IFRS Convergence: The Role of Stochastic Mortality Models in the Disclosure of Longevity Risk for Defined Benefit Plans

Yosuke Fujisawa
(joint-work with Johnny Li)

Dept. of Statistics & Actuarial Science
University of Waterloo
AGENDA

1. Introduction
   – International Accounting Standards Board (IASB)
   – Current issues on post-employment benefits (including pensions)
2. Mortality Data
   – Pension plan mortality in Japan and Canada
3. Two-Factor Model
   – Simulations on pension plan mortality rates up to 2010
4. Guidance for Longevity Risk Disclosures
   – Proposed methods:
     • Longevity Value-at-Risk (VaR)
     • Probability of longevity deficit
     • Probabilistic corridor rule
   – Case Studies
     • Domestic company
     • Multinational company
International Accounting Standards Board

• Objective
  – International harmonization of accounting standards

• History and roadmap for IFRS adoption, accepted by 100+ countries
  – European Union (2005)
  – Canada, India, Korea (2011)
  – United States (TBD in 2011)
    • Early use in 2010
    • Mandatory use in 2014?
  – Japan (TBD in 2012)
    • Early use in 2010
    • Mandatory use in 2015 or 2016?

• Convergence project between IFRSs, US GAAP, and Japanese GAAP (deadline 2011)
Post-employment Benefits Project

• Purpose:
  – Restructure accounting model

• IASB Discussion paper:
  – “Preliminary Views on Amendments to IAS 19 Employee Benefits” (Mar, 2008)
  – 150 comments (60% from EU, 17% from N.A., 9% from Asia)

• Two exposure drafts:
  1. Recognition, presentation, and disclosures (Q4, 2009)
     • Quantitative disclosure of actuarial assumptions (IASB meeting, May 2009)
       – Discussion focused on mortality rates
       – Transparency vs. Costs
       – Complains from multinational companies
       – Tentative decision: Disclose decision-process and sensitivity analysis
  2. Contribution-based promises (TBD)
Our Work

• **Objective**
  - To create measures to quantify longevity risk
  - To decide the materiality of longevity risk for defined benefit pension plans (DB plans)

• **Proposed methods**
  1) Longevity VaR
  2) Probability of longevity deficit
  3) Probabilistic corridor rule

• **Case studies**
  1) Domestic company (DB plan in Japan)
  2) Multinational company (DB plans in Japan and Canada)
Pension Plan Mortality Data

- **Mortality tables**
  - Japan: 19th mortality tables (2005)
    - DB liabilities evaluated using 19th mortality tables
    - Published every 5 years
  - Used as base mortality rates in the following simulations

(source: Ministry of Health, Labour and Welfare and SOA)
Mortality Data

- Life tables in Human Mortality Database (HMD)
  - Used for calculating trend and volatility of mortality rates, applied to project pension plan mortality

(source: Ministry of Health, Labour and Welfare and Human Mortality Database)
Two-Factor Model

- Introduced by Cairns, Blake, and Dowd (2006)
  - To predict mortality rates for England & Wales
  - To price longevity derivatives
- Model specification:
\[
q(t, x) = \frac{e^{A_1(t)+A_2(t)x}}{1 + e^{A_1(t)+A_2(t)x}}
\]

\[
\log \frac{q(t, x)}{1 - q(t, x)} = A_1(t) + A_2(t)x
\]

19th pension mortality in Japan

RP-2000 mortality rates

Least squares
Estimated Parameters $A_1, A_2$ (1966-2005)

**Japan**

- **Level of the mortality curve**
  - $A_1(t)$

- **Slope of the mortality curve**
  - $A_2(t)$

**Canada**

- **Level of the mortality curve**
  - $A_1(t)$

- **Slope of the mortality curve**
  - $A_2(t)$
Stochastic Mortality Model

- Two-dimensional random walk with drift:
  \[ A(t + 1) = A(t) + \mu + CZ(t + 1) \]
  - \( \mu \): 2-D vector (trend of A1 and A2)
  - \( C \): 2 \times 2 upper triangular matrix (volatility of A1 and A2)
- Parameter uncertainties: Markov Chain Monte Carlo
- Simulation results (e.g. age 65):

[Graphs showing mortality rates for Japan (2005-2010) and Canada (2000-2010)]
Guidance for Longevity Disclosure

• Principle-based accounting standards vs. J-SOX
  – No guidance for longevity disclosure
  – Need guidance for longevity disclosure

• Principle of Materiality with probability:
  – On balance sheet:
    • DB liabilities include mortality improvements
    • Updating mortality rates using the latest information
  – On the notes:
    • Decision-process and sensitivity analysis disclosed on the notes
    • Sensitivity analysis based on simulated mortality rates
  – Off balance sheet:
    • Financial statements exclude longevity risk
1. Domestic company:
   – A closed DB plan in Japan
   – 3000 annuitants aged 60-100; age distribution follows the 2005-census in Japan
   – Based on the 19th pension plan mortality
   – Form of pension: life only, paid 1 yearly in advance
   – Interest rate: 3% (fixed)

2. Multinational company:
   – Closed DB plans in Japan and Canada
     – Japan
       • The same demographics and pension plan as that for the domestic company
     – Canada
       • 1000 annuitants aged 60-100; age distribution follows the 2006-census in Canada
       • Based on RP-2000 mortality with no projection
       • Form of pension: life only, paid 1 yearly in advance
       • Interest rate: 3% (fixed)
Results 1 – Longevity VaR

Domestic company (Year 2006)

Domestic company (Year 2010)

Multinational company (Year 2006)

Multinational company (Year 2010)

Loss distribution:

\[ Y(t) = PV(t) - PV(2005) \]

\[ \text{VaR}_{95\%}[Y(t)] \]

\[ \text{median} \]

Longevity deficit (2010):
- Increase
- High uncertainties
Results 2 – Probability of Longevity Deficit

Loss distribution:
\[ Y(t) = PV(t) - PV(2005) \]

Red region: Domestic < Multinational

Deficit occurs
Corridor Rule in IAS 19

• Corridor rule
  – Deferred recognition of actuarial gains and losses
  – Corridor: the greater of 10 % of plan assets and 10 % of plan liabilities

• IASB proposal in DP: Immediate recognition
  – IASB tentatively decides to introduce immediate recognition (Jan, 2009)
    • Organizations represent business in Europe, Japan and the United States (80 % of the world’s capital markets)
    • Disagree with the tentative decision
Results 3 – Probabilistic Corridor Rule

Relative loss distribution:

\[ Z(t) = \frac{PV(t) - PV(2005)}{PV(2005)} \]

Red region: Domestic < Multinational

Probabilistic corridor: 1% of liabilities
### Criteria for Longevity Disclosure

- Need criteria for longevity disclosure
- For example:

<table>
<thead>
<tr>
<th>Approach</th>
<th>On balance sheet</th>
<th>On the notes</th>
<th>Off balance sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longevity VaR</td>
<td>Median is greater than DB liabilities by 2%</td>
<td>TVaR&lt;sub&gt;95%&lt;/sub&gt; is greater than DB liabilities by 5%</td>
<td>All other cases</td>
</tr>
<tr>
<td>Probability of longevity deficit</td>
<td>• Pr [Y(t) &gt; 0] &gt; 70%</td>
<td>• Pr [Y(t) &gt; 0] &gt; 60%</td>
<td>All other cases</td>
</tr>
<tr>
<td></td>
<td>• E[Y(t)] / PV(t₀) &gt; 2%</td>
<td>• E[Y(t)] / PV(t₀) &gt; 1%</td>
<td></td>
</tr>
<tr>
<td>Probabilistic corridor rule</td>
<td>Pr [Z(t) &gt; 1%] &gt; 60%</td>
<td>Pr [Z(t) &gt; 1%] &gt; 50%</td>
<td>All other cases</td>
</tr>
</tbody>
</table>
## Results 1 – Longevity VaR

### 1. Domestic company:

<table>
<thead>
<tr>
<th>Year, t</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>TVaR&lt;sub&gt;95%&lt;/sub&gt;/PV(t&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>5.1%</td>
<td>7.4%</td>
<td>9.5%</td>
<td>11.6%</td>
<td>13.5%</td>
</tr>
<tr>
<td>Median/PV(t&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>0.5%</td>
<td>1.0%</td>
<td>1.8%</td>
<td>2.5%</td>
<td>3.0%</td>
</tr>
<tr>
<td>Longevity disclosure</td>
<td>On the notes</td>
<td>On the notes</td>
<td>On the notes</td>
<td>On balance sheet</td>
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### 2. Multinational company:

<table>
<thead>
<tr>
<th>Year, t</th>
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<td>TVaR&lt;sub&gt;95%&lt;/sub&gt;/PV(t&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>5.4%</td>
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<td>8.9%</td>
<td>10.8%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Median/PV(t&lt;sub&gt;0&lt;/sub&gt;)</td>
<td>1.0%</td>
<td>1.6%</td>
<td>2.2%</td>
<td>2.8%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Longevity disclosure</td>
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<td>On the notes</td>
<td>On balance sheet</td>
<td>On balance sheet</td>
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</tbody>
</table>
## Results 2 – Probability of Longevity Deficit

### 1. Domestic company:

<table>
<thead>
<tr>
<th>Year, t</th>
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<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr[Y(t)&gt;0]</td>
<td>61.3%</td>
<td>65.1%</td>
<td>68.2%</td>
<td>72.0%</td>
<td>74.8%</td>
</tr>
<tr>
<td>E[Y(t)]/PV(t₀)</td>
<td>0.6%</td>
<td>1.2%</td>
<td>1.8%</td>
<td>2.5%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Longevity disclosure</td>
<td>Off balance sheet</td>
<td>On the notes</td>
<td>On the notes</td>
<td>On balance sheet</td>
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### 2. Multinational company:

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<tbody>
<tr>
<td>Pr[Y(t)&gt;0]</td>
<td>70.5%</td>
<td>73.8%</td>
<td>76.6%</td>
<td>78.9%</td>
<td>80.2%</td>
</tr>
<tr>
<td>E[Y(t)]/PV(t₀)</td>
<td>1.1%</td>
<td>1.6%</td>
<td>2.2%</td>
<td>2.9%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Longevity disclosure</td>
<td>On the notes</td>
<td>On the notes</td>
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# Results 3 – Probabilistic Corridor Rule

1. Domestic company:

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</tr>
</thead>
<tbody>
<tr>
<td>Pr[Z(t)&gt;1%]</td>
<td>40.6%</td>
<td>50.4%</td>
<td>58.5%</td>
<td>64.9%</td>
<td>67.4%</td>
</tr>
<tr>
<td>Longevity disclosure</td>
<td>Off balance sheet</td>
<td>On the notes</td>
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2. Multinational company:

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</tr>
</thead>
<tbody>
<tr>
<td>Pr[Z(t)&gt;1%]</td>
<td>50.4%</td>
<td>60.0%</td>
<td>66.4%</td>
<td>69.9%</td>
<td>71.7%</td>
</tr>
</tbody>
</table>
Results

• Three approaches capture the amount of longevity deficit and its probability with graphical and numerical results.

• For multinational companies:
  – Loss distributions may not be symmetric
  – In such cases, using the expectation only may be inappropriate
  – Important to see the shape of loss distributions

• Probabilistic corridor rule is consistent with the existing corridor rule.

<table>
<thead>
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<th>Corridor rule</th>
<th>Probabilistic corridor rule</th>
</tr>
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<tbody>
<tr>
<td>Threshold = ( \frac{\text{Actuarial gains and losses}}{\text{Max (assets, liabilities)}} ) (10%)</td>
<td>Threshold = ( \text{Pr} \left( \frac{\text{Actuarial gains and losses}}{\text{Max (assets, liabilities)}} &gt; 1% \right) )</td>
</tr>
</tbody>
</table>
Conclusions

• Pension Accounting:
  – The amendment of pension accounting affects many companies in the world
  – IFRSs may not include explicit guidance for longevity disclosure

• Model-based approach:
  – The use of a country-specific model may improve accuracy of the model; however, it also increases the costs
  – The two-factor model is easy enough to be used in practice
  – Model risk should be taken into account

• Longevity risk disclosure:
  – Graphical and numerical results help senior management to make decisions about longevity disclosures
  – Measures should be applied to multinational companies
  – More realistic case studies, including other actuarial assumptions, are needed to apply these approaches in practice