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Comparison of Mortality Experience for Some Asian Countries

By Lina Xu

To ensure confidence in the pricing and valuation of products, a mortality study is one of the tasks that must be performed by any actuary. Quite often an insurance company's mortality experience is measured by comparing it to its industry's mortality experience. Comparing mortality experience between countries is especially important for managing an international insurance business.

This article compares the insurance industry's mortality experience for Japan, Korea, China, and Taiwan. The industry's mortality experience that has been analyzed includes the variables of age, policy year and gender.

Mortality trends for Japan, Korea, Taiwan, China and/or the United States are studied, and the results are summarized and compared in this article. The trend analysis is focused on the mortality improvement/deterioration. It is important to look at the industry (short-term) mortality trend, as well as the population (long-term) mortality trend for the mortality improvement analysis.

The population data can sufficiently provide length and volume of data to permit such a study. The short-term industry trend analysis, the mortality improvement/deterioration by gender, cause of deaths, and type of medical underwriting are studied for Japan and Korea. The long-term population trend analysis, Lee-Carter model, has been used to model and analyze the mortality trends for Japan, Taiwan, and Korea.

This article will summarize the leading causes of death and mortality experience by cause of death for Japan, Korea, and China. It will summarize the results of the population mortality improvement by age for Japan, Korea, Taiwan and the United States.

1. DATA SUMMARY

Data information for the four countries includes the observation year(s), unit of investigation, the expected mortality, exposure, and number of deaths for each country. The data information will be summarized by attained age (age), policy year, type of underwriting and, if applicable, both genders.

This study is based on the latest insurance industry data information available from the four countries.

Table 1.1 displays the observation years, unit of investigation, the expected mortality and exposure for each country under the investigation in this report.

Please note that China and Korea observation years (Table 1.1) are the same observation period as the period used in developing the industry's table CL00-03 and the 5th EMT, respectively. The expected mortality used for analysis in this report is tables CL00-03, SMT 07, the 6th EMT and 02TSO for China, Japan, Korea and Taiwan, respectively, unless otherwise indicated.

Table 1.1 Data Information by Country

Type of Information	China	Japan	Korea	Taiwan
Observation Year	2000-03	2001-05	2000-02	2007
Expected Mortality	CL00-03	SMT 07	6th EMT	02TSO
Unit of Investigation	Count			
Exposure	79,960,360	285,205,040	73,080,921	26,680,124
Number of Deaths	47,007	898,484	119,135	42,445

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For all four countries, the exposure and the number of deaths were classified by five-year attained age group (except that China gave the issue age information), gender and policy year.

The length of the policy year information given for each country is different. China gave the policy years 1 through 4, and 5+; Korea gave the policy years 1 through 5, and 6+; Taiwan only gave the first policy year; and Japan gave policy years 1 through 10, and 11+.

China has only eight policy years contributed in this study, and about 62 percent of the exposure is concentrated in the first two policy years. The exposure for the fifth and subsequent policy years is only about 11 percent.

Table 2.1 Actual (A) and Expected (E) Mortality Rates and Experience by Gender

	Japan	Korea	China	Taiwan
Sex	Actual Mortality			
Male	3.962	1.630	0.721	2.134
Female	1.922	0.802	0.425	1.068
	Expected Mortality			
Male	5.935	1.926	0.983	2.013
Female	2.861	0.863	0.602	1.110
	Experience A/E			
Male	67%	85%	73%	106%
Female	67%	93%	71%	96%

Japanese data also provides information on the cause of death: the mortality and the percentage of the number of deaths by cause (to the total number of deaths) were provided by age, gender and type of underwriting for each year. Korean data also provides information on the cause of death: the percentage of the number of deaths by cause (to the total number of deaths) was provided by gender and by leading cause of death.

2. MORTALITY RATE AND EXPERIENCE

This section will summarize and compare the mortality rate for attained age, policy year, and the combination of the age and policy year for both male and female. The comparison in this article is the ratio of actual mortality to Japanese actual mortality, unless otherwise indicated.

Table 2.1 shows that the Japanese mortality is apparently the highest among these countries for both the actual and expected mortality. Comparing Korea, China and Taiwan overall mortality to Japanese (the ratio of the country's mortality to the Japanese mortality), it is about 41 percent, 20 percent and 55 percent, respectively. When comparing the expected mortality, it is about 32 percent, 19 percent and 36 percent, respectively.

The high Japanese actual and expected mortality is due to high exposure distribution at the higher policy years and at the older attained ages, both of which will cause mortality rates to rise. In contrast, China has about 89 percent of its exposure distributed through policy years 1 through 4, and a larger percentage of exposure is concentrated at the younger ages. Therefore, comparison of the mortality for different countries should analyze the mortality and the experience by age and policy year, as well as by type of underwriter if the underwriting data information is available.

Mortality Experience by Age

The actual and expected mortality experience by attained age and gender are summarized in this subsection.

Table 2.2 shows that Taiwan had the highest mortality rates for all ages for both genders except for females younger than 20, where Korea was higher than Taiwan. Japan gener-

ally had the lowest mortality except for ages younger than 30, where China is the lowest.

The younger age mortality is noteworthy for China and Korea. The mortality for China and Korea is about 17 percent and 54 percent higher, respectively, than the Japanese mortality for males, while for females it is about 71 percent and 102 percent higher, respectively, than the Japanese mortality. The older age (age older than 64) mortality is significant for Japan. The mortality for age 65 and older for Japan is the lowest among the four countries for both genders except for the Chinese male, where it is 24 percent higher than Japanese male mortality at ages older than 64.

See also Figure 2.1 for graphic illustration. Figure 2.1 displays the mortality by attained age for male only; the female pattern would be similar.

Table 2.3 summarizes the expected mortality by age and gender for each country. The expected mortality is based on each country's latest industry table as summarized in Table 1.1.

Table 2.3 shows that Taiwan has the highest expected mortality across all ages and for both genders, while Korea generally has lower expected mortality for all ages and for both genders except under age 20.

Figure 2.2 on the next page shows that Taiwan males have the highest expected mortality across all ages, while Korean males generally have lower expected mortality for all ages except under age 20, where China is the lowest. Female mortality displays a similar pattern.

Mortality Experience for Policy Year

Japanese policy year actual mortality and the ratio of the actual mortality to the expected

Table 2.2 Mortality (Per 1,000) by Attained Age

	Male				Female			
AttAge	Japan	Korea	China	Taiwan	Japan	Korea	China	Taiwan
0-19	0.25	0.38	0.29	0.40	0.12	0.24	0.20	0.17
20-29	0.52	0.64	0.50	1.08	0.23	0.29	0.22	0.40
30-34	0.58	0.67	0.72	1.98	0.32	0.36	0.31	0.74
35-39	0.79	0.97	0.99	3.06	0.47	0.47	0.44	1.09
40-44	1.22	1.58	1.51	4.30	0.68	0.67	0.68	1.64
50-54	3.24	4.15	3.09	8.86	1.68	1.47	1.63	4.16
55-64	6.30	7.63	5.85	13.70	2.70	2.60	3.80	7.57
65+	19.53	21.29	14.75	23.58	8.18	10.46	9.59	14.10

Figure 2.1 Male Actual Mortality

Male Mortality By Attained Age

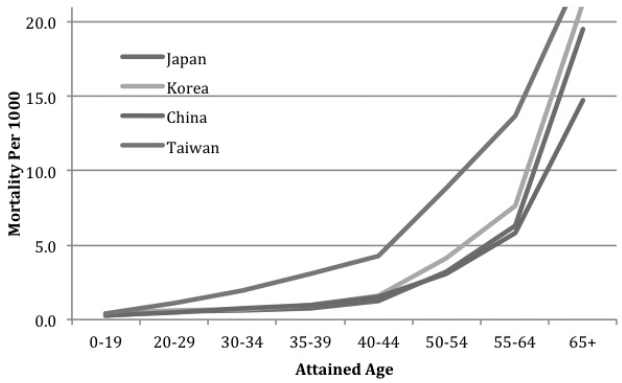

Table 2.3 Expected Mortality Per 1,000

	Male				Female			
AttAge	Japan	Korea	China	Taiwan	Japan	Korea	China	Taiwan
0-19	0.35	0.43	0.40	0.72	0.18	0.32	0.28	0.42
20-29	0.82	0.60	0.75	1.31	0.38	0.34	0.34	0.52
30-34	0.93	0.68	0.99	1.53	0.57	0.39	0.47	0.69
35-39	1.21	0.96	1.37	2.20	0.81	0.54	0.65	1.00
40-44	1.78	1.55	1.98	3.22	1.12	0.76	0.97	1.45
50-54	4.40	4.16	4.13	7.11	2.50	1.50	2.30	3.57
55-64	8.09	7.31	8.01	12.78	3.81	2.71	5.04	6.50
65+	23.66	20.69	19.89	34.86	10.87	9.67	12.76	18.93

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Figure 2.2 Expected Mortality (Per 1,000)

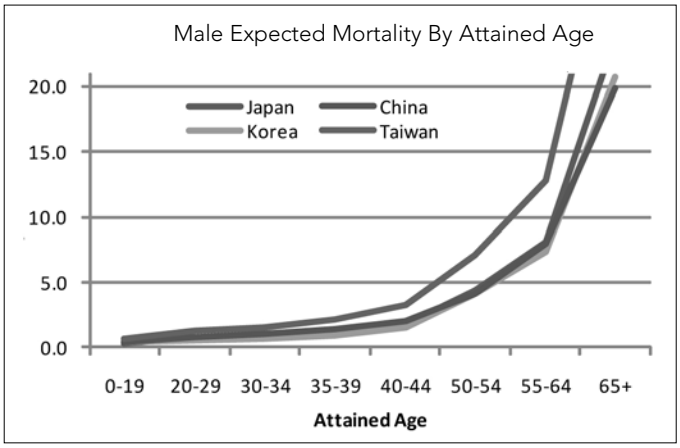
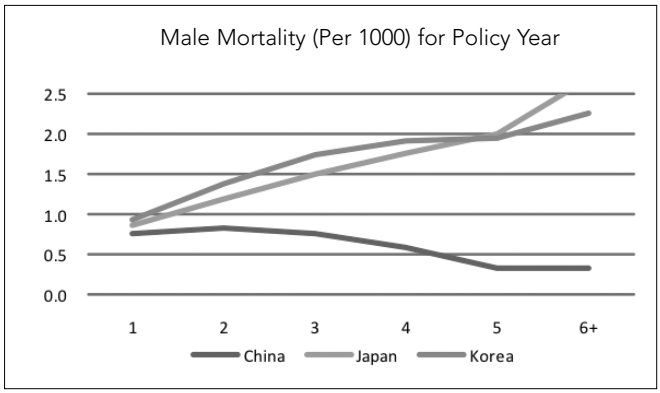
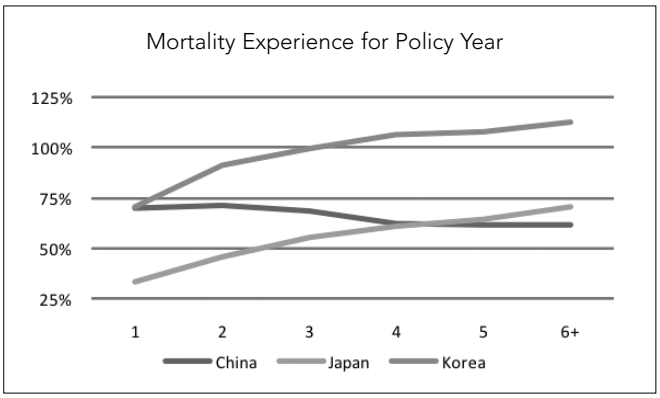


Figure 2.3 China, Japan, and Korea Mortality by Policy Year





mortality (Experience A/E) were available by medical examination and policy years through 11+. However, data from other countries was only available by gender and policy years through 5+ or 6+. For comparison purposes, we used Japanese policy years 6–10 instead of policy years 6+ in Table 2.4.

Table 2.4 shows that Chinese mortality is the lowest by policy year and for both genders. Chinese mortality decreases by policy year from the second policy year for both male and female; the later policy years' mortality, especially 5+, will be solely based on data from issue years prior to 2000. When looking at data more closely, it seemed that this country had not fully collected data for issue years prior to 2000.

Korea experienced a higher-than-expected mortality for policy years 4 and above. This pattern is expected since the underlying data (period 2000–2002) in this study is the base data for developing the 5th EMT. With mortality improvement, the current Korean expected mortality table, the 6th EMT, should have mortality rates generally lower than the prior mortality by attained age. (The 6th EMT is developed based on 2003–2005 data.)

Mortality Experience for Age and Policy Year

Table 2.5 and Figure 2.4 summarize and display the first policy year mortality for the four countries.

Table 2.5 and Figure 2.4 show that the first year mortalities of Korea, China and Taiwan are all higher than the Japanese first year mortalities for all ages. For ages older than 19, Japanese first policy year mortality is the lowest among all four countries.

Since we do not have Taiwan policy years 2 and older data information, we will not analyze and

compare Taiwan's mortality for policy years 2 and older in the rest of this subsection.

Table 2.6 and Figure 2.5 summarize and display the policy years 1–4 mortality for Japan, Korea and China.

Table 2.6 shows that Korean and Chinese policy years 1–4 mortality rates are both higher than Japanese mortality rates for all ages.

Table 2.7 summarizes the mortality rates by policy year for ages 0–19, 30–39 and 50+.

Figure 2.6 graphically displays the mortality by policy year for ages 0–19, 30–39 and 50+ for the three countries. The graphs seem to imply anti-selection mortality for both Korea and China for ages 0–19.

Korean mortality is increased by policy year for ages 30–39; this pattern is different from the pattern in ages 0–19, where the mortality decreases by age.

Table 2.7 shows that the mortality ratios (to the Japanese mortality) are extremely low at policy years 6+, especially for the Chinese comparison; this implies that Japanese mortality rates are high at older ages and older policy years.

3. MORTALITY TREND

Mortality improvement in the short term, using the industry data, and in the long term, using the population data, will be investigated in this section. The mortality improvement/deterioration that uses the industry data will investigate the mortality trend by cause of death. The Lee-Carter method is used to model the long-run age-specific mortality improvement for Japan, Taiwan, the United States and Korea.

Short-Term Mortality Trend

When looking at the mortality trend, it is important to identify the improvement or dete-

Table 2.4 Actual Mortality and Experience A/E

	Actual Mortality Per 1,000						Experience A/E		
	China		Japan*		Korea				
PolYr	Male	Female	Male	Female	Male	Female	China	Japan*	Korea
1	0.766	0.424	0.861	0.377	0.943	0.502	70%	34%	70%
2	0.830	0.494	1.186	0.622	1.382	0.650	71%	46%	91%
3	0.765	0.481	1.503	0.849	1.741	0.839	69%	56%	99%
4	0.597	0.353	1.758	1.039	1.910	0.972	63%	61%	107%
5	0.340	0.240	2.004	1.222	1.948	1.021	62%	64%	108%
6+	0.340	0.240	2.682	1.558	2.255	1.073	62%	71%	113%

*For Japan, the actual mortality and the experience A/E uses policy years 6–10 rather than the policy year 6+.

Table 2.5 and Figure 2.4 First Policy Year Mortality by Age for Male and Female Combined

	Male and Female Combined			
AttAge	Japan	Korea	China	Taiwan
0-19	0.159	0.576	0.338	0.161
20-29	0.292	0.467	0.396	0.386
30-39	0.363	0.531	0.647	0.669
40-49	0.664	0.922	1.286	1.592
50+	1.918	2.339	3.211	5.794
Total	0.653	0.721	0.615	1.591

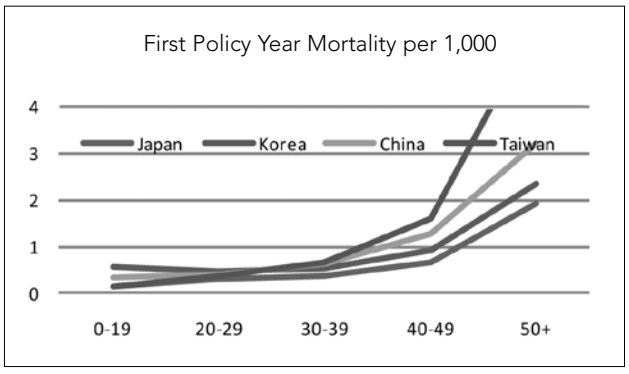


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Table 2.6 and Figure 2.5 Mortality Rates by Age for Policy Years 1–4

AttAge	Male and Female Combined		
	Japan	Korea	China
0-19	0.171	0.354	0.279
20-29	0.345	0.450	0.363
30-39	0.465	0.582	0.623
40-49	0.966	1.216	1.321
50+	3.086	4.033	3.617

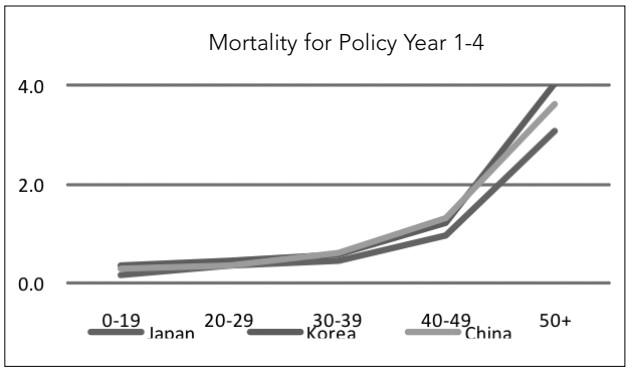

Table 2.7 Mortality by Policy Year for Ages 0–19, 30–39 and 50+

PolYr	Age 0-19			Age 30-39			Age 50+		
	China	Japan	Korea	China	Japan	Korea	China	Japan	Korea
1	0.338	0.159	0.576	0.647	0.363	0.531	3.211	1.918	2.339
2	0.287	0.170	0.306	0.636	0.428	0.600	4.110	2.896	3.828
3	0.219	0.189	0.241	0.619	0.527	0.623	3.798	3.601	4.610
4	0.170	0.183	0.213	0.476	0.571	0.651	3.094	4.027	5.251
5	0.124	0.171	0.223	0.592	0.611	0.681	2.897	4.345	5.189
6+	0.124	0.190	0.223	0.592	0.615	0.671	2.897	4.607	5.633

Figure 2.6 Mortality by Policy Year for Ages 0–19, 30–39 and 50+

rioration by cause of death. For the short-term mortality trend analysis, we first list the leading cause of death for each country for our study period. Then we briefly summarize the trends of the leading causes of death. Thirdly, we study the mortality trend by each cause of death. Finally the mortality improvement/deterioration is studied for each country if data permits.

Leading causes of death and the trends of the causes for each country are summarized in this section for Japan, Korea and China.

The leading cause of death in Table 3.1 is the largest percentage of death due to the cause for each country during the period.

The percentage of the number of deaths for malignant neoplasms and suicide generally increased from the period of 1997 to 1998 to the period of 2001 to 2005. However, the percentage of the number of deaths for heart disease, cerebrovascular and accident generally decreased.

While further investigating the mortality improvement or deterioration for Japan and Korea, the mortality by age and by cause were analyzed for Japan since this country provided this information for the study.

The Japanese mortality deteriorated for deaths due to malignant neoplasm and suicide. However, the mortality improved for deaths due to heart attack, cerebrovascular and accident for both genders from the period of 1997 to 1998 to the period of 2001 to 2005. Table 3.3 summarizes the mortality improvement (or deterioration if negative) by cause of death, type of underwriting and gender. Table 3.4 summarizes the mortality improvement from period to period by gender for Korean insurance industry data.

Table 3.3 shows that while the overall mortality improved by 0.06 percent and 0.94 percent for male and female, respectively, the neoplasm rate deteriorated for both males and females, which is caused by the medical examination policies. Moreover, while all causes other than neoplasm improved for both genders, the medical examination policies either deteriorated (for example, heart disease and suicide) or showed a much lower improvement (than the non-medical examination policies, see cerebrovascular and accident).

Table 3.1 Leading Cause of Death and Data Included in the Analysis

	Leading Cause of death		
Region	Cause	Percent	Period
Japan	Neoplasm	43.00	2001-05
Korea	Neoplasm	32.40	2000-02
China	Accident	35.18	2000-03
Taiwan	Neoplasm	26.55	1995-99

Table 3.2 Japanese and Korean Leading Cause Trend from 1947 to 2005

Japan		Korea	
Period	Cause of Death	Period	Cause of Death
1947-50	Tuberculosis	2000-02	Malignant neoplasms
1951-80	Cerebrovascular	1996-98	Accident
1981-05	Malignant neoplasms		

Tables 3.3 and 3.4 indicate that the male mortality improvement for period 1996 (1997 for Japan) to 2005 is about 0.06 percent and 1.19 percent for Japan and Korea, respectively, while the female improvement over the same period is about 0.94 percent and 2.43 percent, respectively.

Long-Term Mortality Trend

For studying the mortality trend, it is useful to study the population trend since we have the data information for a longer time period, and

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Table 3.3 Percentage of Improvement (or Deterioration if Negative) by Cause of Death, UW and Gender for Period from 1997 to 2005

1997-05	Male		Female		Combined	
Cause	Med	NonMed	Med	NonMed	Male	Female
M.N.	(1.91)	5.79	(1.85)	2.80	(0.06)	(0.04)
H.D.	(1.61)	6.91	(0.75)	5.92	0.48	1.67
C.D.	0.32	8.07	1.26	5.67	2.22	3.18
S.C.	(0.07)	(0.28)	(0.34)	2.90	0.42	1.03
A.D.	2.44	4.78	1.53	5.34	3.18	3.26
Total	(1.63)	5.10	0.94	2.33	0.06	0.94

Table 3.4 Korean EMTs Mortality and Mortality Improvement

Period		Factor Percent		Korea EMT Mortality Per 1,000			
From	To	Male	Female	EMT	Period	Male	Female
3rd EMT	4thEMT	4.88	6.36	3rd	1988-1992	2.972	1.624
4th EMT	5th EMT	1.14	1.08	4th	1996-1998	2.093	1.025
5th EMT	6th EMT	1.25	4.21	5th	2000-2002	2.000	0.982
4th EMT	6th EMT	1.19	2.43	6th	2003-2005	1.926	0.863

we also have older age data information. The population data can be used for annuity and pension mortality trend studies.

The Lee-Carter (LC) model will be briefly described. The results will be summarized and compared for Japan, the United States, Korea and Taiwan.

The LC model is based on the equation

$$\ln(m_{x,t}) = a_x + b_x \cdot k_t + \varepsilon_{x,t} \quad (3.1)$$

The LC model models the age-specific rate and has modeled the covariances across ages by using the same time-varying parameter k. The rates in the LC model are always constrained to a life table system that fits the historical data. The rates obtained from the LC model are cohesive because of the forecasting of the single parameter k, which itself is a kind of compromise among the trends in all the individual age-specific rates.

The results from the LC modeling:

Table 3.5 Population Data Use by Country

Region	Source	CalYr	# of CalYr	ProjPeriod	# of ProjYr
Japan	HMD	1947-08	62	1979-08	30
Taiwan	HMD	1970-08	39	1970-08	39
USA	HMD	1933-06	74	1977-08	30
Korea	Korean Population Statistics	1983-03	21	1983-03	21

Table 3.6 Mortality Improvement by Selected Age Bands and Gender

Age	Male				Female			
	Japan	Korea	Taiwan	US	Japan	Korea	Taiwan	US
5-9	4.28	5.79	3.67	3.64	6.75	6.25	5.08	2.32
20-24	3.63	5.15	3.08	2.82	6.14	5.91	4.61	2.04
30-34	3.54	4.79	2.90	2.76	5.81	5.64	4.37	1.92
40-44	3.14	4.13	2.58	2.50	5.23	5.10	3.93	1.71
50-54	2.66	3.53	2.24	2.15	4.58	4.46	3.40	1.47
70-74	1.74	2.23	1.43	1.40	3.20	2.86	2.15	1.00
80-84	1.20	1.38	1.02	1.02	2.23	1.68	1.50	0.74

Table 3.6 displays that the improvement scale varies by age and gender. U.S. mortality improves the least for all ages and for both genders. For males, the Korean improvement scale is the largest for each age among all countries, while for females the Japanese improvement scale is the largest. See also Figure 3.1. □

Figure 3.1 Mortality Improvement by Age for Male and Female