
Using Taiwan National Health Insurance Database to Design Long-term Care Insurance

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Date: Sept. 29, 2016

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Summary

- ❑ Prolonging Life
- ❑ Taiwan National Health Insurance
- ❑ Handling Big Data
- ❑ Long-term Care & Catastrophic Illness
- ❑ Conclusion and Discussions

Population Trend of 21st Century

□ Population aging and migration are two most important demographic issues in the 21st century.

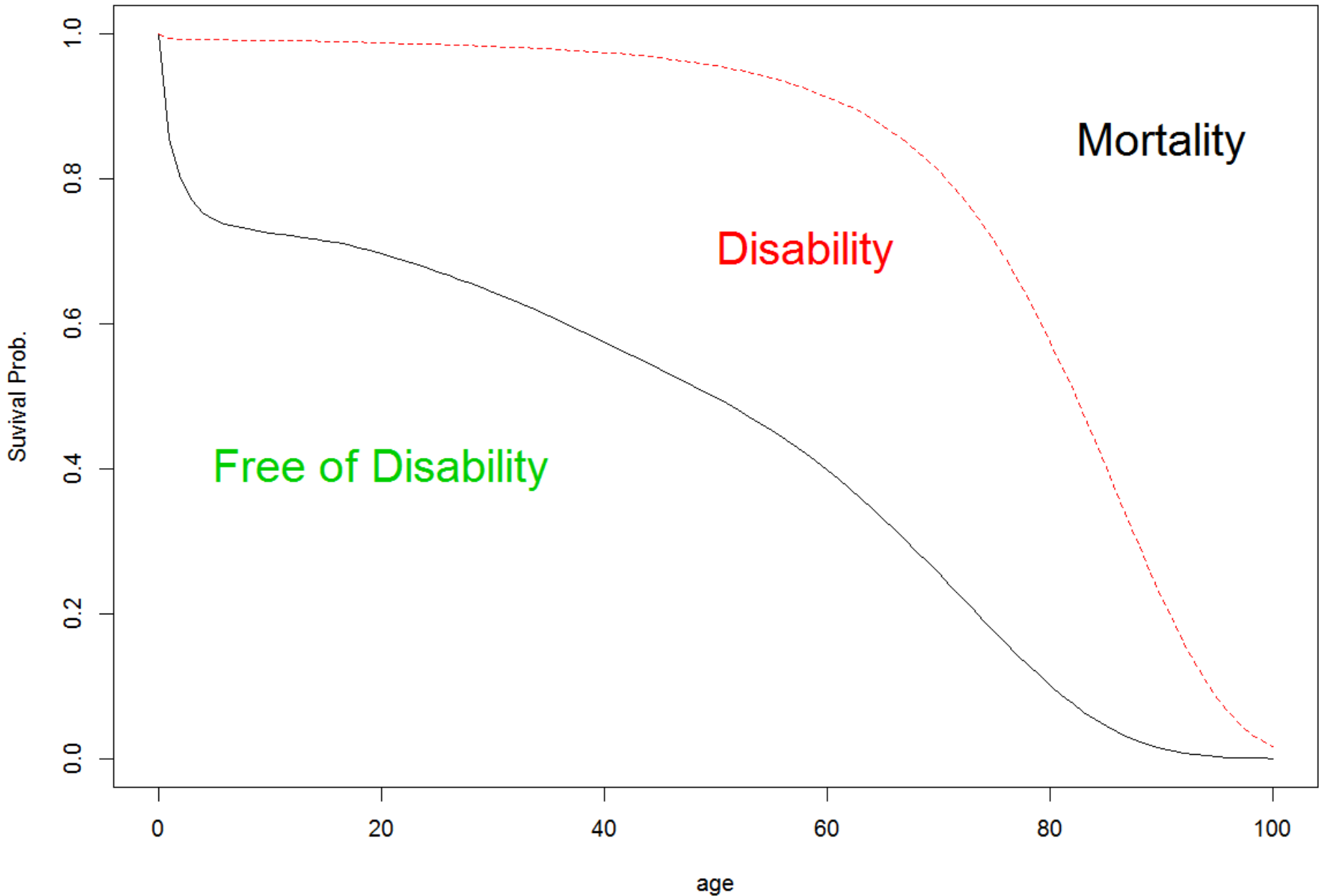
→ The population ageing becomes universal due to the prolonging life expectancy.

→ Need to consider the problems related to the demographic transition about ageing.

Retirement Life Arrangement

- The individual's considerations to the prolonging life expectancy include:
 - (1) Income/Economic factor
 - Source of income (e.g., Reverse Mortgage)
 - (2) Health/Medical factor
 - Medical cost (e.g., National Health Insurance)
 - (3) Daily activity
 - Life style and living arrangement (e.g., LTC)
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World Health Organization (1984)



Difficulties of LTC Insurance

- Three major difficulties of LTC insurance:
 - Low Consumer Demand, Pricing, and Managing the Risk ◦
 - There is longevity risk for the LTC insurance, such as about ALM (Asset Liability Management)
 - Long-tail Liability Risk;
 - Cash Flow (Asset Management)
- Note: LTC premiums increase 10~40% due to low interest rate and low lapse rate.

Tools for Evaluating LTC Insurance

- There are quite a lot of tools for measuring if individuals need long-term care:
 - Index of Independence of Activities of Daily Living (ADL)
 - Instrumental ADL (IADL)
 - Barthel Index
 - International classification of functioning, disability and health (ICF)

Definition of Disability, Functional Limitations, Activities of Daily Living (ADLs), and Instrumental Activities of Daily Living (IADLs)

A person has a disability if they have either a or ✓

= Person is defined as having a nonsevere disability

✓ = Person is defined as having a severe disability

| Types of Disabilities | Age | | | |
|---|---------|--------|-------------------------------------|-------------------------------------|
| | Under 3 | 3 to 5 | 6 to 14 | 15 and over |
| Used a wheelchair, cane, crutches, or a walker | | | ✓ | ✓ |
| Had difficulty performing one or more functional activities (seeing, hearing, speaking, lifting/carrying, using stairs, walking, or grasping small objects) | | | | <input checked="" type="checkbox"/> |
| Unable to perform or needed help to perform one or more of the functional activities | | | | ✓ |
| Had difficulty with one or more activities of daily living (ADLs included getting around inside the home, getting in or out of bed or a chair, bathing, dressing, eating, and toileting) | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| Unable to perform or needed help to perform one or more ADLs | | | ✓ | ✓ |
| Had difficulty with one or more instrumental activities of daily living (IADLs included going outside the home, keeping track of money and bills, preparing meals, doing light housework, taking prescription medicines in the right amount at the right time, and using the telephone) | | | | <input checked="" type="checkbox"/> |
| Unable to perform or needed help to perform one or more IADLs | | | | ✓ |

Example of ADL & IADL

Study Goal

- ❑ The cost of LTC insurance seems to increase and the longevity risk is also a big issue.
→ Question: Can we design LTC products?
 - ❑ Taiwan has maintained complete records of national health care data since 1995.
→ Big data?
→ Target population?
→ Modeling incidence and mortality rates?
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Social and Commercial Insurance

- NHI is jeopardized by population aging and its coverage is likely to further limited.
- Commercial insurance products in Taiwan can serve as the supplements.
- Claiming of commercial products has been deemed to be difficult and criticized.
- If the claim of CI products is based on the insureds are issued with CI cards, it would attract more consumers.



Taiwan's National Health Insurance

- Taiwan started the national health insurance (NHI) in 1995, and more than 99% population are covered now (excluding oversea workers).
- Waiver of copayment is one of the important policy in NHI. In addition to veterans, pregnant women, and people in remote areas, Catastrophic Illness (CI) patients also enjoy the copayment waiver.

Catastrophic Illness

- In Taiwan, people with Catastrophic Illness (including cancer) are about 920,000 (4% population; 980,000 cards in 2016) but the medical cost is more than 28% in 2013.
 - Catastrophic Illness usually require intensive medical care and its cost often is too heavy for individuals with average incomes.
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Catastrophic Illness Cards

- ❑ Evaluating of issuing CI cards is not done by the NHI administration alone.
→ e.g., Issuing cancer CI cards requires at least 3 anonymous cancer specialists (committee) from the Chinese Oncology to review medical records and case history.
- ❑ Rigorous evaluation has limited the increase of CI cards issued.

Top 10 CI cards in April 2016

| Rank | Illness | # cards | % | growth |
|------|---|----------------|---------------|--------------|
| 1 | 癌症(Cancer) | 451,032 | 46.29% | 7,955 |
| 2 | 慢性精神病(Chronically Mental Disease) | 203,878 | 20.92% | 333 |
| 3 | 需終身治療之全身性自體免疫症候群(Autoimmune Disease) | 101,690 | 10.44% | 473 |
| 4 | 慢性腎衰竭(尿毒症)必須定期透析治療者(Kidney) | 80,974 | 8.31% | 977 |
| 5 | 心、肺、胃腸、腎臟、神經、骨骼系統等之先天性畸型及染色體異常(Congenital Malformations and Chromosomal Abnormalities) | 35,639 | 3.66% | 231 |
| 6 | 先天性新陳代謝疾病(Congenital Metabolic Diseases) | 14,167 | 1.45% | 28 |
| 7 | 小兒麻痺、腦性麻痺、早產兒所引起之神經、肌肉、骨骼、肺臟等之併發症者(其殘障等級在中度以上者) | 12,951 | 1.33% | 13 |
| 8 | 接受心臟、腎臟及骨髓移植後之追蹤治療(Organ Transplant) | 12,816 | 1.32% | 89 |
| 9 | 因呼吸衰竭需長期使用呼吸器者(Human Vegetables) | 12,718 | 1.31% | 1,470 |
| 10 | 肝硬化症(Cirrhosis of the Liver Disease) | 8,793 | 0.90% | 145 |
| | Others | 39,694 | 4.07% | 534 |
| | Total | 974,352 | 100% | 12,248 |

Source: Ministry of Health and Welfare

Eight Groups eligible for LTC Insurance

| Code | CI Type |
|------|--|
| 5-3 | Rheumatoid arthritis |
| 12 | Major trauma (rated 16 or above on the severity scale) |
| 13 | Long-term mechanical ventilation (e.g., Human vegetables) |
| 15 | Air embolism |
| 16 | Myasthenia gravis |
| 18 | Spinal cord injury & disease |
| 28 | Motor neuron disease |
| 29 | Jakob-Creutzfeldt (Mad Cow) disease |

The Proposed LTC Insurance

- The patients with the proposed 8 types of CI require assistance from other people.
→ There will be few disputes if we adapt the CI cards from Taiwan's NHI.
- Limitations
→ However, the causes of LTC is not restricted to diseases of these 8 types and they can be related to ageing or loss of body function.

Handling Big Data

- The size and quality of NHI database make data analysis difficult.
 - Need to rely on database software and data scientists (e.g., IT experts).
 - Data cleaning is a big issue, especially the health care data are from different hospitals.
 - Data Discrepancy?
 - The death records are not complete in NHI database, and many are even wrong!
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| | ID | | HV | | HV_CD | |
|--------------|-----------------|-----------|-----------------|-----------|------------------|---------------------|
| | # of records | Size (GB) | # of records | Size (GB) | # of records | Size(GB) |
| 1997 | | | 877398 | 0.71 | 4,821,312 | 3.34 |
| 1998 | | | 988,862 | 0.69 | 6,115,871 | 4.24 |
| 1999 | | | 1,043,563 | 0.77 | 7,288,350 | 5.06 |
| 2000 | | | 1,109,357 | 0.91 | 8,539,223 | 5.93 |
| 2001 | | | 1,311,013 | 1.12 | 10,062,997 | 6.98 |
| 2002 | 71,657,446 | 15.19 | | | 11,897,596 | 7.57 |
| 2003 | 25,130,194 | 5.33 | | | 13,591,212 | 8.64 |
| 2004 | 25,002,871 | 5.30 | | | 16,287,990 | 10.36 |
| 2005 | 25,941,824 | 5.50 | | | 17,829,677 | 11.34 |
| 2006 | 26,336,050 | 5.58 | | | 18,550,542 | 11.79 |
| 2007 | 26,619,007 | 5.64 | 1,518,127 | 1.43 | 17,946,211 | 12.45 |
| 2008 | 26,970,225 | 5.72 | 1,583,690 | 1.46 | 19,173,919 | 13.30 |
| 2009 | 27,223,008 | 5.77 | 1,785,961 | 1.65 | 20,357,193 | 14.12 |
| 2010 | 27,509,909 | 7.03 | 1,923,757 | 1.83 | 21,619,442 | 15.00 |
| 2011 | 27,841,406 | 5.74 | 1,996,987 | 1.90 | 22,861,178 | 15.86 ₁₈ |
| Total | 66.79 GB | | 12.47 GB | | 148.39 GB | |

Cleaning the Data

- It is difficult to handle the big data using regular software and the database software (e.g., SQL) is required.
- Data cleaning and exploratory data analysis (EDA) are the key to success.

→ For example, more than one databases are available and there exist discrepancy.

Note: ID → Incidence; HV_CD → Mortality

Some examples of database:

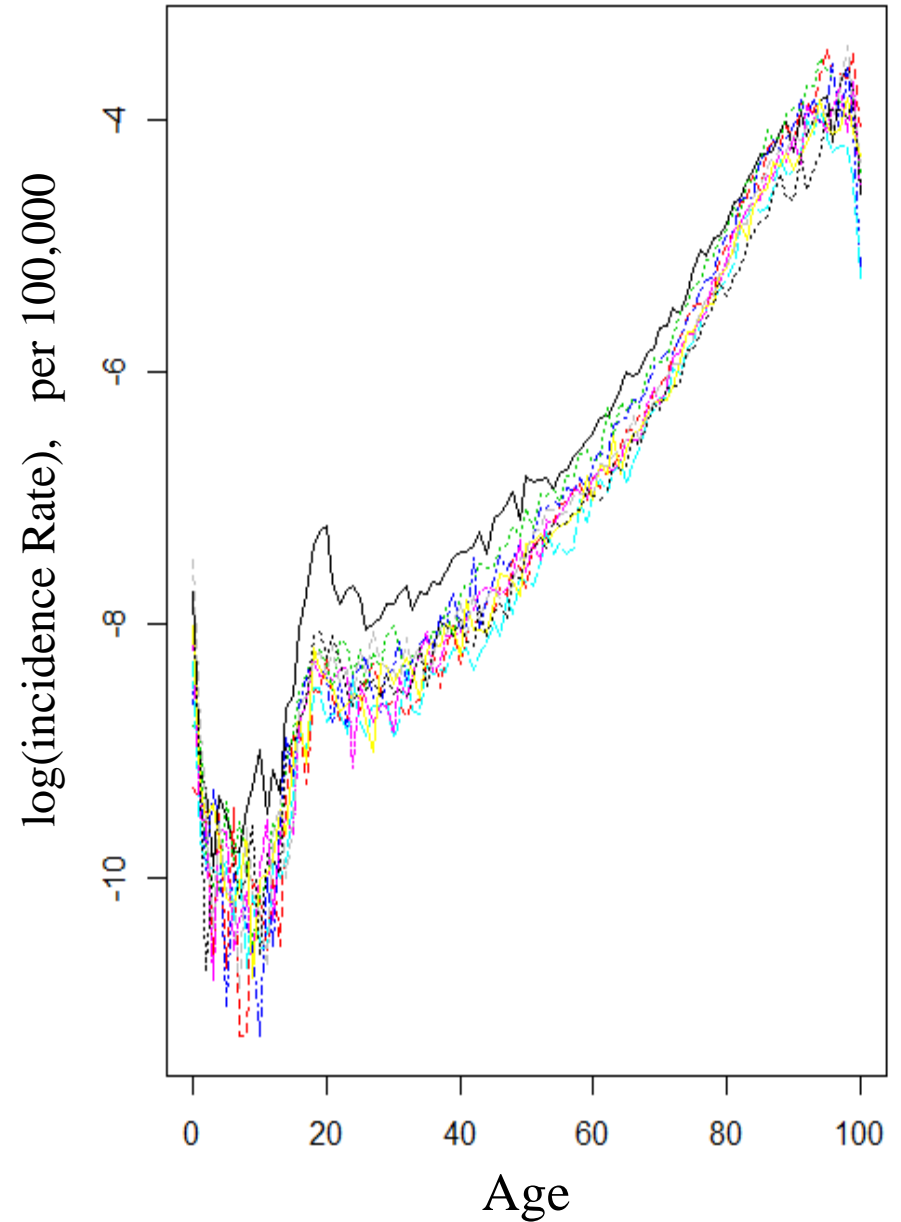
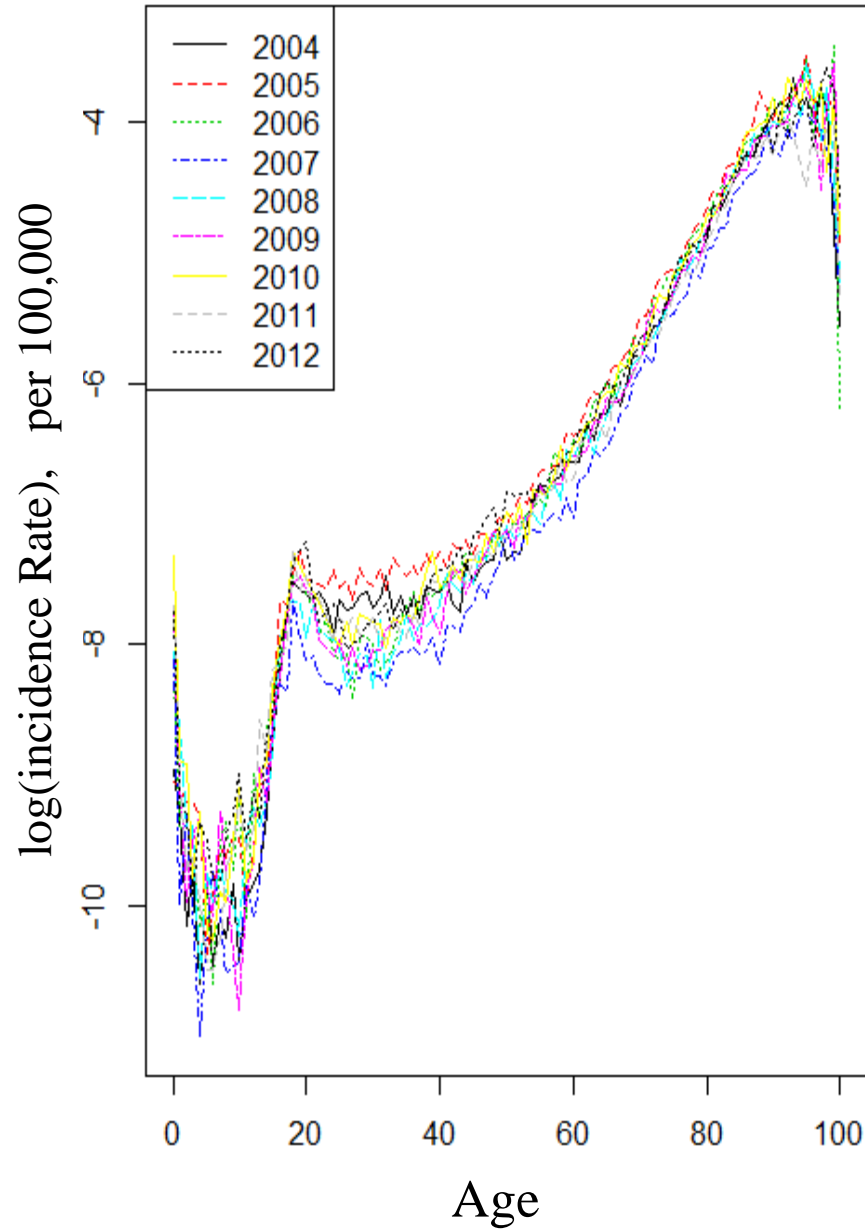
| Year | ID | | HV | | HV_CD | |
|------|------------|------------|-----------|-----------|-----------|------------|
| | # persons | # records | # persons | # records | # persons | # records |
| 2007 | 26,421,498 | 26,619,007 | 1,103,431 | 1,453,483 | 649,106 | 17,946,211 |
| 2008 | 26,780,636 | 26,970,225 | 1,164,465 | 1,529,866 | 678,544 | 19,173,919 |
| 2009 | 27,067,952 | 27,223,008 | 1,276,315 | 1,733,251 | 712,828 | 20,357,173 |
| 2010 | 27,369,795 | 27,509,909 | 1,350,786 | 1,863,254 | 746,746 | 21,619,442 |
| 2011 | 27,699,442 | 27,841,406 | 1,401,449 | 1,933,455 | 779,179 | 22,861,178 |

Discrepancy between Different Database?

| | HV | | HV_CD | |
|------|---------------|------------|---------------|------------|
| | # of Patients | # of Cases | # of Patients | # of Cases |
| 2007 | 1,103,431 | 1,453,483 | 649,106 | 17,946,211 |
| 2008 | 1,164,465 | 1,529,866 | 678,544 | 19,173,919 |
| 2009 | 1,276,315 | 1,733,251 | 712,828 | 20,357,173 |
| 2010 | 1,350,786 | 1,863,254 | 746,746 | 21,619,442 |
| 2011 | 1,401,449 | 1,933,455 | 779,179 | 22,861,178 |

- Note: HV and HV_CD contain the list and out-patient visit records of individual CI patient.

Taiwan Age-specific LTC Incidence Rate



Death Note is not good enough...

- ❑ Death note only covers partial death records and we need to rely on the outpatient visit to judge if patients are still alive.

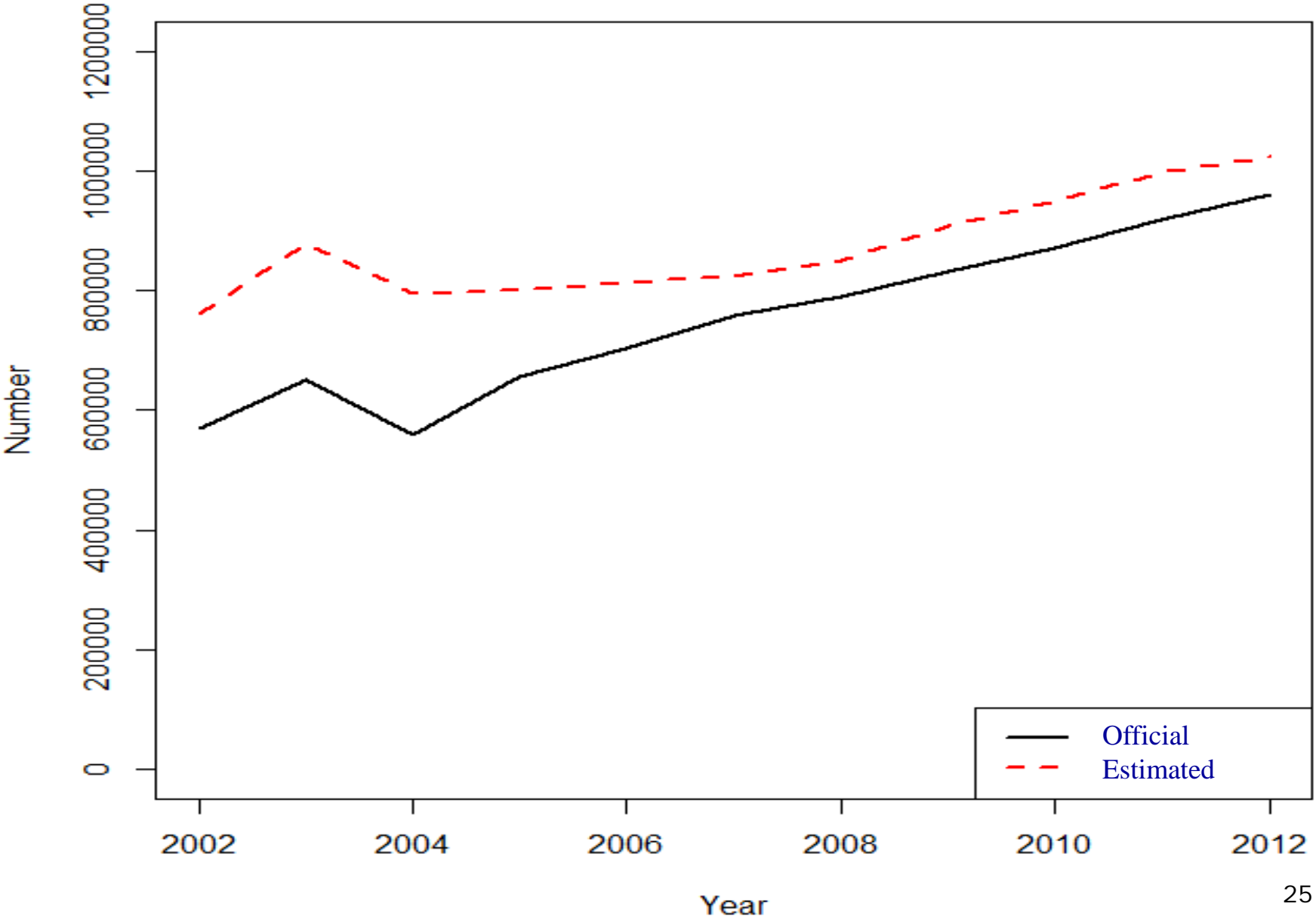
→ e.g., 7,517 persons with “Death Note = Y” in 2007, but 40,306 cancer deaths in official record.

| t | Death note at year t | Outpatient Visit at year t | Outpatient Visit at year t+1 | Outpatient Visit at year t+2 |
|------|----------------------|----------------------------|------------------------------|------------------------------|
| 2007 | 7,517 | 1,304 | 214 | 0 |
| 2008 | 8,295 | 1,145 | 177 | 0 |
| 2009 | 9,264 | 898 | 137 | 0 |

Death Note Records of Catastrophic Illness in 2007

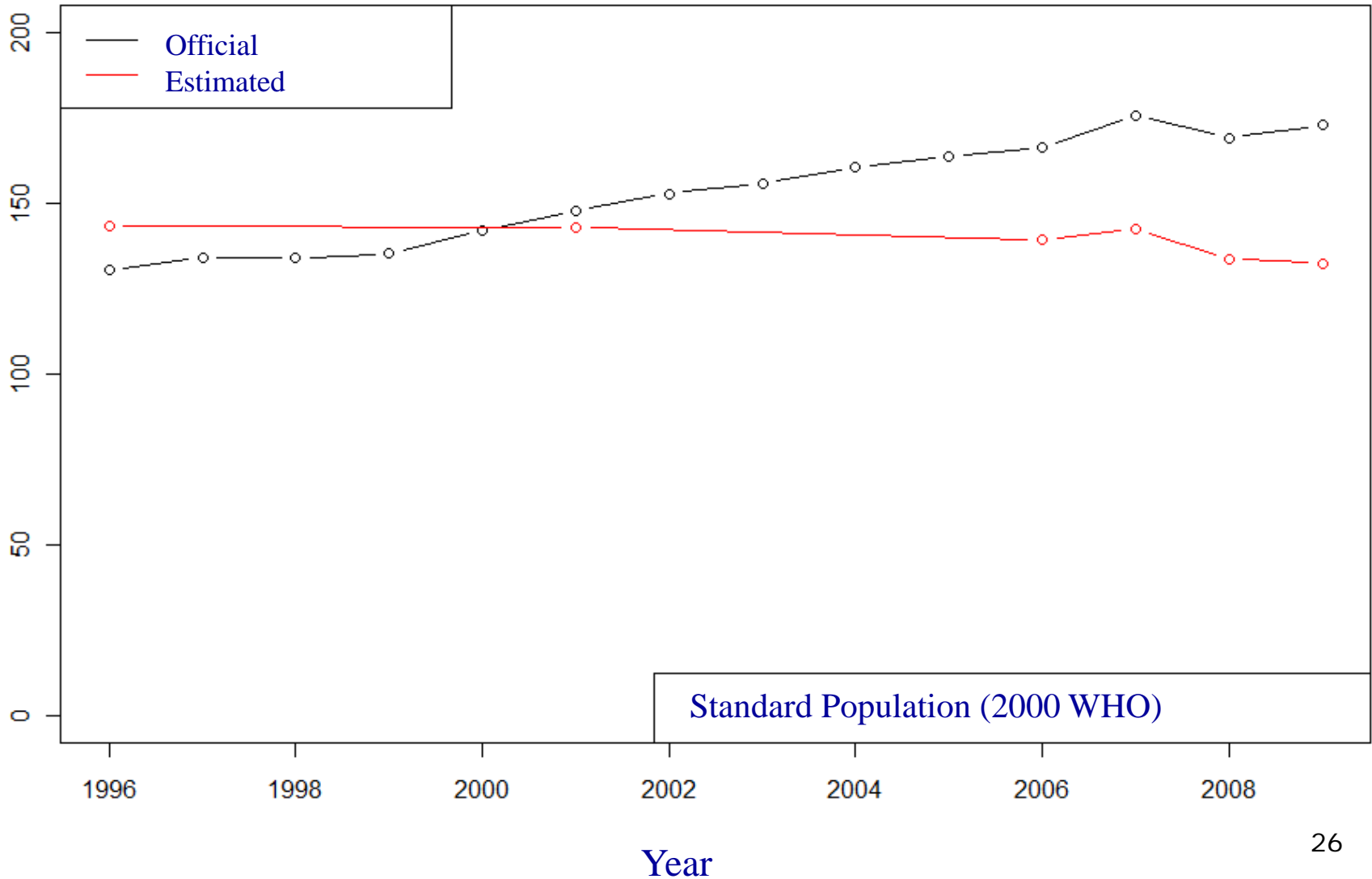
| | | | | | | |
|--------------|---------|---------|--------|---------|--------|--------------|
| Death Note | Empty | 0 | 1 | 2 | 3 | 4 |
| # of Records | 675,923 | 288,325 | 35,353 | 136,591 | 10,184 | 15,820 |
| Death Note | 5 | 6 | 7 | 8 | 9 | Y |
| # of Records | 9,382 | 9,015 | 9,641 | 6,892 | 11,828 | 7,517 |

The size of CI Patients (official vs. estimated)

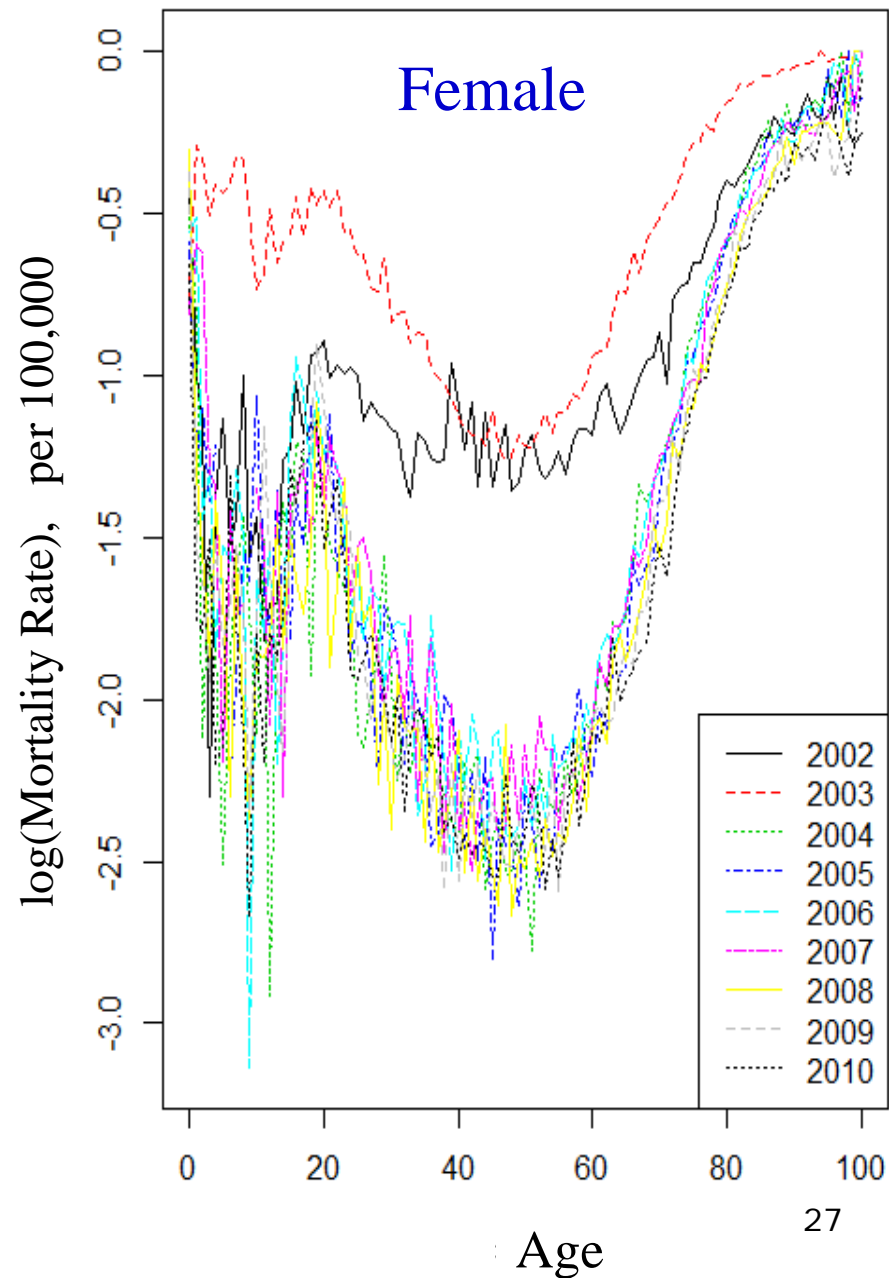
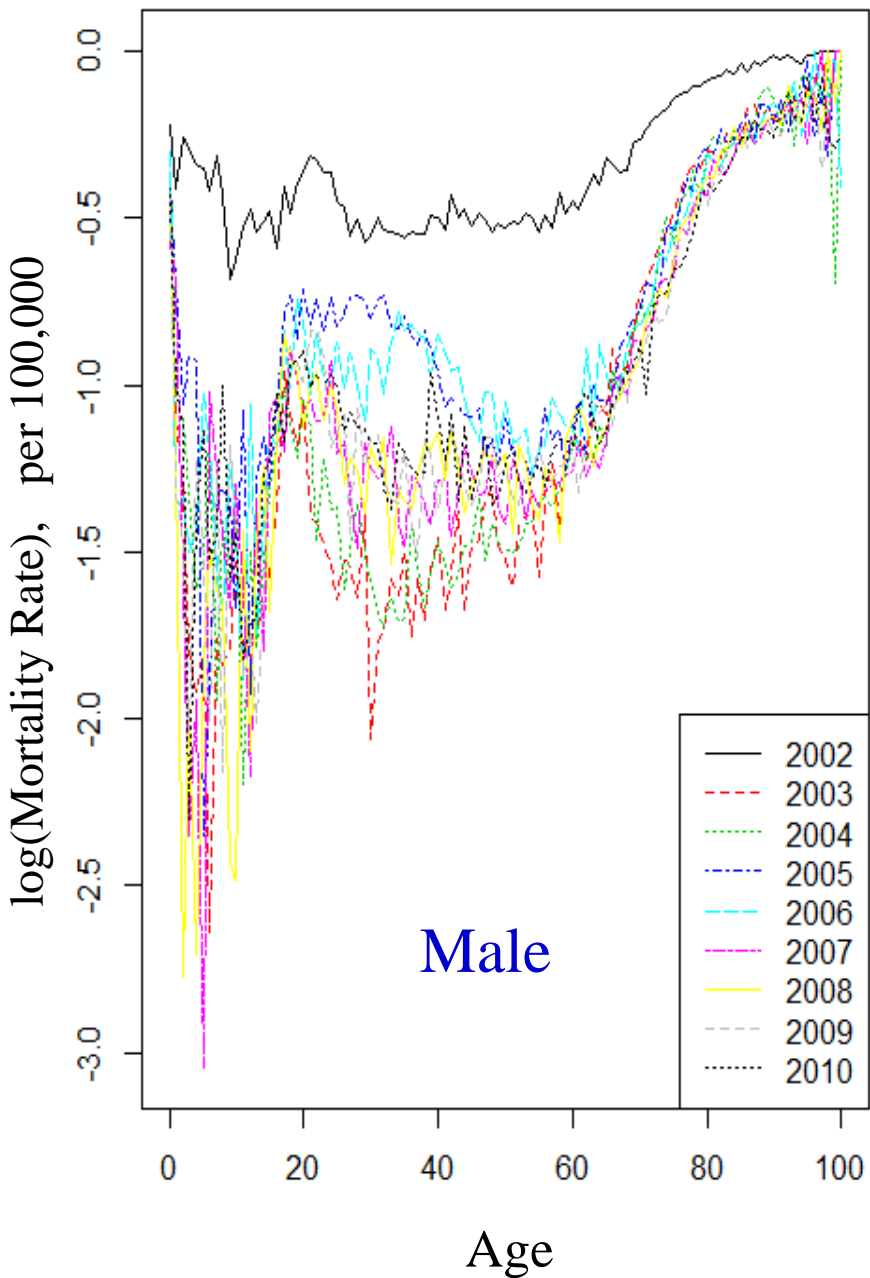


Cancer Mortality Rates (official vs. estimated)

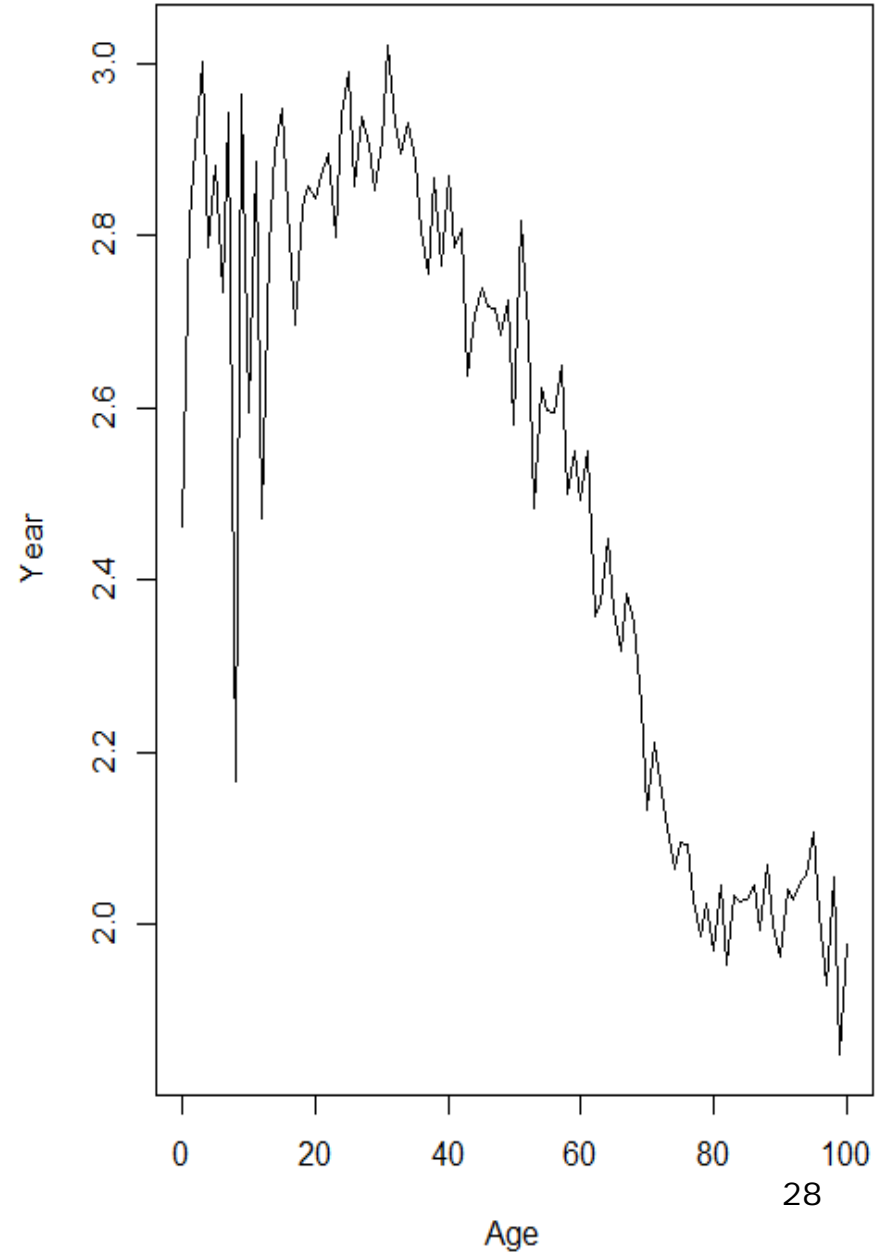
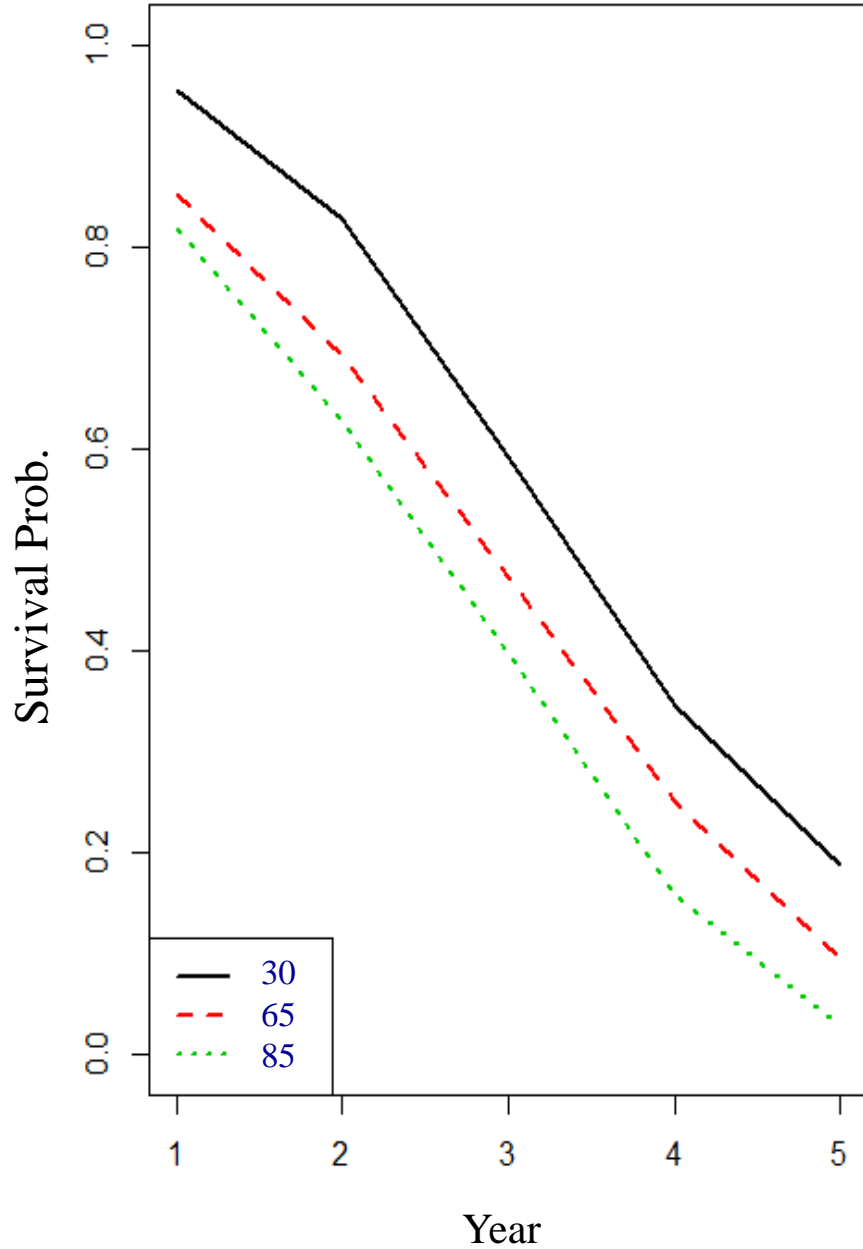
Per 100,000



Taiwan Age-specific LTC Mortality Rate



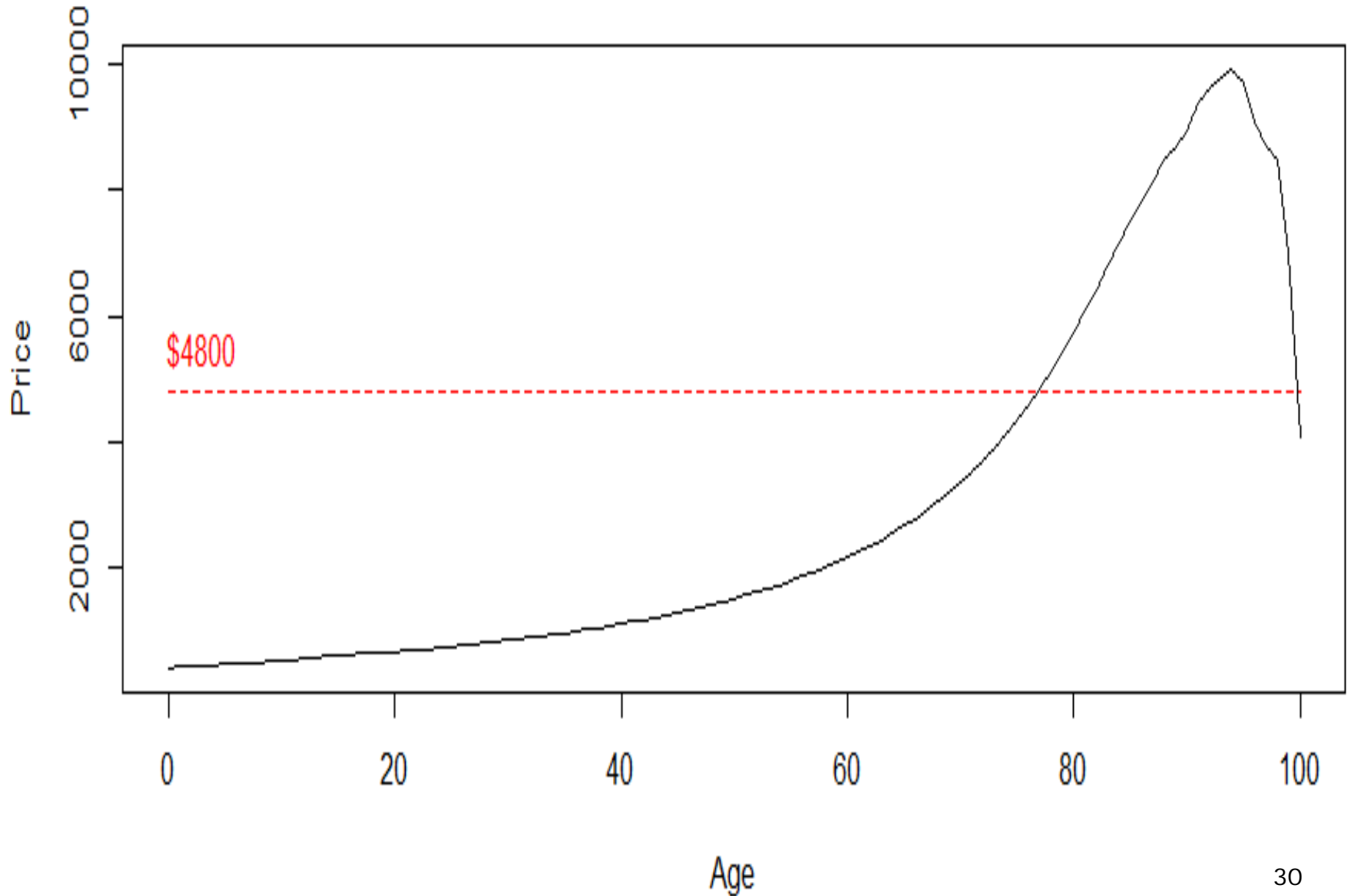
Survival Prob. & 5-year life expectancy of LTC Patient



| Item | Period | Note |
|-----------------|-----------|--|
| Raw Data | 2002~2012 | CI Data Base |
| Incidence | 2004~2012 | New in CI-List |
| Mortality | 2004~2010 | No outpatient visits for two consecutive years |
| Life Expectancy | 2004~2005 | 5-year survival prob. |

Note: CI patients of the 8 types are eligible with monthly benefit \$20,000 NT (about \$650 US, average cost for hiring a foreign labor) upon survival.

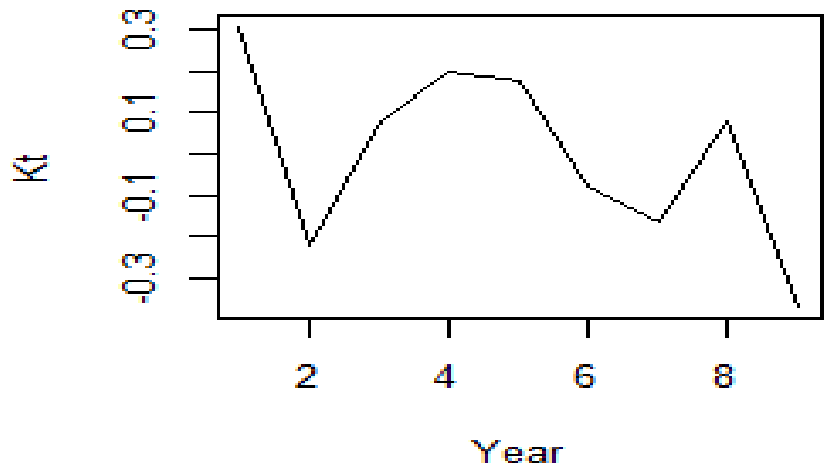
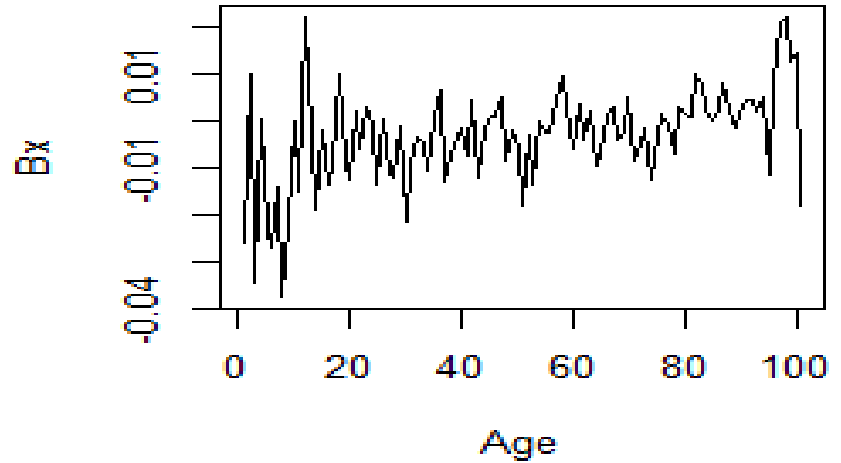
Age-wise Pure Premium of LTC Insurance



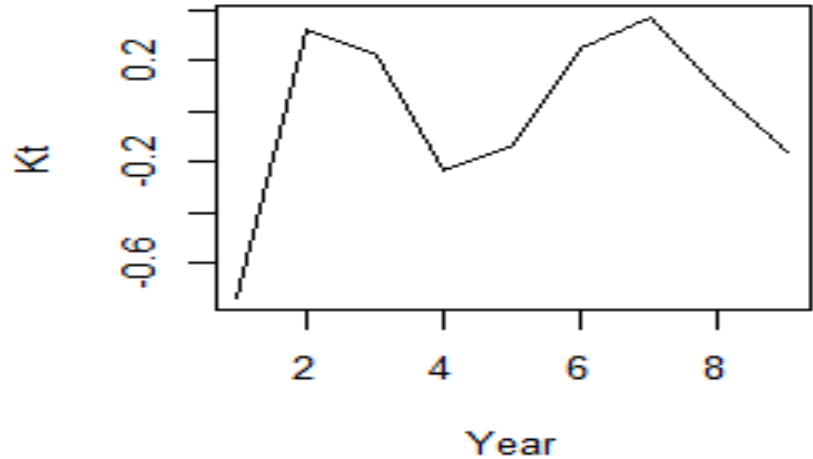
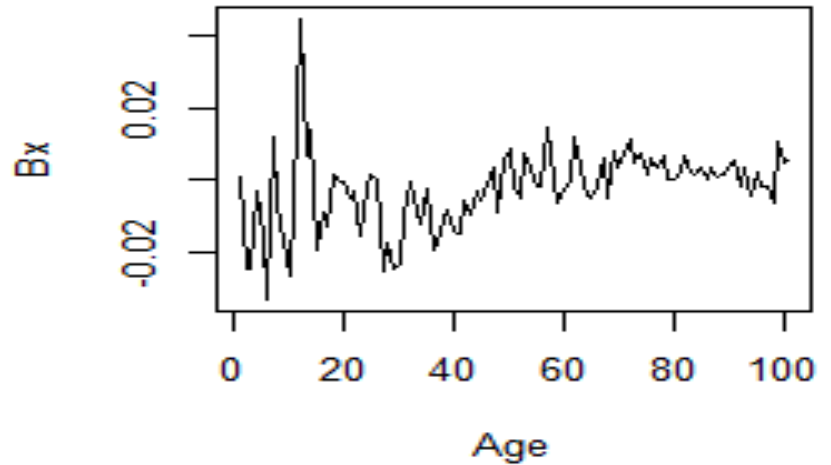
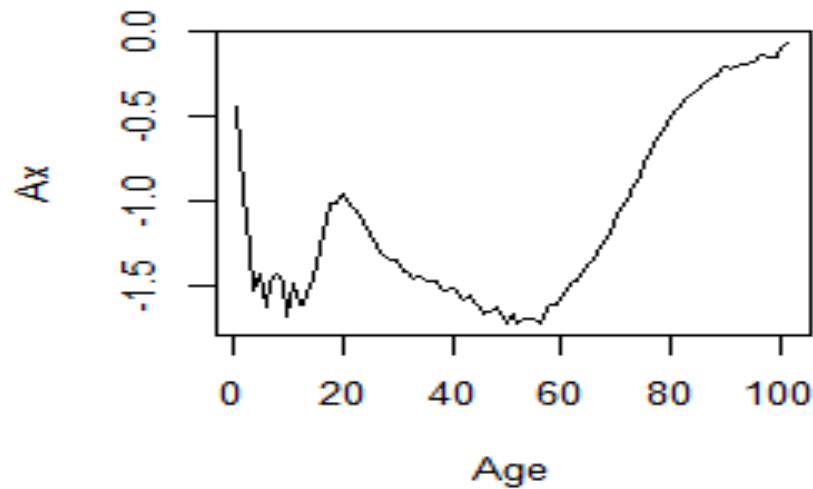
LTC Insurance via CI Card

- The pure premium of LTC insurance is about the same as that of Taiwan's social LTC insurance system designed in 2015.
 - The social LTC insurance is in doubt and the ICF measure is used.
 - Maybe the proposed 8 types of CI can be used to design LTC insurance.
 - Need to consider a wider definition of LTC!
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Incidence Rates of LTC Insurance (Lee-Carter model)



Mortality Rates of LTC Insurance (Lee-Carter model)



Conclusion

- It takes a lot of efforts to use the database from Taiwan National Health Insurance.
 - Knowledge in application fields (e.g., ICD code) and experience accumulation in handling data are important.
 - Not enough data to project the incidence rates and mortality rates of proposed approach (8 types CI).
 - Longevity risk!?
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Discussions and Future Study

- Need to accumulate more data and apply survival analysis for survivorship products.
 - Survival analysis is especially important.
- In addition to actuaries, insurance companies also need experts in big data (& information technology), such as data scientist/statistician.
- Data are an important asset, and regulating the data trading would become necessary.
 - Let the users bear the burden of privacy issue.

Thank you
for your Attention!

Q & A