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Life Insurance in East Asia: The Survival Function, Net Single Premium, Life Annuity Due, and Benefit Premiums of Hong Kong, Japan, and South Korea

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ABSTRACT

Insurances, specifically life insurances, play a major role in reducing financial risk due to adverse events. In the global COVID-19 pandemic, the market for life insurances grew especially in Hong Kong, Japan, and South Korea. In this study, the Survival Function, Net Single Premium, Life Annuity Due, and Benefit Premiums are computed based on the life tables for males and females in Hong Kong, Japan, and South Korea. The study used the 2019 life tables of Hong Kong, 2020 life tables of Japan, and 2018 life tables of South Korea. Computations were done through the use of the `lifecontingencies` package in R. The values of the functions at ages 0, 20, 40, 60, and 80 were also selected for a more concrete analysis. Comparisons were made for the said actuarial functions in males versus females. The behavior of the actuarial functions as age increases were also observed. The results show that males have consistently lower survival function values against females, implying that the life span of males are shorter and mortality rates are higher in males. Mortality was also higher in older ages. Consequently, the Net Single Premium and Benefit Premiums for males are higher than females, while the Life Annuity Dues are lower in males than in females. It was also found that Net Single Premiums and Benefit Premiums increase as age increases. Conversely, the Life Annuity Due decreases as age increases.

Key words: Life Insurance, Survival Function, Net Single Premium, Life Annuity Due, Benefit Premiums

INTRODUCTION

Background of the Study

Insurance, as defined by Bowers et. al. (1997), is a financial risk management tool that protects insured individuals from severe financial losses due to random adverse events. These losses may be due to loss or destruction of property, or loss of human life. Due to the uncertainty of financial losses and when these losses will be suffered, insurance plays an important part in financial security of an individual.

Insurance became even more important in recent years especially due to the COVID-19 pandemic. According to the Global Market Insurance Trends study of the Organization of Economic Co-operation and Development in 2022, the demand of life insurance in Asian countries grew in 2020. The report of the Global Market Insurance Trends noted that the growth of the demand for insurance products may be a result of the emphasis on life and non-life insurance coverages across different territories. The study also found that Asian countries had higher claims for life insurance in 2020, including Japan, Korea, Singapore, Malaysia, and Hong Kong.

Using available mortality data, it is possible to compute the values of important actuarial functions. These actuarial functions are: the Net Single Premium for a Whole Life Insurance paid at the End of Year of Death, Whole Life Annuity Due, and Benefit Premiums. Survivorship also became an important consideration in the computation of these actuarial functions, for they also depend on probabilities of survival and death during certain periods of time. Thus, this study focused on computing the survivorship, net single premium, life annuity due, and benefit premiums for all possible integral ages for males and females in the cases of the 3 countries. The results of males and females for each country are compared to show if there are differences in patterns of survivorship, net single premiums, life annuities, and benefit premiums. Patterns in the actuarial functions according to age are also observed and discussed.

Case Profile of Hong Kong, Japan, and South Korea

This section discusses the profiles of the cases investigated in this study. The cases of interest included are Hong Kong, Japan, and South Korea. This section includes the demographic profile, insurances, and the actuarial society of each country.

Hong Kong and The Actuarial Society of Hong Kong

The population of Hong Kong Chinese Special Administrative Region in 2020 was reported to be nearly 7.5 million. The mortality rate that year is 6.828 per 1000 people, in which the leading cause of death for both sexes is Malignant Neoplasm - a cancerous tumor (HealthyHK, 2021). As for the country's life insurance market, Hong Kong is reported to have had over 13 million active individual life insurance policies in 2020 - wherein the average age of a life policyholder is 48 years old (Slotta, 2022).

Considered as a full member association of the International Actuarial Association (IAA), the Actuarial Society of Hong Kong (ASHK) was incorporated in January 1994. Their mission statement is "*Representing, Developing and Inspiring the Actuarial Profession in Hong Kong to Serve the Public Interest.*" The ASHK caters to actuaries working in different industries such as insurance, consultancy, finance, education institutes and government. The organization undertakes numerous activities to advance the actuarial profession in Hong Kong, such as actuarial symposiums, seminars, and professional guidance for actuaries (ASHK, 2020).

Japan and Institute of Actuaries of Japan (IAJ)

According to the United Nations, the population of Japan last 2017 was around 127.5 million. The crude death rate that year is 10.307 per 1000 people. Decreasing to 10.20 per 1000 people in 2020, Japan still ranked 34 worldwide in death rate (CIA WF, 2020). The leading cause of death for both sexes in 2019 is Alzheimer's disease, the most common type of dementia (IHME, 2022). This begs to question the adequacy of life and health insurance in the country. According to the 2017 annual report of T&D Holdings, a total of 173.02 million policies were in force. This report found that 53.68 million people, corresponding to 42.10% of the total population, have whole life insurance, while 61.23 million people, corresponding to 48.02% of the total population, have health insurance. Further, around 22 million people, or 17.43% of the population, have term life insurance, and around 13.76 million or 10.79% of the population have endowment insurance. With nearly half of the population having health insurance, Japan indeed provides satisfactory insurance to its citizens. A report by Ernst & Young Global in 2019 further confirms that the Japanese life insurance market is the 3rd largest in the world, as nearly 90% of Japanese households have life insurance policies.

The Institute of Actuaries of Japan (IAJ) is one of the 74 full member associations under the IAA. Founded in 1899 and having the slogan of: "*Think the future, manage the risk*", the IAJ has been serving the public interest through the actuary profession and development of financial systems and institutions for over 100 years. As of writing, there are at least 5,000 members in the IAJ working in different industries. The IAJ has recently appointed Yasushi Ueda as the new president of the association on April 1, 2022 (IAJ, 2022).

South Korea and Institute of Actuaries of Korea

The population of the Republic of Korea (South Korea) last 2018, reported by the U.N., is 51.172 million. The mortality rate that year is 5.918 per 1000 people. The leading cause of death in their country is stroke, followed by ischemic heart disease (IHME, 2022). Although there is no publicly available data on how many citizens of the Republic of Korea are insured, a report by Ernst & Young Global (2019) states that the gross written life premiums in 2018 totaled to $104B. The same report states that the Republic of Korea's insurance market grows healthier than other developed markets, and is in fact seventh-largest globally.

The Institute of Actuaries of Korea officially joined the IAA as a full member association in 1973. The institute's vision, "*New Actuary with New Paradigm",* is deemed to be accomplished through enabling networking between members, strengthening ties through seminars and training, enabling international relations, and establishing its role as a self-regulatory body. They appointed a new president, Lee Jae-Min, in March 2021. A month later, they developed projects for actuarial development such as the Actuary Practice Institute, Actuary Training Institute, and Actuary Research Institute. (Institute of Actuaries of Korea, 2022)

Scope and Limitations of the Study

The data assumes that the limiting age of each person in the three countries is 110. It is possible that this may not be representative of the true limiting age of the population. This study focuses on the calculation of the Net Single Premium (NSP) of a benefit of 1 at the End of Year of Death, the Whole Life Annuity due of 1 paid at the beginning of each year, and the Benefit Premium for a whole life insurance. The annual interest rate considered in this study is set at 6%, as discussions in different literature regarding net single premium and actuarial functions assume also the same interest rate. However, due to the scarcity of data during the pandemic, no comparisons were made for pre-pandemic and pandemic periods.

Conceptual Framework

This section discusses the different actuarial functions computed in the study. These actuarial functions include: the Survival Function, Net Single Premium, Life Annuity Due, and the Benefit Premium. It is assumed that for all functions, the interest rate is level at $i = 0.06$, and that the limiting age for all countries is 110.

Survival Function

The survival function, $s(x)$, is a function that shows the probability of survival of an individual from birth to a certain age, x. Using life tables, this can be computed as:

$$s(x) = \frac{l_x}{l_0}$$

with l_x denoting the number of people that survived to age x, and l_0 denoting the number of newborns in a cohort. Thus, a higher value of $s(x)$ implies that there are more survivors to age x. It is important to note that the survival function decreases as x increases, since less people survive to older ages.

Net Single Premium of a Whole Life Insurance Payable at the End of Year of Death

The net single premium of a whole life insurance payable at the end of year of death, A_x, is the present value of the benefits to be paid at the end of year of death of the insured individual aged (x). This is also a single premium that will fund all of the future claims of the policy owner. Bowers (1997) define this actuarial function to be:

$$A_x = \sum_{k=0}^{(110-x)-1} v^{k+1} {}_kp_x q_{x+k}.$$

Note that the upper limit is $110 - x$ since the limiting age of all the countries is 110, and the remaining possible life span of an individual aged x would be $110 - x$. Since the computations for the net single premiums are based on life tables, an equivalent formula is used to calculate the net single premium using the life table functions. This is given by:

$$A_x = \sum_{k=0}^{(110-x)-1} v^{k+1} \frac{d_{x+k}}{l_x}$$

where d_{x+k} denotes the expected number of individuals that die at age $x + k$. Generally, the net single premium is greater for older ages as mortality in older ages tends to be higher than in younger ages. Another reason why the net single premium is greater for the elderly is that on the average, fewer individuals survive to older ages. From this, it can be inferred that it is more expensive to insure an older person than a younger person. Following the same logic, high-risk individuals such as those who work at high-risk workplaces, individuals with pre-existing health conditions, and among others would also have higher net single premiums and thus more expensive insurance premiums due to relatively higher mortality rates and lower number of survivors at older ages.

Whole Life Annuity Due

The Whole Life Annuity Due, $\ddot{a}_x$, pertains to an annuity with payments of 1 at the beginning of each year provided the annuitant is alive. Since payments can only be made when the annuitant is alive, payments of this annuity will depend on the survival of the annuitant. The whole life annuity due, under the current payment technique, can be can be computed as follows:

$$\ddot{a}_x = \sum_{k=0}^{(110-x)-1} v^k {}_kp_x$$

It is important to note that ${}_kP_x = \frac{s(x+k)}{s(x)} = \frac{l_{x+k}}{l_x}$ as this confirms that the value of the whole life annuity due heavily depends on the survivorship of the annuitant to older ages. Alternatively, the whole life annuity due can be computed as:

$$\ddot{a}_x = \frac{1-A_x}{d}$$

where $d = iv$. This relationship shows that a higher net single premium implies a lower value of the annuity due. This is consistent with the relationship between the actuarial functions with the survival function, since lower survival also results in higher single premiums, and consequently, lower life annuity values. On the other hand, higher survivorship results in lower single premiums, and consequently higher life annuity values.

Benefit Premium of Whole Life Insurance

The benefit premium of a Whole Life Insurance refers to payments at the beginning of each year the insured individual is alive to fund the benefits of the insurance product. The benefit premium can be computed as:

$$P_x = \frac{A_x}{\ddot{a}_x}.$$

Clearly, the benefit premium depends on two things: the net single premium, and the whole life annuity due. Previously, it was discussed that lower survivorship results in a higher single premium and lower life annuity. Thus, it can be inferred that lower survivorship also results in higher benefit premiums. This implies that individuals who have high risks or are of old age tend to pay more for insurance premiums due to higher risks or lower chances of survival.

METHODOLOGY

Data

The data used in this study are the 2020 life tables of Japan, 2019 life tables of Hong Kong, and 2018 life tables of South Korea. Each country has two life tables: one for each sex - Male and Female. The life tables are sourced from the official website of the Human Mortality Database of the Max Planck Institute for Demographic Research (MPIDR, 2022). These tables include entries for several mortality indicators of each country. However, the only variables of interest in the study are: the number of people living at a certain age x (l_x), number of people that die at age x (d_x), and the proportion of people who survive to age x then die before the next year (q_x). Each life table assumes a radix, or number of newborns, of 100,000.

Calculation of Actuarial Functions

One of the main objectives of the study is to investigate the net single premium of a whole life insurance paid at the end of year of death (A_x), whole life annuity with a payment of 1 at the beginning of every year ($\ddot{a}_x$), and benefit premium of the whole life insurance (P_x), for all integer ages x. In order to achieve this, all the calculations are done through RStudio using the `lifecontingencies` package. The `Axn` and `axn` functions were used to calculate A_x and $\ddot{a}_x$ respectively at an interest rate of 6% p.a. The calculation for the Benefit Premium P_x is from the results of A_x and $\ddot{a}_x$, since P_x is simply the ratio of A_x to $\ddot{a}_x$.

After generating the calculations for all functions, the results are then visualized using the plots of R. The results for ages 0, 20, 40, 60, and 80 are also compared to aid in the analysis.

RESULTS AND DISCUSSION

Resulting Tables

After processing the life table and applying the different formulas to find the values of A_x, $\ddot{a}_x$, and P_x, the results of the computations are summarized in the tables that follow. Tables 1 and 2 shows the resulting computations of the actuarial functions for the Males and Females in Hong Kong, respectively. Then, Tables 3 and 4 show the resulting computations of the actuarial functions for the Males and Females in Japan, respectively. Lastly, Tables 5 and 6 show the resulting computations of the actuarial functions of Males and Females in South Korea respectively.

Table 1: Results for Hong Kong Male

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00158	100000	158	1	0.014769	17.40575	0.000849
1	0.00023	99842	23	0.99842	0.014097	17.41761	0.000809
2	0.00021	99819	21	0.99819	0.014716	17.40668	0.000845
3	0.00013	99798	13	0.99798	0.015392	17.39474	0.000885
4	0	99785	0	0.99785	0.016187	17.38069	0.000931
5	0	99785	0	0.99785	0.017159	17.36353	0.000988
6	0	99785	0	0.99785	0.018188	17.34534	0.001049
7	0.00006	99785	6	0.99785	0.01928	17.32606	0.001113
8	0	99779	0	0.99779	0.020377	17.30667	0.001177
9	0.00013	99779	12	0.99779	0.0216	17.28507	0.00125
10	0.00006	99766	6	0.99766	0.022769	17.26442	0.001319
11	0	99760	0	0.9976	0.024076	17.24132	0.001396
12	0.00024	99760	23	0.9976	0.025521	17.2158	0.001482
13	0.00007	99737	7	0.99737	0.026828	17.19271	0.00156
14	0.00007	99729	7	0.99729	0.028359	17.16565	0.001652

15	0.00024	99722	24	0.99722	0.029993	17.13679	0.00175
16	0.00015	99698	15	0.99698	0.031559	17.10912	0.001845
17	0.00039	99683	39	0.99683	0.033307	17.07824	0.00195
18	0.00025	99644	25	0.99644	0.034928	17.0496	0.002049
19	0.00024	99619	24	0.99619	0.036782	17.01685	0.002162
20	0.00014	99595	14	0.99595	0.038758	16.98195	0.002282
21	0.00024	99581	24	0.99581	0.040948	16.94325	0.002417
22	0.0004	99558	40	0.99558	0.043184	16.90375	0.002555
23	0.00032	99518	32	0.99518	0.045392	16.86475	0.002692
24	0.00018	99486	18	0.99486	0.047809	16.82204	0.002842
25	0.00034	99468	34	0.99468	0.050506	16.7744	0.003011
26	0.00036	99434	36	0.99434	0.053212	16.72658	0.003181
27	0.00047	99398	46	0.99398	0.056063	16.67621	0.003362
28	0.00041	99351	41	0.99351	0.058982	16.62465	0.003548
29	0.00062	99310	61	0.9931	0.062134	16.56896	0.00375
30	0.00039	99249	39	0.99249	0.065288	16.51324	0.003954
31	0.00078	99210	77	0.9921	0.06884	16.4505	0.004185
32	0.00059	99133	59	0.99133	0.07225	16.39025	0.004408
33	0.00071	99074	70	0.99074	0.076035	16.32338	0.004658
34	0.00054	99004	54	0.99004	0.079947	16.25427	0.004919
35	0.00049	98951	49	0.98951	0.084254	16.17819	0.005208
36	0.00067	98902	66	0.98902	0.088858	16.09685	0.00552
37	0.00081	98836	80	0.98836	0.093584	16.01335	0.005844
38	0.00106	98756	105	0.98756	0.09847	15.92704	0.006183

39	0.00092	98651	91	0.98651	0.103424	15.8395	0.00653
40	0.00098	98560	97	0.9856	0.108808	15.74439	0.006911
41	0.00136	98463	134	0.98463	0.114465	15.64446	0.007317
42	0.00161	98329	159	0.98329	0.120135	15.54428	0.007729
43	0.00165	98170	162	0.9817	0.12593	15.4419	0.008155
44	0.00152	98009	149	0.98009	0.132062	15.33357	0.008613
45	0.00176	97860	172	0.9786	0.138677	15.21671	0.009113
46	0.00194	97687	190	0.97687	0.145487	15.0964	0.009637
47	0.00176	97498	172	0.97498	0.152576	14.97115	0.010191
48	0.00242	97326	235	0.97326	0.160249	14.83559	0.010802
49	0.00281	97090	273	0.9709	0.167847	14.70138	0.011417
50	0.00236	96818	229	0.96818	0.175608	14.56426	0.012057
51	0.00281	96589	272	0.96589	0.184215	14.41221	0.012782
52	0.00359	96317	346	0.96317	0.192995	14.25709	0.013537
53	0.00392	95971	376	0.95971	0.201707	14.10318	0.014302
54	0.00377	95595	361	0.95595	0.210717	13.944	0.015112
55	0.00458	95234	436	0.95234	0.220416	13.77265	0.016004
56	0.004	94798	379	0.94798	0.230116	13.60128	0.016919
57	0.00432	94419	408	0.94419	0.240888	13.41097	0.017962
58	0.005	94011	470	0.94011	0.25211	13.21272	0.019081
59	0.00586	93541	548	0.93541	0.263555	13.01053	0.020257
60	0.00612	92993	569	0.92993	0.275122	12.80619	0.021483
61	0.00737	92424	681	0.92424	0.287268	12.5916	0.022814
62	0.00794	91743	728	0.91743	0.299341	12.3783	0.024183

63	0.00849	91014	772	0.91014	0.311833	12.15761	0.025649
64	0.00977	90242	881	0.90242	0.324816	11.92824	0.027231
65	0.0102	89361	912	0.89361	0.337841	11.69814	0.02888
66	0.0118	88449	1044	0.88449	0.351493	11.45696	0.030679
67	0.01202	87405	1051	0.87405	0.365088	11.21677	0.032548
68	0.01361	86355	1175	0.86355	0.37954	10.96146	0.034625
69	0.01329	85180	1132	0.8518	0.394068	10.7048	0.036812
70	0.0179	84048	1505	0.84048	0.409869	10.42564	0.039314
71	0.01609	82543	1328	0.82543	0.42415	10.17335	0.041692
72	0.02	81215	1624	0.81215	0.440599	9.882749	0.044583
73	0.02008	79591	1598	0.79591	0.45616	9.607835	0.047478
74	0.02298	77993	1792	0.77993	0.472948	9.311254	0.050793
75	0.02753	76201	2098	0.76201	0.489598	9.01711	0.054297
76	0.03093	74103	2292	0.74103	0.505355	8.738735	0.057829
77	0.03275	71811	2352	0.71811	0.520856	8.464877	0.061531
78	0.03145	69459	2185	0.69459	0.536941	8.18071	0.065635
79	0.03861	67274	2597	0.67274	0.555164	7.858769	0.070643
80	0.04185	64677	2707	0.64677	0.57195	7.562222	0.075632
81	0.04636	61970	2873	0.6197	0.589067	7.259808	0.081141
82	0.05325	59097	3147	0.59097	0.606152	6.957976	0.087116
83	0.05807	55950	3249	0.5595	0.622414	6.670678	0.093306
84	0.06474	52701	3412	0.52701	0.638784	6.38149	0.100099
85	0.06938	49289	3419	0.49289	0.654759	6.099261	0.107351
86	0.08408	45870	3857	0.4587	0.671239	5.808104	0.115569

87	0.09226	42013	3876	0.42013	0.685029	5.564482	0.123107
88	0.10045	38137	3831	0.38137	0.698297	5.33009	0.13101
89	0.10501	34306	3602	0.34306	0.711182	5.102456	0.13938
90	0.10095	30704	3100	0.30704	0.724976	4.858754	0.14921
91	0.12496	27604	3449	0.27604	0.742474	4.549628	0.163194
92	0.13903	24155	3358	0.24155	0.756612	4.299854	0.175962
93	0.16327	20796	3395	0.20796	0.770029	4.062822	0.189531
94	0.17899	17401	3115	0.17401	0.780377	3.880014	0.201127
95	0.18498	14286	2643	0.14286	0.789521	3.718467	0.212324
96	0.20088	11644	2339	0.11644	0.799883	3.535399	0.22625
97	0.21752	9305	2024	0.09305	0.809637	3.363086	0.240742
98	0.23485	7281	1710	0.07281	0.818801	3.201185	0.255781
99	0.25278	5571	1408	0.05571	0.82739	3.049441	0.271325
100	0.27122	4163	1129	0.04163	0.835444	2.907154	0.287375
101	0.29006	3034	880	0.03034	0.84299	2.773847	0.303906
102	0.30919	2154	666	0.02154	0.850088	2.648451	0.320975
103	0.32848	1488	489	0.01488	0.856824	2.529441	0.33874
104	0.3478	999	347	0.00999	0.863315	2.414772	0.357514
105	0.36703	652	239	0.00652	0.869936	2.297789	0.378597
106	0.38603	412	159	0.00412	0.876773	2.17701	0.402742
107	0.40468	253	102	0.00253	0.884997	2.031715	0.435591
108	0.42288	151	64	0.00151	0.896282	1.832353	0.489143
109	0.44052	87	38	0.00087	0.91332	1.531338	0.59642
110	1	49	49	0.00049	0.943396	1	0.943396

Table 2: Results for Hong Kong Female

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00135	100000	135	1	0.010482	17.48148	0.0006
1	0.00016	99865	16	0.99865	0.009775	17.49398	0.000559
2	0.00007	99849	7	0.99849	0.010202	17.48642	0.000583
3	0.00011	99841	11	0.99841	0.010735	17.47701	0.000614
4	0.00007	99831	7	0.99831	0.01128	17.46738	0.000646
5	0	99824	0	0.99824	0.011888	17.45665	0.000681
6	0.00007	99824	7	0.99824	0.012601	17.44404	0.000722
7	0.00007	99817	7	0.99817	0.013288	17.43191	0.000762
8	0.00006	99810	6	0.9981	0.014016	17.41905	0.000805
9	0.00007	99804	7	0.99804	0.014798	17.40524	0.00085
10	0.0001	99797	10	0.99797	0.015617	17.39077	0.000898
11	0.0001	99787	10	0.99787	0.016455	17.37596	0.000947
12	0.00007	99777	7	0.99777	0.017344	17.36025	0.000999
13	0.00007	99770	7	0.9977	0.018316	17.34309	0.001056
14	0.00019	99762	19	0.99762	0.019336	17.32506	0.001116
15	0.00016	99743	16	0.99743	0.02031	17.30786	0.001173
16	0.00015	99727	15	0.99727	0.021371	17.2891	0.001236
17	0.00019	99711	19	0.99711	0.022497	17.26922	0.001303
18	0.00007	99693	7	0.99693	0.02367	17.24849	0.001372
19	0.00029	99686	29	0.99686	0.025022	17.22461	0.001453
20	0.00006	99657	6	0.99657	0.02624	17.20309	0.001525
21	0.00025	99651	25	0.99651	0.027756	17.17631	0.001616

Age	qx	lx	dx	s(x)	Ax	ax	Px
22	0.00014	99626	14	0.99626	0.029178	17.15119	0.001701
23	0.00009	99612	9	0.99612	0.030792	17.12267	0.001798
24	0.00019	99603	19	0.99603	0.032553	17.09157	0.001905
25	0.00019	99585	19	0.99585	0.034331	17.06015	0.002012
26	0.00018	99566	18	0.99566	0.036207	17.02701	0.002126
27	0.00014	99548	14	0.99548	0.038206	16.9917	0.002248
28	0.00015	99534	15	0.99534	0.040363	16.95358	0.002381
29	0.00026	99520	26	0.9952	0.04265	16.91318	0.002522
30	0.00019	99494	19	0.99494	0.04496	16.87238	0.002665
31	0.00026	99475	26	0.99475	0.047476	16.82793	0.002821
32	0.00041	99449	40	0.99449	0.050076	16.78199	0.002984
33	0.00025	99408	25	0.99408	0.05269	16.73581	0.003148
34	0.00028	99384	28	0.99384	0.055623	16.68399	0.003334
35	0.0003	99356	30	0.99356	0.058695	16.62972	0.00353
36	0.00034	99326	33	0.99326	0.061934	16.5725	0.003737
37	0.00043	99292	43	0.99292	0.06533	16.51251	0.003956
38	0.0003	99249	30	0.99249	0.068846	16.45038	0.004185
39	0.00045	99219	45	0.99219	0.072697	16.38235	0.004438
40	0.00066	99175	66	0.99175	0.076649	16.31253	0.004699
41	0.00037	99109	37	0.99109	0.080636	16.24209	0.004965
42	0.00085	99072	85	0.99072	0.085133	16.16265	0.005267
43	0.00071	98987	71	0.98987	0.08946	16.08621	0.005561
44	0.00058	98917	58	0.98917	0.094187	16.0027	0.005886

Age	qx	lx	dx	s(x)	Ax	ax	Px
45	0.00079	98859	79	0.98859	0.09931	15.91219	0.006241
46	0.00089	98781	88	0.98781	0.104562	15.8194	0.00661
47	0.00087	98692	86	0.98692	0.110034	15.72273	0.006998
48	0.00139	98606	137	0.98606	0.115866	15.61971	0.007418
49	0.00126	98469	124	0.98469	0.121597	15.51845	0.007836
50	0.00153	98345	151	0.98345	0.127794	15.40896	0.008294
51	0.00166	98195	163	0.98195	0.134142	15.29683	0.008769
52	0.00141	98031	138	0.98031	0.140755	15.18	0.009272
53	0.00174	97893	170	0.97893	0.148001	15.05199	0.009833
54	0.00264	97723	258	0.97723	0.155414	14.92102	0.010416
55	0.00233	97465	227	0.97465	0.162528	14.79534	0.010985
56	0.00223	97238	217	0.97238	0.170347	14.6572	0.011622
57	0.0026	97021	252	0.97021	0.178735	14.50901	0.012319
58	0.0027	96769	261	0.96769	0.187349	14.35684	0.013049
59	0.00249	96508	241	0.96508	0.196422	14.19654	0.013836
60	0.00311	96267	299	0.96267	0.206226	14.02335	0.014706
61	0.00365	95968	350	0.95968	0.216165	13.84776	0.01561
62	0.00397	95618	379	0.95618	0.226313	13.66847	0.016557
63	0.00388	95238	369	0.95238	0.236859	13.48216	0.017568
64	0.00443	94869	420	0.94869	0.248157	13.28256	0.018683
65	0.00526	94449	497	0.94449	0.259769	13.07741	0.019864
66	0.00507	93953	476	0.93953	0.27153	12.86964	0.021099
67	0.00595	93477	556	0.93477	0.284195	12.64588	0.022473

Age	qx	lx	dx	s(x)	Ax	ax	Px
68	0.00551	92921	512	0.92921	0.297066	12.4185	0.023921
69	0.00655	92409	605	0.92409	0.311094	12.17067	0.025561
70	0.00773	91804	710	0.91804	0.325343	11.91894	0.027296
71	0.0081	91094	738	0.91094	0.339757	11.66429	0.029128
72	0.00939	90356	848	0.90356	0.354916	11.39648	0.031143
73	0.00907	89508	811	0.89508	0.370302	11.12467	0.033287
74	0.0108	88697	958	0.88697	0.386965	10.83028	0.03573
75	0.01321	87739	1159	0.87739	0.403743	10.53387	0.038328
76	0.01393	86580	1206	0.8658	0.42031	10.24119	0.041041
77	0.01682	85374	1436	0.85374	0.437696	9.934033	0.04406
78	0.01545	83938	1297	0.83938	0.454787	9.632088	0.047216
79	0.02016	82641	1666	0.82641	0.473946	9.293617	0.050997
80	0.02145	80975	1737	0.80975	0.492145	8.972107	0.054853
81	0.02758	79238	2186	0.79238	0.511188	8.635678	0.059195
82	0.02975	77053	2293	0.77053	0.528868	8.323336	0.06354
83	0.03579	74760	2675	0.7476	0.547123	8.000831	0.068383
84	0.03714	72085	2677	0.72085	0.564363	7.696262	0.073329
85	0.04196	69408	2912	0.69408	0.582728	7.371802	0.079048
86	0.04968	66496	3304	0.66496	0.60095	7.049887	0.085242
87	0.05758	63192	3639	0.63192	0.618028	6.748179	0.091584
88	0.0643	59553	3829	0.59553	0.634035	6.465388	0.098066
89	0.06868	55724	3827	0.55724	0.649544	6.191391	0.104911
90	0.06679	51897	3466	0.51897	0.665547	5.908668	0.112639

Age	qx	lx	dx	s(x)	Ax	ax	Px
91	0.08081	48431	3914	0.48431	0.684402	5.575558	0.12275
92	0.09265	44517	4125	0.44517	0.701329	5.276519	0.132915
93	0.10185	40392	4114	0.40392	0.717205	4.99605	0.143554
94	0.11841	36278	4296	0.36278	0.733047	4.716163	0.155433
95	0.13071	31982	4181	0.31982	0.74708	4.468259	0.167197
96	0.14461	27802	4020	0.27802	0.760618	4.22909	0.179854
97	0.15954	23781	3794	0.23781	0.773495	4.001585	0.193297
98	0.17549	19987	3508	0.19987	0.785719	3.785637	0.207553
99	0.19243	16480	3171	0.1648	0.797294	3.581136	0.222637
100	0.21031	13309	2799	0.13309	0.808233	3.387884	0.238566
101	0.22905	10510	2407	0.1051	0.818571	3.205249	0.255385
102	0.24855	8102	2014	0.08102	0.82836	3.032312	0.273178
103	0.26869	6089	1636	0.06089	0.837749	2.866438	0.292261
104	0.28933	4453	1288	0.04453	0.846871	2.705283	0.313043
105	0.31032	3164	982	0.03164	0.856	2.544008	0.336477
106	0.33149	2182	723	0.02182	0.865667	2.373216	0.364765
107	0.35268	1459	515	0.01459	0.876778	2.176928	0.402759
108	0.37371	944	353	0.00944	0.89086	1.928142	0.46203
109	0.39443	591	233	0.00591	0.911049	1.571465	0.579745
110	1	358	358	0.00358	0.943396	1	0.943396

Table 3: Results for Japan Male

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00182	100000	182	1	0.015342	17.39562	0.000882
1	0.00025	99818	25	0.99818	0.014469	17.41105	0.000831
2	0.00015	99792	15	0.99792	0.01508	17.40025	0.000867
3	0.00009	99777	9	0.99777	0.015837	17.38687	0.000911
4	0.00009	99768	9	0.99768	0.016699	17.37165	0.000961
5	0.00007	99759	7	0.99759	0.017612	17.35552	0.001015
6	0.00005	99753	5	0.99753	0.01861	17.33789	0.001073
7	0.00006	99747	6	0.99747	0.019668	17.31921	0.001136
8	0.00005	99741	5	0.99741	0.020789	17.2994	0.001202
9	0.00007	99737	7	0.99737	0.021997	17.27806	0.001273
10	0.00005	99730	5	0.9973	0.023248	17.25595	0.001347
11	0.00006	99724	6	0.99724	0.024584	17.23235	0.001427
12	0.0001	99718	10	0.99718	0.026001	17.20732	0.001511
13	0.00012	99709	12	0.99709	0.027473	17.18131	0.001599
14	0.00012	99697	12	0.99697	0.029004	17.15426	0.001691
15	0.00016	99685	16	0.99685	0.030628	17.12557	0.001788
16	0.00025	99669	25	0.99669	0.03231	17.09585	0.00189
17	0.00028	99644	28	0.99644	0.034007	17.06588	0.001993
18	0.00031	99616	31	0.99616	0.035776	17.03462	0.0021
19	0.00041	99585	40	0.99585	0.037623	17.00199	0.002213
20	0.00039	99545	39	0.99545	0.039495	16.96892	0.002327
21	0.00052	99507	51	0.99507	0.041499	16.93352	0.002451

Age	qx	lx	dx	s(x)	Ax	ax	Px
22	0.00054	99455	53	0.99455	0.043489	16.89837	0.002574
23	0.00053	99402	53	0.99402	0.045589	16.86125	0.002704
24	0.00048	99349	48	0.99349	0.047817	16.8219	0.002843
25	0.00048	99302	48	0.99302	0.050237	16.77915	0.002994
26	0.0005	99254	50	0.99254	0.052793	16.73399	0.003155
27	0.0005	99204	49	0.99204	0.055485	16.68643	0.003325
28	0.00047	99155	46	0.99155	0.058349	16.63584	0.003507
29	0.00051	99108	50	0.99108	0.061405	16.58185	0.003703
30	0.00052	99058	51	0.99058	0.064617	16.52509	0.00391
31	0.00055	99006	54	0.99006	0.068005	16.46524	0.00413
32	0.00058	98952	57	0.98952	0.071579	16.4021	0.004364
33	0.00068	98895	67	0.98895	0.075341	16.33564	0.004612
34	0.00068	98828	67	0.98828	0.079238	16.2668	0.004871
35	0.00069	98761	68	0.98761	0.083371	16.19378	0.005148
36	0.00071	98693	71	0.98693	0.087745	16.11651	0.005444
37	0.00075	98622	74	0.98622	0.092357	16.03503	0.00576
38	0.00075	98548	74	0.98548	0.097221	15.9491	0.006096
39	0.00084	98474	82	0.98474	0.10238	15.85796	0.006456
40	0.00092	98391	90	0.98391	0.10777	15.76272	0.006837
41	0.00106	98301	105	0.98301	0.113426	15.66281	0.007242
42	0.00111	98196	109	0.98196	0.119291	15.5592	0.007667
43	0.00124	98087	122	0.98087	0.125477	15.4499	0.008122
44	0.00133	97965	130	0.97965	0.131926	15.33597	0.008602

Age	qx	lx	dx	s(x)	Ax	ax	Px
45	0.00151	97835	148	0.97835	0.138699	15.21632	0.009115
46	0.00164	97687	160	0.97687	0.145728	15.09213	0.009656
47	0.00179	97527	174	0.97527	0.153085	14.96216	0.010231
48	0.00201	97352	196	0.97352	0.160764	14.8265	0.010843
49	0.00214	97157	208	0.97157	0.168745	14.6855	0.011491
50	0.00247	96949	240	0.96949	0.177108	14.53776	0.012183
51	0.00273	96709	264	0.96709	0.185719	14.38564	0.01291
52	0.00299	96445	289	0.96445	0.194663	14.22761	0.013682
53	0.00307	96156	295	0.96156	0.203958	14.06341	0.014503
54	0.00349	95862	335	0.95862	0.213791	13.88968	0.015392
55	0.00405	95527	387	0.95527	0.223907	13.71098	0.01633
56	0.00439	95140	418	0.9514	0.234239	13.52844	0.017315
57	0.00473	94722	448	0.94722	0.244976	13.33876	0.018366
58	0.00512	94274	483	0.94274	0.256157	13.14123	0.019493
59	0.00577	93791	541	0.93791	0.267774	12.93598	0.0207
60	0.00607	93250	566	0.9325	0.279686	12.72555	0.021978
61	0.00695	92683	645	0.92683	0.292163	12.50512	0.023364
62	0.0077	92039	709	0.92039	0.304863	12.28075	0.024824
63	0.00836	91330	764	0.9133	0.3179	12.05043	0.026381
64	0.0093	90566	842	0.90566	0.331381	11.81226	0.028054
65	0.01006	89724	902	0.89724	0.345176	11.56855	0.029837
66	0.0112	88822	995	0.88822	0.359447	11.31643	0.031763
67	0.01238	87827	1087	0.87827	0.374001	11.05931	0.033818

Age	qx	lx	dx	s(x)	Ax	ax	Px
68	0.01362	86740	1181	0.8674	0.388878	10.79649	0.036019
69	0.0151	85558	1292	0.85558	0.40409	10.52774	0.038383
70	0.01699	84267	1431	0.84267	0.419578	10.25413	0.040918
71	0.01836	82835	1521	0.82835	0.435153	9.978956	0.043607
72	0.02016	81314	1639	0.81314	0.451185	9.695725	0.046534
73	0.02173	79675	1732	0.79675	0.467524	9.407081	0.049699
74	0.0235	77943	1832	0.77943	0.484366	9.109532	0.053171
75	0.02715	76112	2067	0.76112	0.501723	8.802898	0.056995
76	0.02948	74045	2183	0.74045	0.518757	8.501962	0.061016
77	0.03211	71862	2308	0.71862	0.536209	8.193646	0.065442
78	0.03537	69555	2460	0.69555	0.554065	7.878179	0.070329
79	0.03946	67095	2647	0.67095	0.572178	7.558185	0.075703
80	0.04394	64447	2832	0.64447	0.590341	7.237307	0.081569
81	0.04838	61615	2981	0.61615	0.608561	6.915431	0.088
82	0.0549	58635	3219	0.58635	0.627036	6.589034	0.095164
83	0.06263	55416	3470	0.55416	0.645179	6.268511	0.102924
84	0.06901	51945	3585	0.51945	0.662767	5.95779	0.111244
85	0.07986	48360	3862	0.4836	0.680481	5.644838	0.120549
86	0.08752	44498	3894	0.44498	0.697122	5.350843	0.130283
87	0.10135	40604	4115	0.40604	0.713914	5.054183	0.141252
88	0.11413	36489	4164	0.36489	0.729317	4.782071	0.152511
89	0.12522	32324	4048	0.32324	0.743836	4.525561	0.164363
90	0.14194	28276	4013	0.28276	0.758183	4.272098	0.177473

Age	qx	lx	dx	s(x)	Ax	ax	Px
91	0.15594	24263	3784	0.24263	0.771203	4.042087	0.190793
92	0.17261	20479	3535	0.20479	0.783749	3.820439	0.205146
93	0.18965	16944	3214	0.16944	0.795468	3.613394	0.220144
94	0.20508	13731	2816	0.13731	0.806505	3.418414	0.23593
95	0.22754	10915	2484	0.10915	0.817459	3.22489	0.253484
96	0.24807	8431	2092	0.08431	0.827176	3.053226	0.270919
97	0.26932	6340	1707	0.0634	0.836176	2.894227	0.288912
98	0.29113	4632	1349	0.04632	0.844438	2.748264	0.307262
99	0.3133	3284	1029	0.03284	0.852047	2.613836	0.325976
100	0.33566	2255	757	0.02255	0.858984	2.491277	0.344797
101	0.358	1498	536	0.01498	0.865307	2.379572	0.36364
102	0.38011	962	366	0.00962	0.871106	2.277125	0.382546
103	0.40181	596	240	0.00596	0.876316	2.185084	0.401045
104	0.42293	357	151	0.00357	0.881292	2.097166	0.42023
105	0.44329	206	91	0.00206	0.885916	2.015484	0.439555
106	0.46278	115	53	0.00115	0.890858	1.928184	0.462019
107	0.48127	62	30	0.00062	0.896702	1.824929	0.491363
108	0.4987	32	16	0.00032	0.904102	1.694197	0.533646
109	0.515	16	8	0.00016	0.916696	1.471698	0.622883
110	1	8	8	0.00008	0.943396	1	0.943396

Table 4: Results for Japan Female

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00171	100000	171	1	0.010972	17.47283	0.000628
1	0.00018	99829	18	0.99829	0.009937	17.49111	0.000568
2	0.00009	99811	9	0.99811	0.010355	17.48373	0.000592
3	0.0001	99803	10	0.99803	0.010897	17.47415	0.000624
4	0.00006	99793	6	0.99793	0.011452	17.46435	0.000656
5	0.00007	99787	7	0.99787	0.01208	17.45326	0.000692
6	0.00006	99780	6	0.9978	0.012735	17.44168	0.00073
7	0.00007	99773	7	0.99773	0.01343	17.4294	0.000771
8	0.00007	99767	7	0.99767	0.014176	17.41622	0.000814
9	0.00005	99760	5	0.9976	0.014958	17.40241	0.00086
10	0.00006	99755	6	0.99755	0.015806	17.38743	0.000909
11	0.00004	99749	4	0.99749	0.016695	17.37172	0.000961
12	0.00007	99745	7	0.99745	0.017658	17.35471	0.001017
13	0.0001	99737	10	0.99737	0.018638	17.33739	0.001075
14	0.00008	99728	8	0.99728	0.019668	17.31919	0.001136
15	0.00011	99720	11	0.9972	0.02077	17.29973	0.001201
16	0.00013	99710	13	0.9971	0.021918	17.27945	0.001268
17	0.00019	99697	19	0.99697	0.023106	17.25847	0.001339
18	0.00021	99678	21	0.99678	0.024306	17.23726	0.00141
19	0.00016	99656	16	0.99656	0.025549	17.2153	0.001484
20	0.00022	99640	22	0.9964	0.026926	17.19097	0.001566
21	0.00023	99618	23	0.99618	0.028327	17.16622	0.00165

Age	qx	lx	dx	s(x)	Ax	ax	Px
22	0.00027	99595	27	0.99595	0.029803	17.14015	0.001739
23	0.0002	99568	20	0.99568	0.031328	17.1132	0.001831
24	0.00027	99548	27	0.99548	0.033014	17.08343	0.001932
25	0.00026	99521	26	0.99521	0.034733	17.05306	0.002037
26	0.00024	99494	24	0.99494	0.036555	17.02086	0.002148
27	0.00025	99471	25	0.99471	0.038526	16.98604	0.002268
28	0.00027	99445	27	0.99445	0.040587	16.94963	0.002395
29	0.00028	99419	28	0.99419	0.042772	16.91103	0.002529
30	0.00027	99391	27	0.99391	0.045069	16.87044	0.002672
31	0.00028	99364	28	0.99364	0.047515	16.82724	0.002824
32	0.00026	99336	26	0.99336	0.050098	16.7816	0.002985
33	0.00031	99310	31	0.9931	0.052856	16.73288	0.003159
34	0.00037	99279	36	0.99279	0.055733	16.68206	0.003341
35	0.00037	99242	37	0.99242	0.058726	16.62918	0.003531
36	0.00045	99206	45	0.99206	0.061909	16.57294	0.003736
37	0.00046	99161	46	0.99161	0.0652	16.51481	0.003948
38	0.00051	99115	51	0.99115	0.06868	16.45333	0.004174
39	0.00049	99064	49	0.99064	0.072323	16.38896	0.004413
40	0.00063	99015	62	0.99015	0.076205	16.32037	0.004669
41	0.00063	98953	62	0.98953	0.080202	16.24977	0.004936
42	0.00068	98891	67	0.98891	0.08444	16.17489	0.00522
43	0.00071	98824	70	0.98824	0.088889	16.09629	0.005522
44	0.00084	98754	83	0.98754	0.093581	16.01341	0.005844

Age	qx	lx	dx	s(x)	Ax	ax	Px
45	0.00092	98671	90	0.98671	0.098438	15.9276	0.00618
46	0.001	98581	98	0.98581	0.103526	15.8377	0.006537
47	0.00109	98483	107	0.98483	0.108852	15.74361	0.006914
48	0.00118	98376	116	0.98376	0.114421	15.64523	0.007313
49	0.00132	98260	130	0.9826	0.120249	15.54227	0.007737
50	0.00147	98130	144	0.9813	0.126308	15.43523	0.008183
51	0.00155	97986	152	0.97986	0.132614	15.32383	0.008654
52	0.00179	97834	175	0.97834	0.139235	15.20685	0.009156
53	0.00175	97659	171	0.97659	0.146062	15.08624	0.009682
54	0.00187	97488	182	0.97488	0.153343	14.95761	0.010252
55	0.00209	97306	203	0.97306	0.160977	14.82274	0.01086
56	0.0022	97103	214	0.97103	0.168902	14.68273	0.011503
57	0.00241	96889	234	0.96889	0.177223	14.53573	0.012192
58	0.00236	96655	228	0.96655	0.18589	14.38261	0.012925
59	0.00271	96427	262	0.96427	0.195145	14.21911	0.013724
60	0.0028	96165	270	0.96165	0.204693	14.05043	0.014568
61	0.00299	95896	287	0.95896	0.214778	13.87226	0.015483
62	0.00336	95609	322	0.95609	0.225346	13.68555	0.016466
63	0.00364	95287	346	0.95287	0.236295	13.49213	0.017514
64	0.00393	94941	373	0.94941	0.247741	13.28991	0.018641
65	0.00422	94568	399	0.94568	0.259697	13.07869	0.019856
66	0.00451	94169	424	0.94169	0.272208	12.85766	0.021171
67	0.00519	93744	487	0.93744	0.285315	12.6261	0.022597

Age	qx	lx	dx	s(x)	Ax	ax	Px
68	0.00556	93258	518	0.93258	0.298799	12.38789	0.02412
69	0.00598	92740	554	0.9274	0.31291	12.13859	0.025778
70	0.00688	92185	634	0.92185	0.327661	11.87799	0.027586
71	0.0076	91552	696	0.91552	0.342808	11.61039	0.029526
72	0.00835	90855	759	0.90855	0.358493	11.3333	0.031632
73	0.00909	90097	819	0.90097	0.374786	11.04545	0.033931
74	0.00985	89278	880	0.89278	0.391744	10.74586	0.036455
75	0.0116	88398	1026	0.88398	0.409428	10.43345	0.039242
76	0.01268	87373	1108	0.87373	0.427353	10.11676	0.042242
77	0.01402	86265	1209	0.86265	0.445969	9.787889	0.045563
78	0.01623	85056	1380	0.85056	0.465232	9.44757	0.049244
79	0.01881	83675	1574	0.83675	0.484781	9.102211	0.05326
80	0.02145	82101	1761	0.82101	0.504547	8.752995	0.057643
81	0.02393	80341	1922	0.80341	0.52463	8.398207	0.062469
82	0.02781	78418	2180	0.78418	0.545222	8.034407	0.067861
83	0.03226	76238	2459	0.76238	0.565867	7.669687	0.07378
84	0.03702	73779	2731	0.73779	0.586481	7.305502	0.080279
85	0.04345	71047	3087	0.71047	0.607122	6.940848	0.087471
86	0.04899	67961	3330	0.67961	0.627363	6.583249	0.095297
87	0.0575	64631	3717	0.64631	0.647745	6.223171	0.104086
88	0.06711	60914	4088	0.60914	0.667487	5.874405	0.113626
89	0.07575	56826	4304	0.56826	0.686496	5.538568	0.123948
90	0.09026	52522	4741	0.52522	0.705371	5.205118	0.135515

Age	qx	lx	dx	s(x)	Ax	ax	Px
91	0.10261	47781	4903	0.47781	0.722658	4.899707	0.14749
92	0.11631	42879	4987	0.42879	0.739268	4.606259	0.160492
93	0.13209	37891	5005	0.37891	0.755141	4.325849	0.174565
94	0.14929	32886	4910	0.32886	0.770079	4.06194	0.189584
95	0.16585	27977	4640	0.27977	0.784048	3.815157	0.205509
96	0.18597	23337	4340	0.23337	0.797507	3.577376	0.222931
97	0.20752	18997	3942	0.18997	0.810028	3.356168	0.241355
98	0.23037	15055	3468	0.15055	0.821614	3.151493	0.260706
99	0.25434	11587	2947	0.11587	0.832274	2.963163	0.280873
100	0.27921	8640	2412	0.0864	0.842034	2.79074	0.301724
101	0.30471	6227	1898	0.06227	0.85092	2.633743	0.323084
102	0.33056	4330	1431	0.0433	0.85903	2.490465	0.344928
103	0.35644	2899	1033	0.02899	0.866429	2.359757	0.367169
104	0.38204	1865	713	0.01865	0.873182	2.240457	0.389734
105	0.40707	1153	469	0.01153	0.879612	2.126851	0.413575
106	0.43126	684	295	0.00684	0.88603	2.013473	0.440051
107	0.45436	389	177	0.00389	0.893077	1.888967	0.472786
108	0.4762	212	101	0.00212	0.90213	1.729041	0.521751
109	0.49664	111	55	0.00111	0.916456	1.475948	0.620927
110	1	56	56	0.00056	0.943396	1	0.943396

Table 5: Results for South Korea Male

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00313	100000	313	1	0.017666	17.35458	0.001018
1	0.00019	99687	19	0.99687	0.015644	17.39028	0.0009
2	0.00013	99668	13	0.99668	0.016396	17.37701	0.000944
3	0.00011	99655	11	0.99655	0.017251	17.3619	0.000994
4	0.00008	99643	8	0.99643	0.018168	17.3457	0.001047
5	0.00011	99635	11	0.99635	0.019179	17.32783	0.001107
6	0.0001	99624	10	0.99624	0.020222	17.30941	0.001168
7	0.00006	99615	6	0.99615	0.021347	17.28954	0.001235
8	0.00009	99608	9	0.99608	0.022559	17.26812	0.001306
9	0.00007	99600	7	0.996	0.023834	17.2456	0.001382
10	0.00008	99593	8	0.99593	0.025196	17.22154	0.001463
11	0.0001	99585	9	0.99585	0.026629	17.19622	0.001549
12	0.00009	99576	9	0.99576	0.028139	17.16954	0.001639
13	0.00009	99567	9	0.99567	0.02974	17.14126	0.001735
14	0.00014	99558	14	0.99558	0.031437	17.11129	0.001837
15	0.00018	99545	18	0.99545	0.033197	17.08019	0.001944
16	0.0002	99527	20	0.99527	0.035014	17.04809	0.002054
17	0.00026	99507	26	0.99507	0.036921	17.01439	0.00217
18	0.00029	99482	29	0.99482	0.038895	16.97952	0.002291
19	0.00034	99452	34	0.99452	0.040939	16.9434	0.002416
20	0.00036	99419	35	0.99419	0.043078	16.90562	0.002548
21	0.00034	99384	34	0.99384	0.045327	16.86589	0.002687

Age	qx	lx	dx	s(x)	Ax	ax	Px
22	0.00039	99350	39	0.9935	0.047721	16.8236	0.002837
23	0.00045	99311	45	0.99311	0.050211	16.7796	0.002992
24	0.00047	99266	47	0.99266	0.052795	16.73396	0.003155
25	0.00044	99220	44	0.9922	0.055525	16.68573	0.003328
26	0.0005	99176	50	0.99176	0.058439	16.63425	0.003513
27	0.00052	99126	51	0.99126	0.061472	16.58067	0.003707
28	0.00058	99075	57	0.99075	0.064679	16.52401	0.003914
29	0.0006	99018	59	0.99018	0.068023	16.46492	0.004131
30	0.00056	98958	55	0.98958	0.071542	16.40276	0.004362
31	0.00069	98903	68	0.98903	0.075321	16.336	0.004611
32	0.00074	98835	73	0.98835	0.079207	16.26735	0.004869
33	0.00077	98762	76	0.98762	0.083282	16.19535	0.005142
34	0.00079	98687	78	0.98687	0.087586	16.11931	0.005434
35	0.00081	98609	80	0.98609	0.092124	16.03915	0.005744
36	0.00089	98529	88	0.98529	0.096919	15.95444	0.006075
37	0.00098	98441	96	0.98441	0.101932	15.86587	0.006425
38	0.00111	98345	109	0.98345	0.107177	15.77321	0.006795
39	0.0012	98237	118	0.98237	0.112633	15.67682	0.007185
40	0.00119	98118	117	0.98118	0.118323	15.5763	0.007596
41	0.00133	98002	131	0.98002	0.124387	15.46916	0.008041
42	0.00139	97871	136	0.97871	0.130688	15.35784	0.00851
43	0.00162	97735	158	0.97735	0.137331	15.24049	0.009011
44	0.00188	97577	184	0.97577	0.144187	15.11936	0.009537

Age	qx	lx	dx	s(x)	Ax	ax	Px
45	0.002	97394	195	0.97394	0.151247	14.99464	0.010087
46	0.00225	97199	219	0.97199	0.158637	14.86408	0.010672
47	0.00233	96980	226	0.9698	0.166277	14.72911	0.011289
48	0.00268	96753	259	0.96753	0.174321	14.587	0.01195
49	0.00301	96494	290	0.96494	0.182592	14.44088	0.012644
50	0.00322	96204	309	0.96204	0.191116	14.29028	0.013374
51	0.00345	95895	331	0.95895	0.200014	14.13309	0.014152
52	0.00393	95564	375	0.95564	0.209285	13.9693	0.014982
53	0.00432	95189	411	0.95189	0.218777	13.80161	0.015852
54	0.00445	94778	422	0.94778	0.228572	13.62855	0.016772
55	0.00503	94356	475	0.94356	0.238898	13.44614	0.017767
56	0.00506	93881	475	0.93881	0.249454	13.25965	0.018813
57	0.00587	93406	549	0.93406	0.26068	13.06132	0.019958
58	0.00632	92857	587	0.92857	0.272042	12.86059	0.021153
59	0.00656	92271	605	0.92271	0.283845	12.65207	0.022435
60	0.00708	91666	649	0.91666	0.296262	12.43271	0.023829
61	0.0074	91017	674	0.91017	0.309146	12.20508	0.025329
62	0.00823	90343	743	0.90343	0.322679	11.966	0.026966
63	0.0096	89600	860	0.896	0.336584	11.72035	0.028718
64	0.00971	88739	862	0.88739	0.350538	11.47383	0.030551
65	0.01037	87878	912	0.87878	0.365413	11.21103	0.032594
66	0.012	86966	1044	0.86966	0.380913	10.9372	0.034827
67	0.01289	85922	1108	0.85922	0.396523	10.66142	0.037192

Age	qx	lx	dx	s(x)	Ax	ax	Px
68	0.01437	84814	1219	0.84814	0.412742	10.3749	0.039783
69	0.01518	83596	1269	0.83596	0.429311	10.08218	0.042581
70	0.01664	82327	1370	0.82327	0.44667	9.775502	0.045693
71	0.01959	80957	1586	0.80957	0.46456	9.459447	0.049111
72	0.01951	79371	1549	0.79371	0.482291	9.146194	0.052731
73	0.02397	77822	1866	0.77822	0.5015	8.806839	0.056944
74	0.02507	75956	1904	0.75956	0.520082	8.478546	0.061341
75	0.03238	74052	2398	0.74052	0.53975	8.131082	0.066381
76	0.03553	71654	2546	0.71654	0.557816	7.811917	0.071406
77	0.03895	69109	2692	0.69109	0.576234	7.486539	0.076969
78	0.04597	66417	3053	0.66417	0.595033	7.154417	0.08317
79	0.05116	63364	3241	0.63364	0.612943	6.838005	0.089638
80	0.05675	60122	3412	0.60122	0.630831	6.521981	0.096724
81	0.06678	56710	3787	0.5671	0.648747	6.205468	0.104544
82	0.07518	52923	3979	0.52923	0.665323	5.912631	0.112526
83	0.08412	48945	4117	0.48945	0.681286	5.630619	0.120997
84	0.09321	44828	4178	0.44828	0.696646	5.359249	0.12999
85	0.10343	40649	4204	0.40649	0.711555	5.095855	0.139634
86	0.11328	36445	4128	0.36445	0.725901	4.842418	0.149905
87	0.12446	32316	4022	0.32316	0.739998	4.593364	0.161102
88	0.1413	28294	3998	0.28294	0.75375	4.350411	0.17326
89	0.15612	24297	3793	0.24297	0.765906	4.135668	0.185195
90	0.17243	20503	3536	0.20503	0.777045	3.938866	0.197276

Age	qx	lx	dx	s(x)	Ax	ax	Px
91	0.18313	16968	3107	0.16968	0.786932	3.764198	0.209057
92	0.19343	13861	2681	0.13861	0.796972	3.586832	0.222194
93	0.20443	11179	2285	0.11179	0.807553	3.399897	0.237523
94	0.23	8894	2046	0.08894	0.819012	3.197454	0.256145
95	0.25464	6848	1744	0.06848	0.82876	3.025234	0.273949
96	0.27421	5105	1400	0.05105	0.836997	2.879713	0.290653
97	0.29421	3705	1090	0.03705	0.8446	2.745395	0.307643
98	0.3145	2615	822	0.02615	0.851625	2.621296	0.324887
99	0.33493	1792	600	0.01792	0.858046	2.507852	0.342144
100	0.35535	1192	424	0.01192	0.86399	2.402849	0.359569
101	0.3756	768	289	0.00768	0.86936	2.307978	0.376676
102	0.39554	480	190	0.0048	0.874434	2.218331	0.394186
103	0.41503	290	120	0.0029	0.879007	2.137541	0.411223
104	0.43395	170	74	0.0017	0.883569	2.056942	0.429555
105	0.45217	96	43	0.00096	0.8877	1.983969	0.447436
106	0.46962	53	25	0.00053	0.893063	1.88922	0.472715
107	0.48621	28	14	0.00028	0.89901	1.784156	0.503885
108	0.5019	14	7	0.00014	0.905901	1.662412	0.544932
109	0.51664	7	4	0.00007	0.920511	1.404313	0.655488
110	1	3	3	0.00003	0.943396	1	0.943396

Table 6: Results for South Korea Female

Age	qx	lx	dx	s(x)	Ax	ax	Px
0	0.00246	100000	246	1	0.012499	17.44585	0.000716
1	0.00023	99754	23	0.99754	0.010815	17.47559	0.000619
2	0.00015	99731	15	0.99731	0.011236	17.46816	0.000643
3	0.0001	99716	10	0.99716	0.011762	17.45887	0.000674
4	0.00007	99706	7	0.99706	0.012369	17.44815	0.000709
5	0.00006	99700	6	0.997	0.013051	17.43609	0.000749
6	0.00007	99694	7	0.99694	0.013775	17.42331	0.000791
7	0.00004	99687	4	0.99687	0.014532	17.40993	0.000835
8	0.00009	99683	9	0.99683	0.015365	17.39522	0.000883
9	0.00007	99674	7	0.99674	0.016198	17.3805	0.000932
10	0.00009	99667	9	0.99667	0.017101	17.36455	0.000985
11	0.00004	99657	4	0.99657	0.018028	17.34817	0.001039
12	0.00008	99653	8	0.99653	0.019071	17.32975	0.0011
13	0.00011	99645	11	0.99645	0.020136	17.31093	0.001163
14	0.00013	99635	13	0.99635	0.021246	17.29132	0.001229
15	0.00017	99621	17	0.99621	0.022384	17.27122	0.001296
16	0.00016	99604	16	0.99604	0.02356	17.25044	0.001366
17	0.00014	99588	14	0.99588	0.024817	17.22823	0.00144
18	0.00017	99574	17	0.99574	0.026169	17.20435	0.001521
19	0.00021	99557	21	0.99557	0.027573	17.17954	0.001605
20	0.00023	99537	23	0.99537	0.029032	17.15376	0.001692
21	0.00022	99514	22	0.99514	0.03055	17.12694	0.001784

Age	qx	lx	dx	s(x)	Ax	ax	Px
22	0.00027	99492	27	0.99492	0.032169	17.09834	0.001881
23	0.00029	99465	29	0.99465	0.033837	17.06887	0.001982
24	0.00026	99436	26	0.99436	0.035587	17.03797	0.002089
25	0.00028	99410	28	0.9941	0.03747	17.0047	0.002204
26	0.00029	99382	29	0.99382	0.039448	16.96976	0.002325
27	0.00026	99353	26	0.99353	0.041535	16.93288	0.002453
28	0.0003	99327	30	0.99327	0.043777	16.89328	0.002591
29	0.00032	99298	32	0.99298	0.046125	16.85179	0.002737
30	0.0004	99266	40	0.99266	0.048586	16.80832	0.002891
31	0.00041	99226	40	0.99226	0.051119	16.76357	0.003049
32	0.00042	99186	42	0.99186	0.053804	16.71613	0.003219
33	0.00049	99144	48	0.99144	0.056633	16.66615	0.003398
34	0.00048	99096	47	0.99096	0.059576	16.61416	0.003586
35	0.00046	99049	46	0.99049	0.062706	16.55887	0.003787
36	0.00054	99003	54	0.99003	0.066034	16.50006	0.004002
37	0.00058	98949	58	0.98949	0.069489	16.43903	0.004227
38	0.00062	98891	62	0.98891	0.073115	16.37497	0.004465
39	0.00067	98829	66	0.98829	0.076923	16.3077	0.004717
40	0.0007	98763	69	0.98763	0.080925	16.237	0.004984
41	0.00066	98694	65	0.98694	0.085141	16.16251	0.005268
42	0.00081	98628	79	0.98628	0.08964	16.08302	0.005574
43	0.00082	98549	80	0.98549	0.094293	16.00082	0.005893
44	0.00086	98469	84	0.98469	0.09922	15.91378	0.006235

Age	qx	lx	dx	s(x)	Ax	ax	Px
45	0.00092	98384	90	0.98384	0.1044	15.82227	0.006598
46	0.00099	98294	97	0.98294	0.10985	15.72599	0.006985
47	0.00104	98197	103	0.98197	0.115568	15.62497	0.007396
48	0.00113	98094	111	0.98094	0.121581	15.51874	0.007834
49	0.00132	97983	130	0.97983	0.127888	15.4073	0.008301
50	0.0013	97854	127	0.97854	0.134422	15.29187	0.00879
51	0.00138	97726	135	0.97726	0.141364	15.16923	0.009319
52	0.00158	97591	154	0.97591	0.14867	15.04016	0.009885
53	0.00157	97436	153	0.97436	0.15625	14.90624	0.010482
54	0.00168	97283	163	0.97283	0.164313	14.7638	0.011129
55	0.00174	97120	169	0.9712	0.172786	14.61412	0.011823
56	0.00177	96951	171	0.96951	0.181729	14.45612	0.012571
57	0.0021	96780	203	0.9678	0.191206	14.28869	0.013382
58	0.00215	96577	208	0.96577	0.201003	14.11562	0.01424
59	0.00235	96368	226	0.96368	0.211356	13.93271	0.01517
60	0.00236	96142	227	0.96142	0.222214	13.74089	0.016172
61	0.00266	95915	255	0.95915	0.233737	13.53731	0.017266
62	0.0029	95660	277	0.9566	0.245756	13.32497	0.018443
63	0.00322	95382	308	0.95382	0.258346	13.10255	0.019717
64	0.00338	95075	321	0.95075	0.271502	12.87013	0.021096
65	0.00375	94754	355	0.94754	0.28538	12.62496	0.022604
66	0.00423	94398	399	0.94398	0.299872	12.36893	0.024244
67	0.00463	93999	436	0.93999	0.314969	12.10222	0.026026

Age	qx	lx	dx	s(x)	Ax	ax	Px
68	0.00553	93564	517	0.93564	0.33077	11.82306	0.027977
69	0.00602	93047	560	0.93047	0.347008	11.53619	0.03008
70	0.00658	92486	609	0.92486	0.363994	11.23611	0.032395
71	0.00798	91878	734	0.91878	0.381769	10.92208	0.034954
72	0.00779	91144	710	0.91144	0.399881	10.6021	0.037717
73	0.01052	90434	951	0.90434	0.419351	10.25814	0.04088
74	0.01169	89483	1046	0.89483	0.438608	9.917921	0.044224
75	0.01421	88437	1257	0.88437	0.458596	9.564803	0.047946
76	0.0169	87180	1473	0.8718	0.478702	9.209592	0.051979
77	0.01876	85707	1608	0.85707	0.498959	8.851727	0.056369
78	0.02324	84099	1954	0.84099	0.519889	8.481965	0.061293
79	0.02692	82145	2211	0.82145	0.540404	8.119537	0.066556
80	0.03009	79934	2405	0.79934	0.561012	7.755453	0.072338
81	0.03547	77529	2750	0.77529	0.582099	7.382913	0.078844
82	0.04244	74779	3174	0.74779	0.602941	7.014703	0.085954
83	0.05012	71605	3589	0.71605	0.623121	6.658193	0.093587
84	0.05717	68016	3888	0.68016	0.642594	6.314164	0.10177
85	0.06597	64128	4231	0.64128	0.661819	5.974537	0.110773
86	0.07631	59897	4571	0.59897	0.680444	5.645483	0.120529
87	0.08563	55327	4738	0.55327	0.698248	5.330951	0.13098
88	0.09905	50589	5011	0.50589	0.715806	5.020768	0.142569
89	0.11414	45578	5202	0.45578	0.73223	4.730595	0.154786
90	0.13033	40376	5262	0.40376	0.747326	4.463915	0.167415

Age	qx	lx	dx	s(x)	Ax	ax	Px
91	0.14379	35113	5049	0.35113	0.761013	4.222099	0.180245
92	0.15497	30065	4659	0.30065	0.774214	3.988885	0.194093
93	0.1783	25406	4530	0.25406	0.78778	3.749212	0.210119
94	0.18184	20876	3796	0.20876	0.799253	3.546525	0.225362
95	0.21544	17080	3680	0.1708	0.813251	3.299235	0.246497
96	0.23768	13400	3185	0.134	0.82416	3.106507	0.265301
97	0.26089	10215	2665	0.10215	0.834202	2.929106	0.284797
98	0.28485	7550	2151	0.0755	0.843397	2.766645	0.304845
99	0.30935	5399	1670	0.05399	0.851771	2.618718	0.325262
100	0.3341	3729	1246	0.03729	0.859381	2.484266	0.34593
101	0.35885	2483	891	0.02483	0.866255	2.362835	0.366617
102	0.38331	1592	610	0.01592	0.872465	2.253111	0.387227
103	0.40724	982	400	0.00982	0.878109	2.153412	0.407776
104	0.43039	582	250	0.00582	0.883232	2.062903	0.42815
105	0.45256	332	150	0.00332	0.888203	1.975079	0.449705
106	0.47359	181	86	0.00181	0.892687	1.895855	0.470863
107	0.49334	96	47	0.00096	0.898656	1.790404	0.50193
108	0.51173	48	25	0.00048	0.905152	1.675656	0.540178
109	0.52872	24	12	0.00024	0.918921	1.43239	0.64153
110	1	11	11	0.00011	0.943396	1	0.943396

Comparison of Survivorship

After computing the different actuarial functions focused in the study, comparisons of the actuarial functions are made through graphs. The researchers also selected the computed values at ages 0, 20, 40, 60, and 80 to illustrate the comparison of males and females in the different countries. The first set of computations presented is the survival function, as the different actuarial functions are dependent on the survival function. Table 7 shows the comparison of the survival function of males and females across Hong Kong, Japan, and Korea at ages 0, 20,40, 60, and 80. Figure 1 also shows the side-by-side comparison of the graphs of the survival function of the three countries.

Table 7: Survivorship of Males and Females at Selected Ages..

Age	s(x)					
	Hong Kong		Japan		Korea	
	Male	Female	Male	Female	Male	Female
0	1	1	1	1	1	1
20	0.99595	0.99657	0.99545	0.9964	0.99419	0.99537
40	0.9856	0.99175	0.98391	0.99015	0.98118	0.98763
60	0.92993	0.96267	0.9325	0.96165	0.91666	0.96142
80	0.64677	0.80975	0.64447	0.82101	0.60122	0.79934

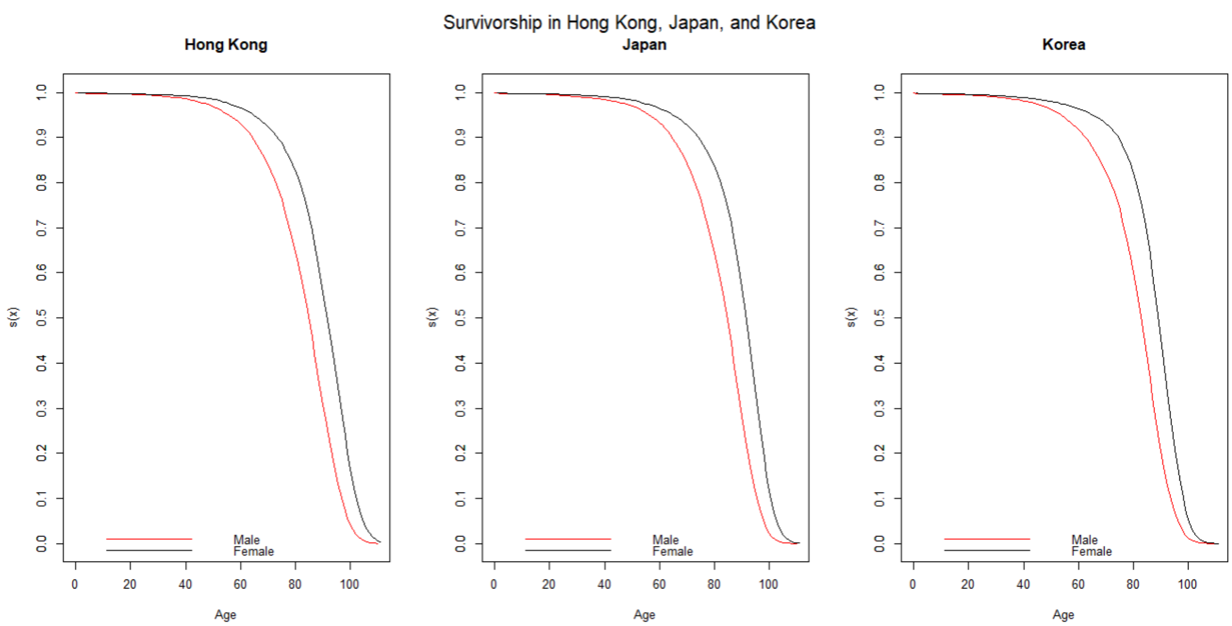

Figure 1. Graphs of Survivorship in the Three Countries.

Interestingly, figure 1 shows that the general behavior of the survival function is similar across countries. Results also show that the survival of males is generally lower than that of females.

The difference is not apparent at ages 0 to 40 according to figure 1. Table 7 also shows that the differences among males and females at ages 0, 20, and 40 do not exceed 0.01. However these differences become more apparent at older ages. The difference in probability of survival to age 60 between males and females range from 0.02 to 0.05. Meanwhile, the differences between males and females in their probabilities of survival to age 80 vary from 0.16 to 0.20. Figure 1 also confirms that the difference is wider at older ages, and that the survivorship of males is generally lower than that of females. Consequently, the net single premium will be consistently higher in males compared to females, and that life annuities of males are consistently lower than in females.

Another important point of comparison is that the survival to age 80 is much lower compared to the survival to age 60 for all the three countries. The rate of survival for males to age 60 ranges from 91% to 93.5%, while survival to age 80 ranges from 60% to 65%. Meanwhile the survival rates for females to age 60 is around 96% while survival to age 80 is around 80%. This may imply that mortality rates are high from ages 60 and up. Consequently, whole life insurance coverage costs are more expensive at older ages.

Net Single Premium

After discussing the results of the survivorship of males and females across Hong Kong, Japan, and Korea, the next set of computations focuses on the Actuarial Present Value of a Whole Life Insurance paid at the End of Year of Death, where a person is assumed to live up to age 110. Table 8 summarizes the comparison of the Net Single Premium at the selected ages for males and females across the three countries. Figure 2 also provides a side-by-side comparison of the graph of the Net Single Premium of Males and Females for the three countries.

Table 8: Actuarial Present Value of a Whole Life Insurance Paid at the End of Year of Death of Males and Females at Selected Ages.

Age	Ax					
	Hong Kong		Japan		Korea	
	Male	Female	Male	Female	Male	Female
0	0.014769	0.010482	0.015342	0.010972	0.017666	0.012499
20	0.038758	0.02624	0.039495	0.026926	0.043078	0.029032
40	0.108808	0.076649	0.10777	0.076205	0.118323	0.080925
60	0.275122	0.206226	0.279686	0.204693	0.296262	0.222214
80	0.57195	0.492145	0.590341	0.504547	0.630831	0.561012

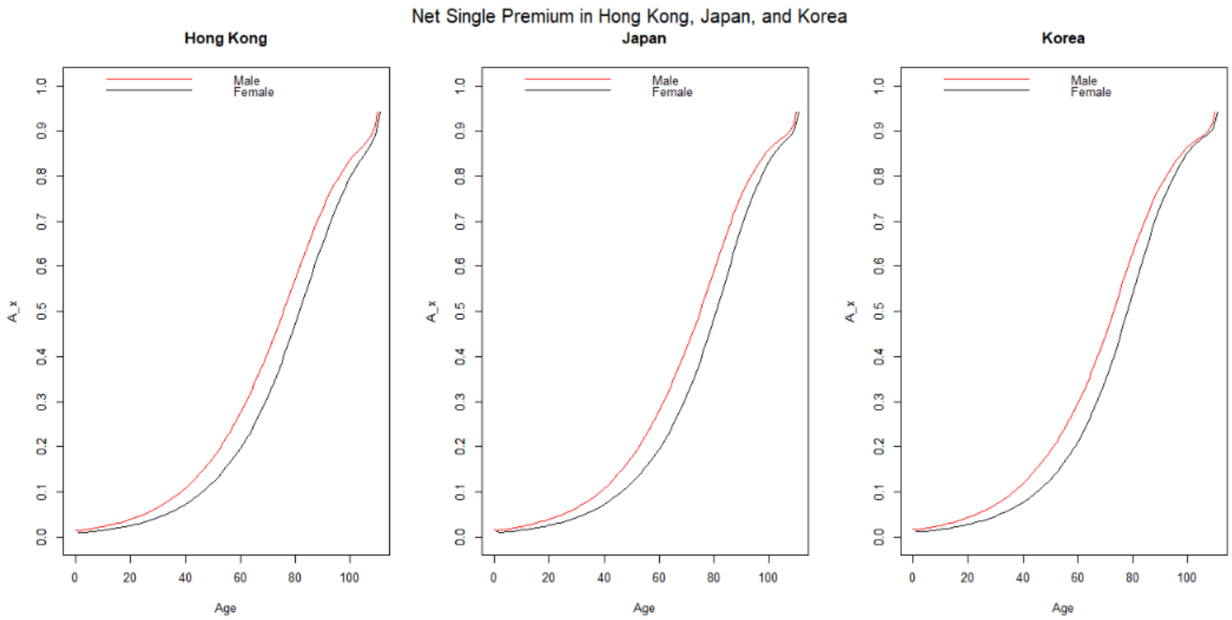

Figure 2: Graphs of Net Single Premium Across the Three Countries

The results show that the net single premium for Males is consistently higher compared to females in all the three countries. This was expected as the survivorship of males is generally lower than that of females, implying that mortality in males is higher than that in females. The differences between males and females is apparent at age 0 according to figure 2. Results from table 8 also found that males have net single premiums that are around 40% than those of females at that age. However, it becomes more noticeable at age 20, with males having around 47-48% higher net single premiums than females. The gap between males and females widens from ages 40 and above with males having around 42%, 30%, and 16% higher net single premiums than females at ages 40, 60 and 80 respectively. Although the percentage may be lower at older ages, the absolute difference between males and females is large, with around 0.07 at age 60 and 0.08 at age 80. Since the net single premium is higher in males than in females, this implies that the cost of the benefits of an insured female is generally higher than that of males. This also affects the benefit premiums, the periodic payments made by the insured individual that funds the benefits, as a higher net single premium results in lower expected values of the life annuities of males, and higher benefit premiums of males.

The graphs in figure 2 also show that the present value of the benefits dramatically increases by age. The results from Table 8 also show that increments of 20 years in age corresponds to at least double in the net single premium for both sexes in Hong Kong, Japan, and Korea. This may be partly due to the fact that mortality rates are usually higher at older ages than in younger ages. These imply that benefit premiums for a whole life insurance are more expensive at older ages, since it is also expected that the life span, and thus life annuities, of individuals at older ages are lower.

Life Annuity

After discussing the results on the net single premium, it is logical to present the results of the life annuities, as the life annuities are also contingent to the survival of the insured person. The next set of results show the present values of the whole life annuity due of males and females. Specifically, table 9 compares the values of the expected present value of the life annuity due at selected ages across the three countries for ages 0, 20, 40, 60 and 80, while figure 3 shows the behavior of the actuarial present value of the life annuity.

Table 9. Expected Value of the Life Annuity Due of Males and Females at Selected Ages

Age	ax					
	Hong Kong		Japan		Korea	
	Male	Female	Male	Female	Male	Female
0	17.40575	17.48148	17.39562	17.47283	17.35458	17.44585
20	16.98195	17.20309	16.96892	17.19097	16.90562	17.15376
40	15.74439	16.31253	15.76272	16.32037	15.5763	16.237
60	12.80619	14.02335	12.72555	14.05043	12.43271	13.74089
80	7.562222	8.972107	7.237307	8.752995	6.521981	7.755453

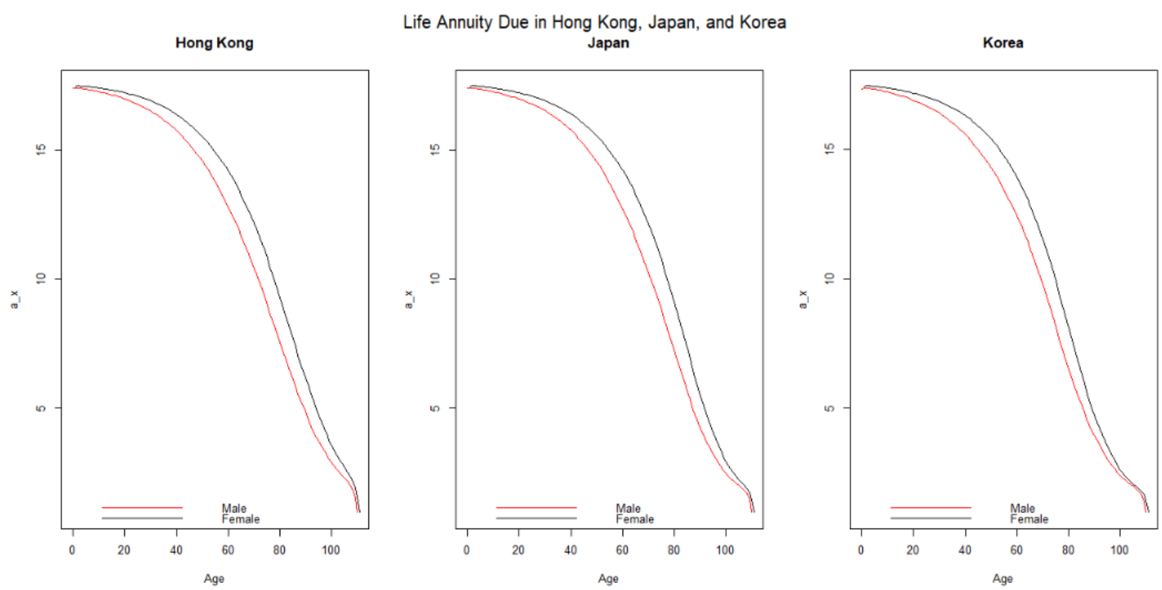

Figure 3. Expected Value of the Life Annuity due Across the Three countries.

The results show that in all the countries of interest, the expected value of the life annuity due of males is consistently lower than that of females. This is not surprising as first, a consistently higher Net Single Premium also implies lower Life annuity, based on the relationship between NSP and life annuity. Second, previous results show that males have lower survivorship to older ages than females. Knowing that the life annuities are contingent to the life span of the insured, it is also expected that the life annuities of males are lower than those of females. The differences between males and females for life annuities is apparent at age 20, as females have expected life annuities that are around 1.30% larger than males at age 20. However the difference becomes more prevalent at older ages.

The results also show that life annuities at older ages are lower than life annuities at younger ages. The values of life annuities at age 60 are around 20% lower than life annuities at age 40, while life annuities at age 80 are around 40-50% lower than life annuities at age 60. This may be due to the low life expectancy at older ages, since life annuities are contingent to the lifetime of the individual.

Benefit Premium

After discussing the results of the net single premium of the life insurance and the expected value of the life annuity due, the researchers now discuss the results for the benefit premium. It is important to note that the benefit premium is directly affected by the previous results, as it is defined to be the ratio of the net single premium to the life annuity due. Table 10 compares the benefit premiums paid by insured males and females at selected ages. Figure 4 also shows a side-by-side comparison of the graphs of the benefit premiums paid by males and females in the three countries.

Table 10. Benefit Premiums Paid by Males and Females at Selected Ages.

Age	Px					
	Hong Kong		Japan		Korea	
	Male	Female	Male	Female	Male	Female
0	0.000849	0.0006	0.000882	0.000628	0.001018	0.000716
20	0.002282	0.001525	0.002327	0.001566	0.002548	0.001692
40	0.006911	0.004699	0.006837	0.004669	0.007596	0.004984
60	0.021483	0.014706	0.021978	0.014568	0.023829	0.016172
80	0.075632	0.054853	0.081569	0.057643	0.096724	0.072338

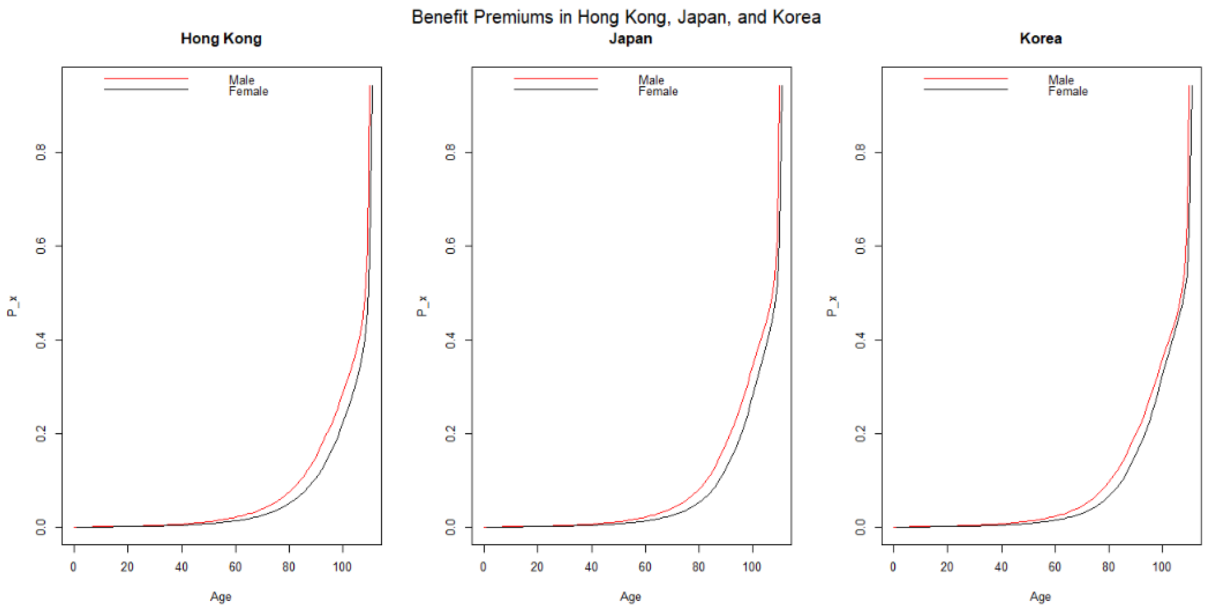

Figure 4: Benefit Premiums in the Three Countries.

In all the three countries, the benefit premiums of the males are consistently higher than that of females. At age 0, the benefit premiums of males are around 40% larger than that of females. At age 20, males pay 50% larger premiums than that of females. At ages 40 and 60, males pay around 45% larger premiums than those of females. Lastly, insured males aged 80 pay 40% higher premiums than females. The graphs also show that males have considerably higher premiums than those of females. This result is a consequence of males having higher net single premiums and lower expected values of the life annuity dues. These results are somewhat consistent with a report of Mineau (2021), where Males in Canada and Ontario pay 25% higher in insurance than females. The difference of the percentage found in the study to that of Mineau (2021) may be explained as benefit premiums only account for the funding of the benefit received by the insured individual. In other words, the computations done do not account for any other expenses such as administrative expenses, maintenance, profit margins, and among other possible expenses related to the insurance product (Bowers et. al., 1997).

Benefit premiums are also increasing as the age increases. From table 10, the benefit premiums for age 20 is around 2.5 times that for newborns. Starting from age 20 up to age 80, increments of 20 are associated with a multiplicative increase of at least 3 to the benefit premiums. For example, A Hong Kong Male aged 80 has a benefit premium of 0.07632, which is 3.5206 times that of a benefit premium for a Hong Kong Male aged 60. This is also a result of the elderly population having lower life spans, thus higher net single premiums and lower life annuities.

Discussion

These results of the comparisons for males and females stem from the fact that males have lower life spans than females in general. There are several factors that make the average life span of males lower than females. First, males in general take higher risk careers and jobs. De Vore (2018) and White (2021) reported that fatality in the workplace is ten times higher for males than females. They also explained that the nature of the usual work taken by males, such as logging and construction, tend to be of higher risks than work taken by females. These lines of work also tend to have lower income than numerous low risk jobs such as office or corporate jobs (White, 2021). This poses a great risk of financial loss to males as they tend to pay more for insurance coverages than females, discouraging them to avail of life insurance coverages. This is also compounded by the fact that the usual line of work of males is high risk, which is compensated by meager salaries.

Second, studies show that in general males have riskier lifestyles than females. The World Health Organization (2018) and the Centre for Health Protection (2022) reported that in Hong Kong, Japan, and Korea, the proportion of males that smoke is significantly higher than the proportion of females that smoke. In 2015, 18.6% of all males and 3.2% of all females in Hong Kong are daily smokers. In Japan on the other hand, 33.7% of all males and 9.3% of all females are daily smokers. Lastly, in Korea 15% of all males and 3.2% of all females are daily smokers (Centre for Health Protection, 2018). The same organizations have also found that more males drink alcoholic beverages than females. In 2018, 59.1% of all Japanese males and 31.2% of all Japanese females drank alcoholic beverages. In Hong Kong, 18.6% of males and 3.2% of Females drink alcoholic beverages. Lastly, in Korea, 64% of all males and 31.2% of all females drink alcohol (Centre of Health Protection, 2018). The Centers for Disease Control and Prevention (2020) and Stahre et al. (2014) reported that in the United States, smokers are found to have a mortality rate three times higher than those who never smoked, and that the leading cause of premature mortality is due to excessive alcohol consumption. As males are statistically reported to be inclined in doing these vices more than females, shorter lifespan is to be expected due to these health-compromising behaviors.

Third, mental health issues also come into play in terms of the high mortality rates of males. Identifying these issues should be of utmost importance, as it associates with suicide rates. The Organisation for Economic Co-operation and Development (2019) and the Hong Kong Jockey Club Centre for Suicide Reseach and Prevention (2022) reported that suicide rates in Hong Kong, Japan, and Korea are higher in males than in females. In Japan, the suicide rates for males and females are 24.2 and 9.3 out of 100,000 persons respectively. Meanwhile, in Hong Kong the suicide rates for males and females are 17.5 and 12.7 out of 100,000 persons respectively. Lastly, In Korea the suicide rates of males and females are 39.5 and 14.7 out of 100,000 persons respectively.

The results also show that the costs of insurance costs are generally higher for the elderly. Buettgens, Garrett, and Holahan (2010) explains that this may be due to the vulnerability of the elder population to diseases, along with expensive and increasing medical costs. Based on the results, uninsured people ages 60 and above are highly likely to stay uninsured considering the costs of a whole life insurance at ages 60 and above, and the ability to generate income to fund the benefits.

The results of the study also shows the benefits of availing a whole life insurance coverage early on. At younger ages, benefit premiums for a whole life insurance are much lower compared to older ages, implying that it is easier to afford larger benefits at the moment or at the end of year of death when starting a life insurance plan earlier in life. Thus, it is advisable to start a whole life insurance plan as soon as possible to maximize the possible benefits for an affordable price.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The researchers investigated and compared the survivorship of males and females across three countries: Hong Kong, Japan, and South Korea. Findings show that in all the three countries, males have lower survivorship than females. This result also affected the results of the net single premium and the expected value of the life annuity, as lower life spans increase the value of the net single premium and lower the expected value of the life annuity. In turn, the computation for the benefit premiums found that males could pay up to 40-50% higher benefit premiums, depending on their age.

Recommendations

The discussions transpired in this study recommends that one should have a life insurance plan as early as possible. The results found that it is more affordable to fund a larger financial benefit when one starts a life insurance plan earlier in life than later due to lower benefit premiums for individuals at a young age.

Second, the discussions also found that males have riskier lifestyles and careers, making them more vulnerable. Thus, it is recommended that males should exercise caution in their daily activities. Males should also exhibit moderation in harmful vices such as smoking and drinking alcohol to reduce the risk of dying at an earlier age.

Future studies can focus on different actuarial functions at selected cohorts based on socio-economic status, since the study focused on the general population of the three countries. In this manner, the disparity between socio-economic classes in terms of life insurances may be shown, in turn making steps for more affordable insurances available to the general public. It is also recommended for future researchers to compare the values of the actuarial functions before and during the COVID-19 pandemic since most of the life tables used in this study are from pre-pandemic periods.

APPENDIX A: R Codes for the Computation of Actuarial Functions

```{r}
library(readxl)
library(writexl)
library(lifecontingencies)
library(ggplot2)
setwd("C:/Users/albert go/Desktop/Schoolworks/LIFECO1")
```

Hong Kong Males

```{r}
hkm <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="HK-M")
hkm_act <- new("actuarialtable", x=hkm$Age, lx=hkm$lx, interest=0.06)
hkm_act_df <- as(hkm_act,"data.frame")
head(hkm_act_df)

Ax_table <- data.frame()

for(j in hkm_act_df$x){
  Ax <- Axn(hkm_act,x = j)
  ax <- axn(hkm_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
}

View(Ax_table)
hkm_output <- cbind(hkm,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"HK Males Output Table.xlsx")
```

Hong Kong Females

```{r}
hkf <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="HK-F")
hkf_act <- new("actuarialtable", x=hkf$Age, lx=hkf$lx, interest=0.06)
```

````
hkf_act_df <- as(hkf_act,"data.frame")
head(hkf_act_df)

Ax_table <- data.frame()

for(j in hkf_act_df$x){
  Ax <- Axn(hkf_act,x = j)
  ax <- axn(hkf_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
}

View(Ax_table)
hkm_output <- cbind(hkf,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"HK Females Output Table.xlsx")
```
````

Japan Males

````
```{r}
hkf <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="JP-M")
hkf_act <- new("actuarialtable", x=hkf$Age, lx=hkf$lx, interest=0.06)
hkf_act_df <- as(hkf_act,"data.frame")
head(hkf_act_df)

Ax_table <- data.frame()

for(j in hkf_act_df$x){
  Ax <- Axn(hkf_act,x = j)
  ax <- axn(hkf_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
````

```
}

View(Ax_table)
hkm_output <- cbind(hkf,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"JP Males Output Table.xlsx")
```

Japan Females

```{r}
hkf <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="JP-F")
hkf_act <- new("actuarialtable", x=hkf$Age, lx=hkf$lx, interest=0.06)
hkf_act_df <- as(hkf_act,"data.frame")
head(hkf_act_df)

Ax_table <- data.frame()

for(j in hkf_act_df$x){
  Ax <- Axn(hkf_act,x = j)
  ax <- axn(hkf_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
}

View(Ax_table)
hkm_output <- cbind(hkf,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"JP Females Output Table.xlsx")
```

Korea Males

```{r}
hkf <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="KR-M")
hkf_act <- new("actuarialtable", x=hkf$Age, lx=hkf$lx, interest=0.06)
hkf_act_df <- as(hkf_act,"data.frame")
head(hkf_act_df)
```

````
Ax_table <- data.frame()

for(j in hkf_act_df$x){
  Ax <- Axn(hkf_act,x = j)
  ax <- axn(hkf_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
}

View(Ax_table)
hkm_output <- cbind(hkf,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"KR Males Output Table.xlsx")
```

Korea Females
```{r}
hkf <- read_excel("hj_jp_kr_lifetables.xlsx", sheet="KR-F")
hkf_act <- new("actuarialtable", x=hkf$Age, lx=hkf$lx, interest=0.06)
hkf_act_df <- as(hkf_act,"data.frame")
head(hkf_act_df)

Ax_table <- data.frame()

for(j in hkf_act_df$x){
  Ax <- Axn(hkf_act,x = j)
  ax <- axn(hkf_act, x=j)
  Px <- Ax/ax
  Ax_table_1 <- data.frame(Ax)
  ax_table_1 <- data.frame(ax)
  Px_table_1 <- data.frame(Px)
  output.df <- cbind(Ax_table_1,ax_table_1,Px_table_1)
  Ax_table <- rbind(Ax_table, output.df)
}
````

View(Ax_table)
hkm_output <- cbind(hkf,Ax_table)
View(hkm_output)
write_xlsx(hkm_output,"KR Females Output Table.xlsx")
```

variable assignment

```{r}
hongkongmale <- read_excel("HK Males Output Table.xlsx")
hongkongfemale <- read_excel("HK Females Output Table.xlsx")
japanmale <- read_excel("JP Males Output Table.xlsx")
japanfemale <- read_excel("JP Females Output Table.xlsx")
koreamale <- read_excel("KR Males Output Table.xlsx")
koreafemale <- read_excel("KR Females Output Table.xlsx")
```

Hong Kong Comparison of Males and Females

```{r}
par(mfrow=c(2,2))
#Survivorship
plot(hongkongmale$Age, hongkongmale$lx/100000, type = "l", col="red", main = "Survivorship of Males and Females in Hong Kong", xlab = "Age", ylab="px")
lines(hongkongfemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Net Single Premium
plot(hongkongmale$Age, hongkongmale$Ax, type = "l", col="red", main = "A_x of Males and Females in Hong Kong", xlab = "Age", ylab="A_x", ylim=c(0,1))
lines(hongkongfemale$Ax, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Life Annuity due
plot(hongkongmale$Age, hongkongmale$ax, type = "l", col="red", main = "a_x of Males and Females in Hong Kong", xlab = "Age", ylab="a_x")
lines(hongkongfemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))

#Benefit Premium
plot(hongkongmale$Age, hongkongmale$Px, type = "l", col="red", main = "P_x of Males and Females in Hong Kong", xlab = "Age", ylab="P_x")
lines(hongkongfemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
```

Japan Comparison of Males and Females
```{r}
#Survivorship
plot(japanmale$Age, japanmale$lx/100000, type = "l", col="red", main = "Survivorship of Males and Females in Japan", xlab = "Age", ylab="s(x)")
lines(japanfemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Net Single Premium
plot(japanmale$Age, japanmale$Ax, type = "l", col="red", main = "A_x of Males and Females in Japan", xlab = "Age", ylab="A_x", ylim=c(0,1))
lines(japanfemale$Ax, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Life Annuity due
plot(japanmale$Age, japanmale$ax, type = "l", col="red", main = "a_x of Males and Females in Japan", xlab = "Age", ylab="a_x")
lines(japanfemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))

#Benefit Premium
#Life Annuity due
plot(japanmale$Age, japanmale$Px, type = "l", col="red", main = "P_x of Males and Females in Japan", xlab = "Age", ylab="P_x")
lines(japanfemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
```

Korea Comparison of Males and Females
```{r}

````
#Survivorship
plot(koreamale$Age, koreamale$lx/100000, type = "l", col="red", main = "Survivorship of Males and Females in Korea", xlab = "Age", ylab="s(x)")
lines(koreafemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Net Single Premium
plot(koreamale$Age, koreamale$Ax, type = "l", col="red", main = "A_x of Males and Females in Korea", xlab = "Age", ylab="A_x", ylim=c(0,1))
lines(koreafemale$Ax, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Life Annuity due
plot(koreamale$Age, koreamale$ax, type = "l", col="red", main = "a_x of Males and Females in Korea", xlab = "Age", ylab="a_x")
lines(koreafemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))

#Benefit Premium
#Life Annuity due
plot(koreamale$Age, koreamale$Px, type = "l", col="red", main = "P_x of Males and Females in Korea", xlab = "Age", ylab="P_x")
lines(koreafemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1))
```
Males in the three countries
```{r}
#Survivorship
plot(hongkongmale$Age, hongkongmale$lx/100000, type = "l", col="red", main = "Survivorship of Males Across Hong Kong, Japan, and Korea", xlab = "Age", ylab="s(x)")
lines(japanmale$lx/100000, col="black")
lines(koreamale$lx/100000, col="blue")
legend("bottomleft", legend = c("Hong Kong", "Japan", "Korea"), col = c("red","black","blue"), lty =c(1,1,1))
axis(side=2, at = seq(0,1, by = 0.10))

#Net Single Premium
````

```
plot(hongkongmale$Age, hongkongmale$Ax, type = "l", col="red", main = "A_x of Males
Across Hong Kong, Japan, and Korea", xlab = "Age", ylab="A_x")
lines(japanmale$Ax, col="black")
lines(koreamale$Ax, col="blue")
legend("topleft", legend = c("Hong Kong", "Japan", "Korea"), col = c("red","black","blue"), lty
=c(1,1,1))

#Life Annuity Due
plot(hongkongmale$Age, hongkongmale$ax, type = "l", col="red", main = "a_x of Males Across
Hong Kong, Japan, and Korea", xlab = "Age", ylab="a_x")
lines(japanmale$ax, col="black")
lines(koreamale$ax, col="blue")
legend("bottomleft", legend = c("Hong Kong", "Japan", "Korea"), col = c("red","black","blue"),
lty =c(1,1,1))

#Benefit Premiums
plot(hongkongmale$Age, hongkongmale$Px, type = "l", col="red", main = "P_x of Males
Across Hong Kong, Japan, and Korea", xlab = "Age", ylab="P_x")
lines(japanmale$Px, col="black")
lines(koreamale$Px, col="blue")
legend("topleft", legend = c("Hong Kong", "Japan", "Korea"), col = c("red","black","blue"), lty
=c(1,1,1))
```

APPENDIX B: R Codes for the Data Visualization Stage

```
#Plotting Survivorship
par(mfrow=c(1,3))
#HongKong
plot(hongkongmale$Age, hongkongmale$lx/100000, type = "l", col="red", main = "Hong
Kong", xlab = "Age", ylab="s(x)")
lines(hongkongfemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")
axis(side=2, at = seq(0,1, by = 0.10))

#Japan
plot(japanmale$Age, japanmale$lx/100000, type = "l", col="red", main = "Japan", xlab = "Age",
ylab="s(x)")
lines(japanfemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")
axis(side=2, at = seq(0,1, by = 0.10))

#South Korea
plot(koreamale$Age, koreamale$lx/100000, type = "l", col="red", main = "Korea", xlab =
"Age", ylab="s(x)")
lines(koreafemale$lx/100000, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")
axis(side=2, at = seq(0,1, by = 0.10))

mtext("Survivorship in Hong Kong, Japan, and Korea",side = 3, line = -1.25, outer = TRUE)


#Plotting NSP
par(mfrow=c(1,3))
#HongKong
plot(hongkongmale$Age, hongkongmale$Ax, type = "l", col="red", main = "Hong Kong", xlab
= "Age", ylab="A_x", ylim=c(0,1))
lines(hongkongfemale$Ax, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty = "n")
axis(side=2, at = seq(0,1, by = 0.10))

#Japan
plot(japanmale$Age, japanmale$Ax, type = "l", col="red", main = "Japan", xlab = "Age",
ylab="A_x", ylim=c(0,1))
lines(japanfemale$Ax, col="black")
```

```
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty = "n")
axis(side=2, at = seq(0,1, by = 0.10))

#South Korea
plot(koreamale$Age, koreamale$Ax, type = "l", col="red", main = "Korea", xlab = "Age",
ylab="A_x", ylim=c(0,1))
lines(koreafemale$Ax, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty = "n")
axis(side=2, at = seq(0,1, by = 0.10))

mtext("Net Single Premium in Hong Kong, Japan, and Korea",side = 3, line = -1.25, outer =
TRUE)

#Plotting Life Annuity
par(mfrow=c(1,3))
#HongKong
plot(hongkongmale$Age, hongkongmale$ax, type = "l", col="red", main = "Hong Kong", xlab =
"Age", ylab="a_x")
lines(hongkongfemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")

#Japan
plot(japanmale$Age, japanmale$ax, type = "l", col="red", main = "Japan", xlab = "Age",
ylab="a_x")
lines(japanfemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")

#South Korea
plot(koreamale$Age, koreamale$ax, type = "l", col="red", main = "Korea", xlab = "Age",
ylab="a_x")
lines(koreafemale$ax, col="black")
legend("bottomleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")

mtext("Life Annuity Due in Hong Kong, Japan, and Korea",side = 3, line = -1.25, outer =
TRUE)

#Plotting Benefit Premiums
par(mfrow=c(1,3))
#Hong Kong
```

```
plot(hongkongmale$Age, hongkongmale$Px, type = "l", col="red", main = "Hong Kong", xlab =
"Age", ylab="P_x")
lines(hongkongfemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")

#Japan
plot(japanmale$Age, japanmale$Px, type = "l", col="red", main = "Japan", xlab = "Age",
ylab="P_x")
lines(japanfemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")

#South Korea
plot(koreamale$Age, koreamale$Px, type = "l", col="red", main = "Korea", xlab = "Age",
ylab="P_x")
lines(koreafemale$Px, col="black")
legend("topleft", legend = c("Male", "Female"), col = c("red","black"), lty =c(1,1), bty="n")
mtext("Benefit Premiums in Hong Kong, Japan, and Korea",side = 3, line = -1.25, outer =
TRUE)
```

References

Actuarial Society of Hong Kong. (2020). About the ASHK. Retrieved from: https://www.actuaries.org.hk/pages/1/About%20the%20ASHKhttps://www.actuaries.org.hk/pages/1/About%20the%20ASHK

Bowers, N.L., Gerber, H.U., Hickman, J. C., Jones, D.A., & Nesbitt, C.J. (1997). *Actuarial Mathematics.* The Society of Actuaries.

Buettgens, M., Garrett, B., Holahan, J. *The Effects of Premium Increases on Individuals, Families, and Small Businesses.* Retrieved from https://www.urban.org/sites/default/files/publication/28576/412079-The-Effects-of-Large-Premium-Increases-on-Individuals-Families-and-Small-Businesses.PDF on June 27, 2022.

Centers for Disease Control and Prevention (2020). Tobacco-Related Mortality. https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality/index.htm

Central Intelligence Agency World Factbook. (2020). Country Comparison: Death Rate. *Internet Archive Wayback Machine.* Retrieved from: https://web.archive.org/web/20201011041553/https://www.cia.gov/library/publications/the-world-factbook/fields/346rank.html

Centre for Health Protection (2022). Non-Communicable Diseases and Healthy Living. https://www.chp.gov.hk/en/healthtopics/25/index.html

De Vore, C. (2018). *Fatal Employment: Men 10 Times More Likely Than Women to be Killed at Work.* Retrieved from https://www.forbes.com/sites/chuckdevore/2018/12/19/fatal-employment-men-10-times-more-likely-than-women-to-be-killed-at-work/?sh=7f542d8f52e8 on June 27, 2022.

Ernst & Young Global Limited. (2019). 2020 Japan Insurance Outlook. Retrieved from: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/insurance/insurance-outlook-pdfs/ey-global-insurance-outlook-japan.pdf

Ernst & Young Global Limited. (2019). 2020 South Korea Insurance Outlook.

Retrieved from:
https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/insurance/insurance-outlook-pdfs/ey-global-insurance-outlook-south-korea.pdf

HealthyHK. (2021). Leading Cause of all Deaths.
Retrieved from: https://www.healthyhk.gov.hk/phisweb/en/chart_detail/22/

Hong Kong Jockey Club Centre for Suicide Research and Prevention. (2022). Suicide Rate.
https://www.csrp.hku.hk/statistics/

Institute for Health Metrics and Evaluation. (2022). Japan - What causes the most deaths?
Retrieved from: https://www.healthdata.org/japan

Institute for Health Metrics and Evaluation. (2022). Republic of Korea - What causes the most deaths?
Retrieved from: https://www.healthdata.org/south-korea

Max Planck Institute for Demographic Research (2022). Human Mortality Database. Retrieved from https://mortality.org/Country/Country?cntr=HKG on May 15, 2022.

Organisation for Economic Co-operation and Development (2019). Society at a Glance. *OECDiLibrary.*
https://www.oecd-ilibrary.org/sites/0ef32604-en/index.html?itemId=/content/component/0ef32604-en#fig7.10

Organisation for Economic Co-operation and Development (2022). Global Insurance Market Trends. Retrieved from
https://www.oecd.org/daf/fin/insurance/globalinsurancemarkettrends.htm on June 27, 2022.

T&D Holdings. (2018). T&D Holdings Annual Report.
Retrieved from: https://www.td-holdings.co.jp/en/ir/document/pdf/ar2018e_s4.pdf

Slotta, D. (2022). Number of in-force individual life insurance policies in Hong Kong 2015-2020. *Statista*.
Retrieved from:
https://www.statista.com/statistics/1228307/hong-kong-number-of-life-insurance-policies/#statisticContainer

Stahre, M., Roeber, J., Kanny, D., Brewer, R., Zhang, X. (2014). Contribution of Excessive Alcohol Consumption to Deaths and Years of Potential Life Lost in the United States. https://www.cdc.gov/pcd/issues/2014/13_0293.htm

The Institute of Actuaries of Japan. (2022). Home Page. Retrieved from: https://www.actuaries.jp/english/

The Institute of Actuaries of Korea. (2022). Purpose and History.Page. Retrieved from: https://www.actuary.or.kr/about/history.asp

United Nations - Department of Economic and Social Affairs: Population Dynamics. (2019). World Population Prospects. https://population.un.org/wpp/DataQuery/

White, L.T. (2021). Why do Men Have the Most Dangerous Jobs? *Psychology Today.* Retrieeved from https://www.psychologytoday.com/us/blog/culture-conscious/202104/why-do-men-have-the-most-dangerous-jobs on June 26, 2022.

World Health Organization. (2018). Global status report on alcohol and health 2018. World Health Organization. https://apps.who.int/iris/handle/10665/274603.

World Health Organization. (2021). WHO global report on trends in prevalence of tobacco use 2000–2025, 4th ed. World Health Organization. https://apps.who.int/iris/handle/10665/348537