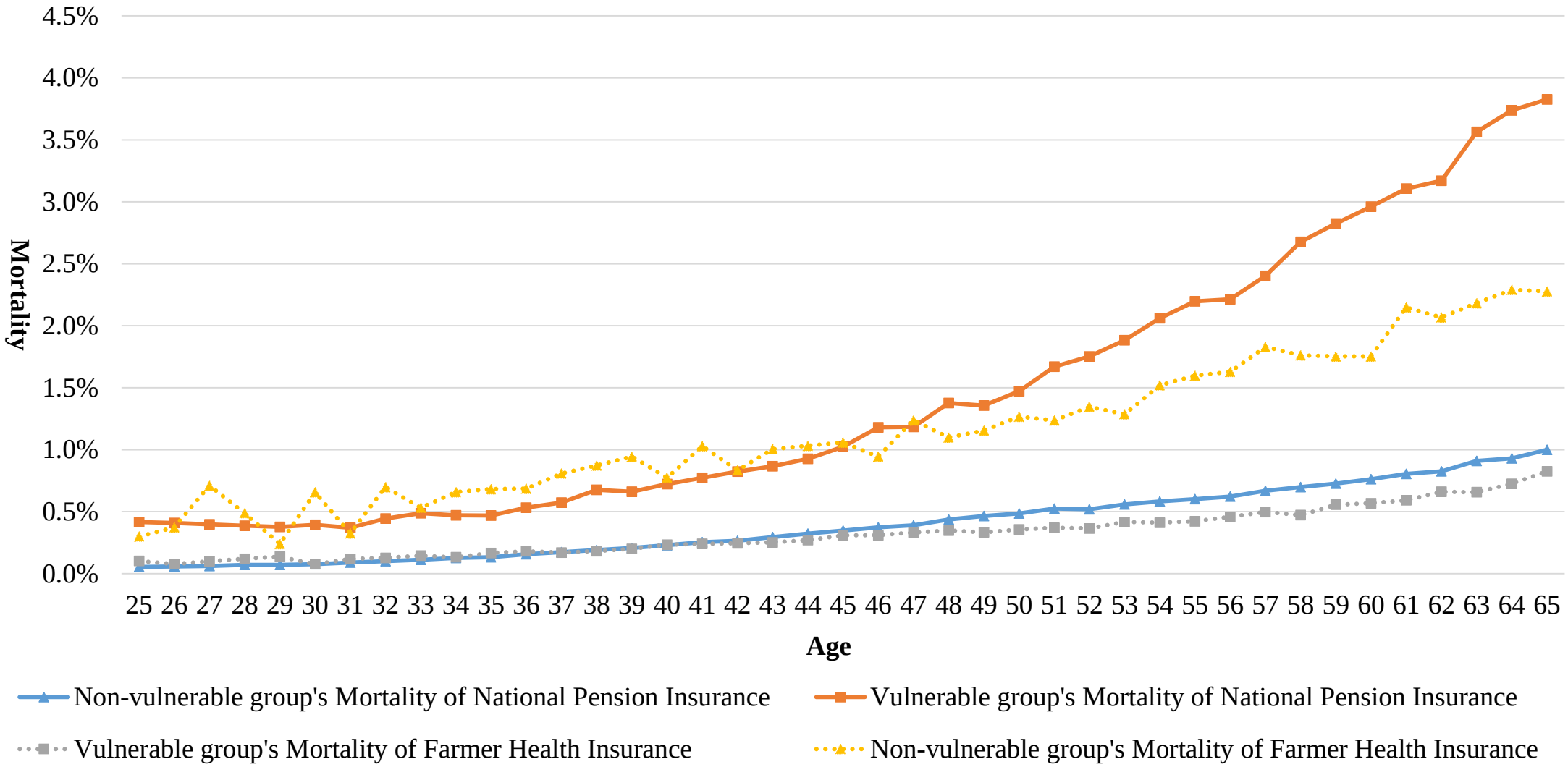


Data Description – Mortality Differential Based on Residence Area





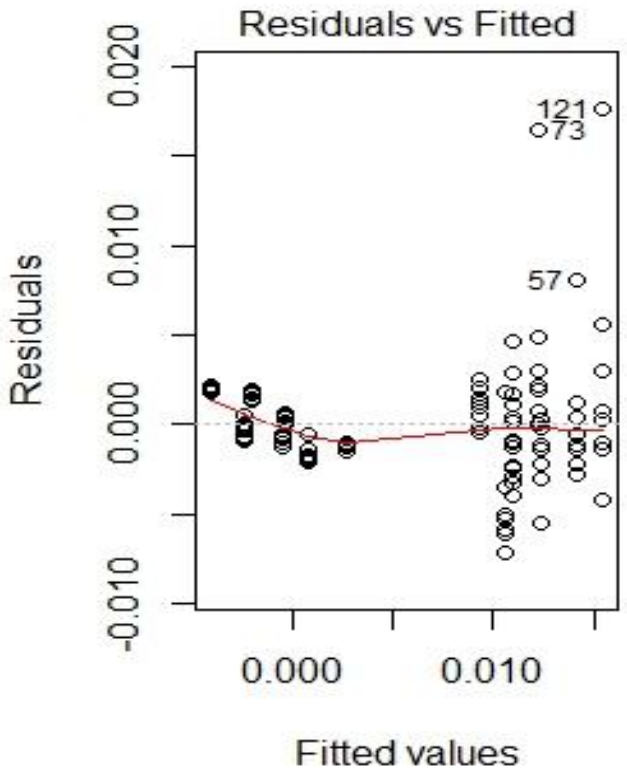
Data Description – Mortality Differential Based on Identity

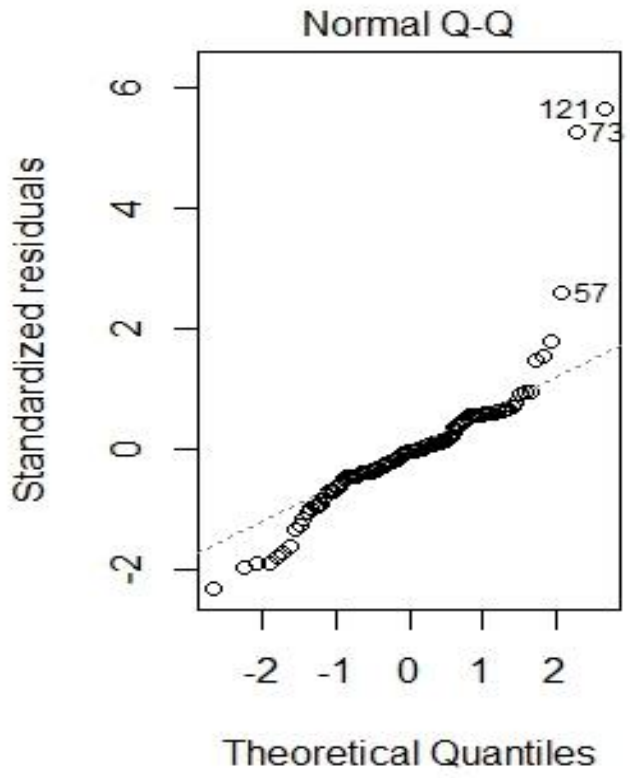


Empirical Study - Neglect Heterogeneity

Variable	β	Standard error	t-value	p-value
Intercept	-0.00048	0.00075	-0.63592	0.52603
Insured Identity	-0.00196	0.00080	-2.44920	0.01575
Underprivileged Groups	0.01141	0.00080	14.24959	<0.0001**
Central Area	-0.00158	0.00080	-1.97241	0.05084
Southern Area	0.00009	0.00080	0.11409	0.90936
Eastern Area and Surrounding Islands	0.00322	0.00080	4.01511	<0.0001**
Interaction Between Insured Identity and Underprivileged Groups	0.00326	0.00113	2.87827	0.00473

Empirical Study - Neglect Heterogeneity





R^2	**86.22%**
Adjustment R^2	81.80%

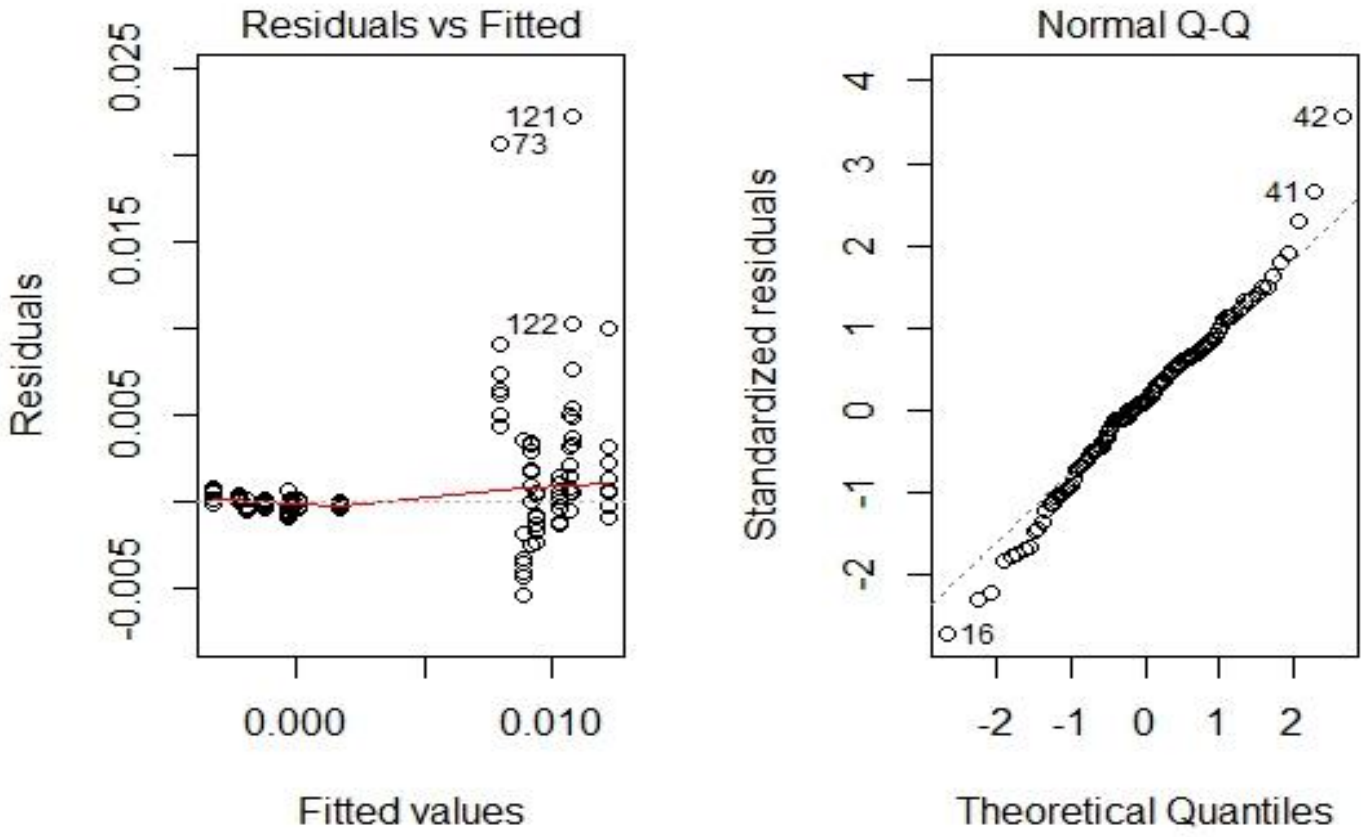
Empirical Study - Does Not Match Actual Data

- Problem: Parameters are not able to describe the variables, data does not match normal distribution and the law of variance heterogeneity
- Reason: Risks with lower exposure have greater variance
- Solving method:
  - Delete observed value with lower exposure
  - Parameters estimation of the regression model uses WLS instead of OLS
  - Strength of WLS: adjust the parameters estimation method to actually reflect the variance of the observed values

Empirical Study - WLS

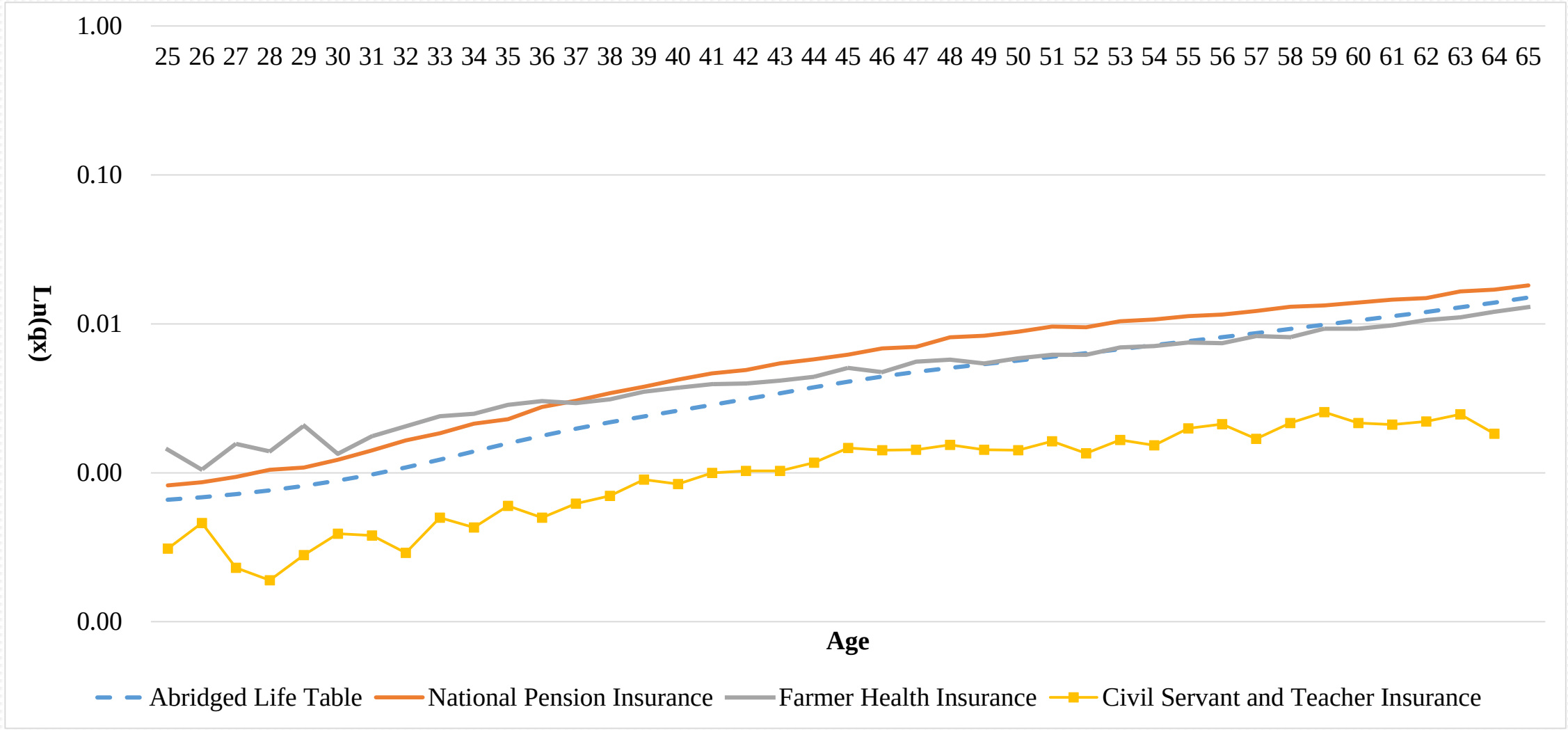
Variable	β	Standard error	t-value	p-value
Intercept	-0.00123	0.00007	-16.60588	<0.0001**
Insured Identity	-0.00203	0.00017	-12.07025	<0.0001**
Underprivileged Groups	0.01061	0.00020	54.29593	<0.0001**
Central Area	0.00094	0.00012	7.70503	<0.0001**
Southern Area	0.00129	0.00012	10.91251	<0.0001**
Eastern Area and Surrounding Islands	0.00287	0.00029	9.88834	<0.0001**
Interaction Between Insured Identity and Underprivileged Groups	0.00060	0.00068	0.88508	0.37787

Empirical Study - WLS



R^2	**96.77%**
Adjustment R^2	96.61%

Mortality Differential amoung Various Insurance



Conclusion

- Analyze mortality differential of National Pension Insurance and Farmers' Health Insurance.
  - Assess the feasibility of social insurance aggregation and single premium rate
- From mortality differential model discovers that:
  - Difference of mortality differential of National Pension Insurance and Farmers' Health Insurance.
  - Identity, the underprivileged groups (vulnerable and non-vulnerable), and area could influence mortality differential
- If government aggregate National Pension Insurance and Farmers' Health Insurance and implement single premium rate.
  - May lead to anti-selection and affect the stability of pension fund
  - Government should carefully assess