A Study of Incidence Experience for Taiwan Life Insurance

Jack C. Yue[1] and Hong-Chih Huang[2]

ABSTRACT

Mortality improvement has become a major issue in ratemaking for the insurance companies, and it is especially difficult in Taiwan. Two reasons contribute to the difficulty: one is the population size and the other is the rapid improvement. Since the history of life insurance in Taiwan is relatively short, traditionally all life insurance products are based on a same experience life table and construction of the table relies partly on the whole population in Taiwan. In this study, we will use the experience data from Taiwan life insurance companies to explore if there are factors affecting the mortality rates. Further, the experience data will be used to evaluate whether they possess similar mortality patterns as the whole population in Taiwan.

Keywords: Mortality Improvement, Experience Rate, Risk Factor, Life Table

1. INTRODUCTION

Mortality improvement has been a popular topic in insurance business and the life expectancy of human being is likely to prolong in the near future. The life expectancy of people in Taiwan has increased significantly since the end of World War II, and becomes even more noticeable after the National Health Insurance (NHI) was

[1] Professor, Department of Statistics, National Chengchi University, Taipei, Taiwan, R.O.C. 11605
[2] Professor, Department of Risk Management and Insurance, National Chengchi University, Taipei, Taiwan, R.O.C. 11605

enforced in 1995. For example, the life expectancies of Taiwan male and female were 72 and 78 years in 1998, smaller than the numbers 73 and 79 for the U.S. male and female in 1998. But now the life expectancies in Taiwan have surpassed those in the U.S., according to the Ministry of Interior, Taiwan government[3]. The trends of life expectancies, shown in Figure 1, provide a better look of the rapid prolonging life in Taiwan, comparing to in the U.S.

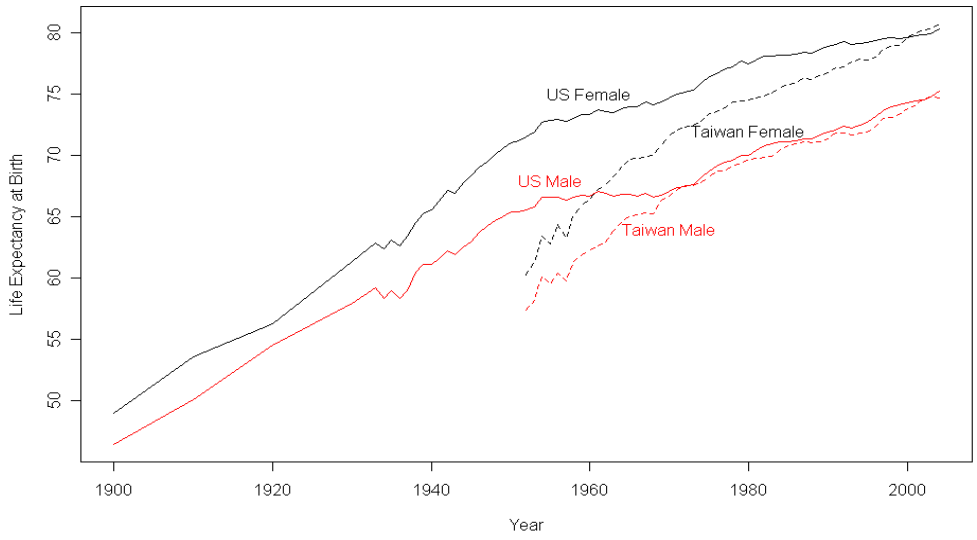

Figure 1. The life Expectancies of Taiwan and U.S.

Still, even though on average every Taiwan people owns at least two life insurance policies in effect since 2008, about 1/3 populations in Taiwan never purchase any life insurance products[4]. It is still unknown whether the population of purchasing insurance products would have similar mortality profiles as those do not purchase. Because often there are not enough data of incidence experience, sometimes the pricing of life insurance products inevitably relies on the mortality

[3] http://www.moi.gov.tw/stat/

[4] It is defined as "Ratio of having Insurance Coverage" in annual report of Taiwan Insurance Institute. http://www.iiroc.org.tw/report_test/1010/PDF1010_2009.pdf (data retrieved on August 13, 2010) The proportion of people never purchased life insurance products is 33.44%at the end of 2008.

rates of population life tables. Thus, we want to explore if the mortality rates of population with insurance policy differ significantly from those without insurance policy.

Also, the life insurance products are Taiwan can be classified into three groups: Term life, Endowment, and Whole life. Endowment products are the most dominant policy and this is probably the most distinct attribute in Taiwan, comparing to other countries (Table 1). The term life products, surprising, only account for about 4% of policies. The mortality risks of these types of insurance products are likely to be different, due to the factors, such as the coverage term, return of principal, and benefit amounts. However, the pricing of these products are all based on a single experience life table[5]. This would possible mix up groups with different risk.

Table 1. Taiwan Insurance Policy (1972~2008)

Type	No. of Policy	%
Term Life	4,268,921	8.4%
Endowment	24,132,752	47.3%
Whole Life	22,610,097	44.3%

In this study, we will use the experience data from Taiwan insurance companies, to explore the characteristics of mortality profiles of life insurance. We shall first introduce the Taiwan experience data in the next section. The empirical study will be separated into two parts: one is to check if the mortality related risk factors, and the other is to compare the mortality rates from population table and experience table. They are covered in Section 3 and 4, respectively. The discussion and related issues of this study is given in Section 5.

[5] The experience life tables used in Taiwan are known as Taiwan Standard Ordinary Experience Mortality Table (TSO). The life insurance industry currently is using the 4th TSO or 2002 TSO.

2. DATA DISCRIPTION

In this paper, we will study the incidence data from Taiwan Life insurance companies, for the years 1972~2008 (27 years of data). However, we shall only use the new policies issued in 1972~2008, and omit those policies issued before 1972 but still valid after 1972. The data were collected via Taiwan Insurance Institute (TII) and cover all life insurance companies in Taiwan[6]. There are three types of insurance policies included in the study: Term life, Endowment, and Whole life.

In the experience data, there are seven other possible candidates which can be related to mortality rates, in addition to the policy type. They are age, gender, health exam, principal repayment, benefit amount, and insurance company size. We will focus on exploring if the mortality rates are correlated to these factors. Among these factors, the option of returning principal is another major attribute in many Taiwan life insurance products. The nature of returning principal will make the insurance products have the function of investment or saving. A term life policy would behave like an endowment policy if the percentage of principal repayment is high.

The experience data were from 28 insurance companies, and we separate these companies into three groups (small, middle, & large) according to the number of policies. In order to be evenly distributed, there are 9 companies in the small group, 10 in the middle group, and 9 in the large group. Briefly speaking, companies in small group have policies no more than 100,000 and companies in large group have policies no less than 400,000. The total number of policies in the small company group is 485,105, in the middle company group is 1,936050, and in the large company is 24,555,354. Since the proportion of small company group is less than 2%, we shall focus on comparing the middle size and large size companies.

[6] The experience data were retained by the Insurance Agency Association of the Republic of China (CIAA) before 2007, and TII has been in charge of the data since 2007. TII now maintains all the experience data since year 1972.

Table 2. Summary of Taiwan Female Data (# of policy)

Risk Factor		Company Size		
		Small	Middle	Large
Health Exam	No	440,407	2,504,019	20,263,883
	Yes	27,955	177,872	2,015,745
Principal Repayment	No	176,093	1,194,873	5,804,234
	Yes	292,269	1,487,018	16,475,394
Benefit Amount	< 0.5M	192,682	1,217,410	13,596,801
	0.5~1.0M	108,728	588,675	5,021,068
	> 1.0M	166,952	875,806	3,661,759

Note: Benefit amount 1.0M is one million New Taiwan Dollars ≈ $33,000 US

Table 3. Summary of Taiwan Male Data (# of policy)

Risk Factor		Company Size		
		Small	Middle	Large
Health Exam	No	443,312	2,415,117	20,312,461
	Yes	26,578	200,704	2,184,334
Principal Repayment	No	182,588	1,173,166	6,153,976
	Yes	287,302	1,442,655	16,342,819
Benefit Amount	< 0.5M	178,209	1,117,410	12,844,392
	0.5~1.0M	114,953	585,970	5,421,639
	> 1.0M	176,728	912,441	4,230,764

Note: Benefit amount 1.0M is one million New Taiwan Dollars ≈ $33,000 US

Tables 2 and 3 are the summary table for the experience data, according to the company size. It seems that different sizes of companies have their own marketing strategy. For example, the small companies have fewer policies with small benefit amount and the large companies have fewer policies with principal repayment. Overall, most of the policies have very small benefit and also most of policies do not require health exam. Interestingly, more than 70% of policies are with principal repayment. If we exclude the endowment products (47.3% from Table 1),

approximately half of the term life and whole life products are with principal repayment. This is a very high percentage for principal repayment.

We shall continue to explore the experience data in the next two sections. We first check whether there are mortality related factors in the next section, following by comparing the mortality rates of population table to those of experience table.

3. EMPIRICAL ANALYSIS

Because the Taiwan population is around 23 millions, the observed mortality rates for single age would have large fluctuations between two consecutive years. To reduce variations, the experience data are partitioned into 5-year and 5-age groups. Also, the youngest age group is 0~14 (ages 0 to 14) and the highest age group is 80+ (ages 80 and over), in order to accumulate sufficient claim data. We found that there are four factors which are related to the mortality rates: Repayment of Principal, Company Size, Health Exam, and Benefit Amount. We shall summarize the major findings according to this order.

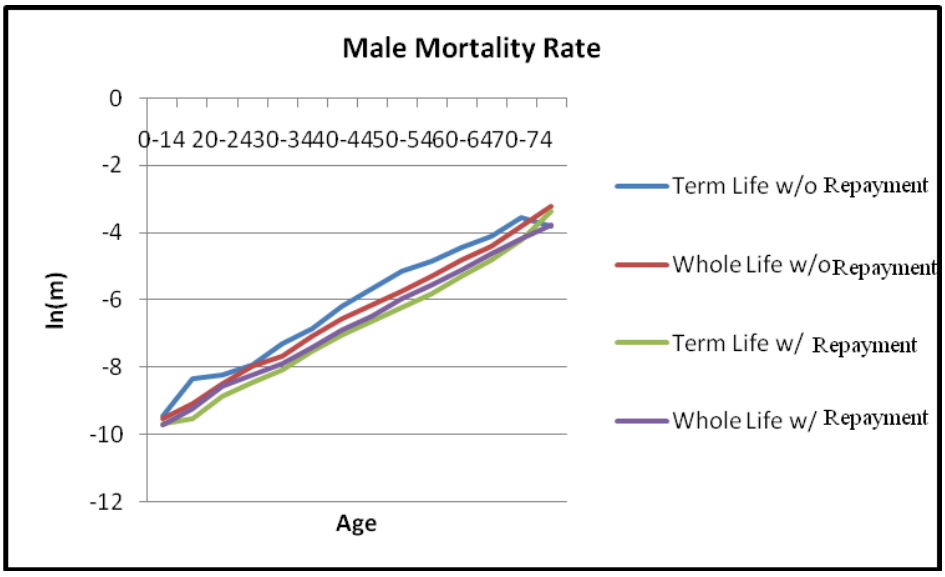

Figure 2. The Mortality Comparison for Principal Repayment (Taiwan Male)

The mortality rates of term life, endowment, and whole life policies are very similar, but there are obvious differences if these policies are separated into with principal repayment and without principal repayment. We only use the term life and whole life policies to explore the effect of principal repayment, since by definition the endowment policy can not have the option without principal repayment. Because the nature of principal repayment is similar to annuity and/or endowment, i.e., payment upon survival, it is not surprise to see the mortality rates are smaller for policies with principal repayment. We shall use the male mortality as a demonstration, as shown in Figure 2. The male mortality rates of the term life with principal repayment are the lowest among all groups, and those of the term life without principal repayment are the highest. The differences are less obvious for the whole life and the mortality rates with principal repayment are still lower.

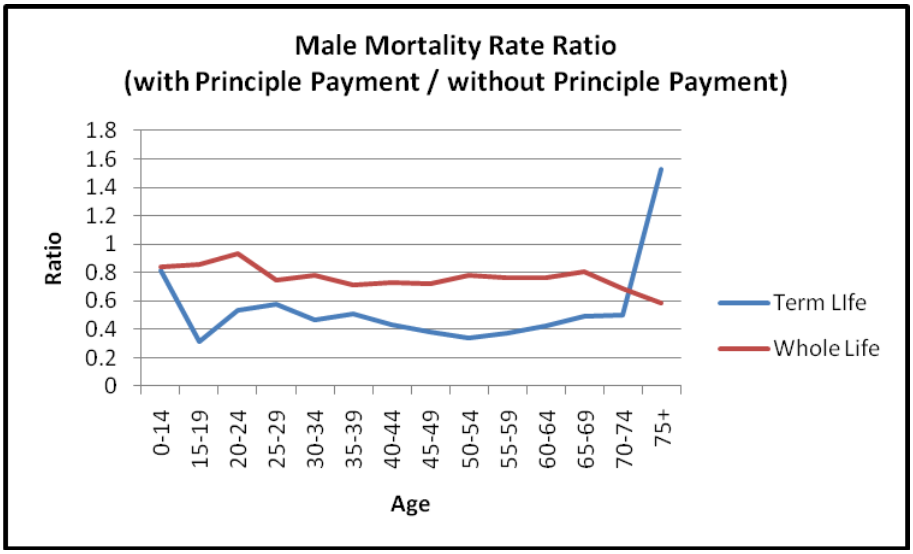

Figure 3. The Mortality Ratio for Principal Repayment (Taiwan Male)

Further comparison can be made using the format of mortality ratio (Figure 3). On average, the differences in the male mortality between with and without Principal

Repayment are about 50% for the term life and 20% for the whole life. This is a very big difference in pure premium, especially for the term life, even after considering the interest rate. The difference in the pure premium for the term life is around 50%, comparing the option of with and without principal repayment. The pure premium difference for the whole life is sensitive to the interest rate and it is a decreasing function of the interest rate.

Table 4. Summary of Company Size

Gender	Company Size	Term Life	Endowment	Whole Life
Male	Large size Company	1,584,231	11,352,337	9,560,227
	Middle size Company	239,357	654,538	1,721,926
Female	Large size Company	2,165,901	10,952,936	9,160,791
	Middle size Company	223,935	712,346	1,745,610

For the factor of company size, we first look at the summary statistics (Table 4). Because the small company group only accounts for less than 2% of policies, we focus on comparing the middle size and large size companies. No matter for the male or female, the middle size companies target on the whole size policies (about 65.6%) while about 50% of policies for the large size company are the endowment products. On the other hand, the middle size companies have less than 1% of term life policies and the large size companies have about 9% of term life.

The overall mortality comparisons for the company size are in Figure 4. The mortality rates of middle size companies are generally smaller in all age groups, and are more obvious for the male. One possible interpretation is that the middle size companies are less tolerant in loss and thus are more risk-sensitive. Besides, the average cost of issuing a new policy is likely to be higher for the middle sizes

companies. The lower mortality rates would provide a better survival opportunity for the middle size companies.

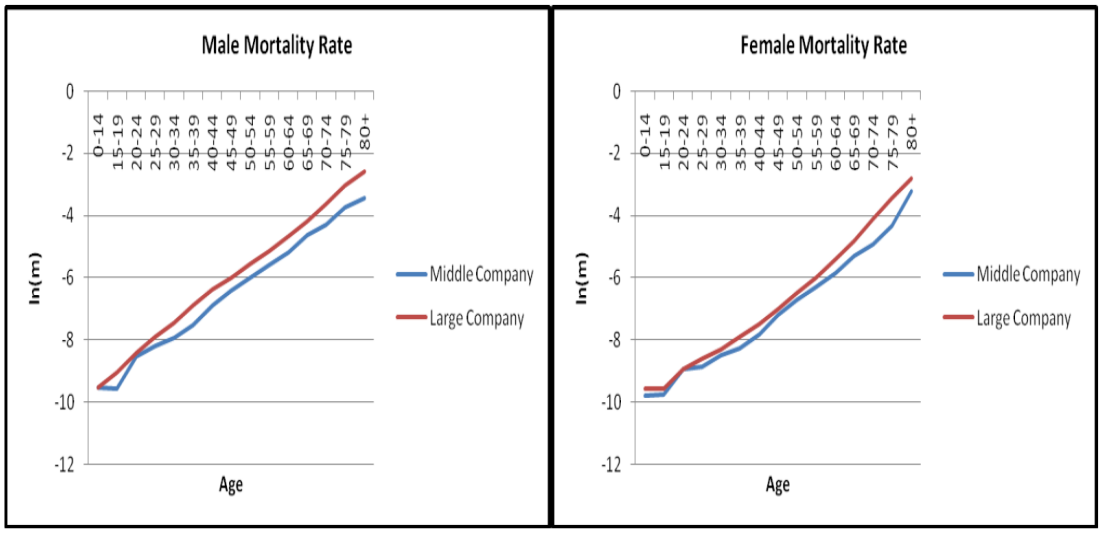

Figure 4. The Mortality Comparison for Company Size (Taiwan Male)

As expected, the mortality rates with health exam are smaller and we will not show the details. The benefit amounts are divided into three categories: less than $0.5 million NT dollars, $0.5~1.0 million NT dollars, and more than $1 million NT dollars. For the term life insurance, the policies with benefit amount less than 0.5 million NT dollars have the smallest mortality rates, while those with benefit amount more than 1.0 millions NT dollars have the largest mortality rates (Figure 5). The patterns reverse for the endowment insurance, the mortality rates are the smallest for benefit amount more than 1.0 million NT dollars. This is an important finding since it might imply that the insurance companies should adopt different mortality rates of pricing according to the benefit amounts in order to avoid biased selection. We can use this information to further differentiate mortality risk (Term Life) and seek a better solution in handling longevity risk (Endowment).

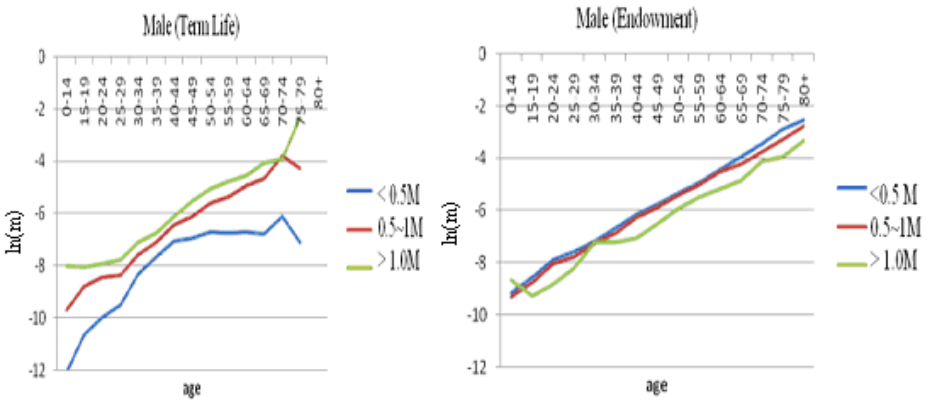

Figure 5. The Mortality Comparison for Benefit Amount (Taiwan Male)

In this section, we found that four factors (Repayment of Principal, Company Size, Health Exam, and Benefit Amount) are highly correlated to the mortality risk. Some of the results are quite unique and we suggest further study to figure out what causes the differences in mortality risk. Also, since the mortality risk is very significant, this suggests that Taiwan insurance companies should pay more attention to pricing the life insurance products. Using a single experience life table (TSO) won't be appropriate and the insurance companies need to include these risks into consideration to avoid risk averse.

4. MORTALITY IMPROVEMENT

In this section, we will continue the empirical study by comparing the mortality rates from population table to those from experience table, and the Lee-Carter model will be used. The Lee-Carter model was proposed by Lee and Carter (1992) and the central mortality rate $m_{x,t}$ is supposed to follow the following equation

$$\ln\left(m_{x,t}\right) = \alpha_x + \beta_x \kappa_t + \varepsilon_{x,t}\,, \tag{1}$$

where the parameter α_x describes the average age-specific mortality, κ_t represents the general mortality level, and the decline in mortality at age x is captured by β_x.

Similar to the previous section the data are in the format of 5-age group but, in order to acquire more observations, we aggregate 3 years of data in applying the Lee-Carter model.

The coefficients α_x and β_x have similar values for the whole Taiwan population and the people purchasing insurance products. However, the mortality improvement over time, which can be expressed in terms of κ_t, behave quite different between these two groups. As shown in Figure 6, the slope of κ_t is steeper for the people purchasing insurance products and this indicates that they have much obvious mortality improvement. Because the life industry only has less than 40 years of history in Taiwan (started in 1970's), sometimes relying on the population data to develop experienced rates is unavoidable. However, based on our findings, this must be handled with care since the mortality improvement is likely to be different. If the annuity table is constructed via the population data, the premiums will be under-estimated.

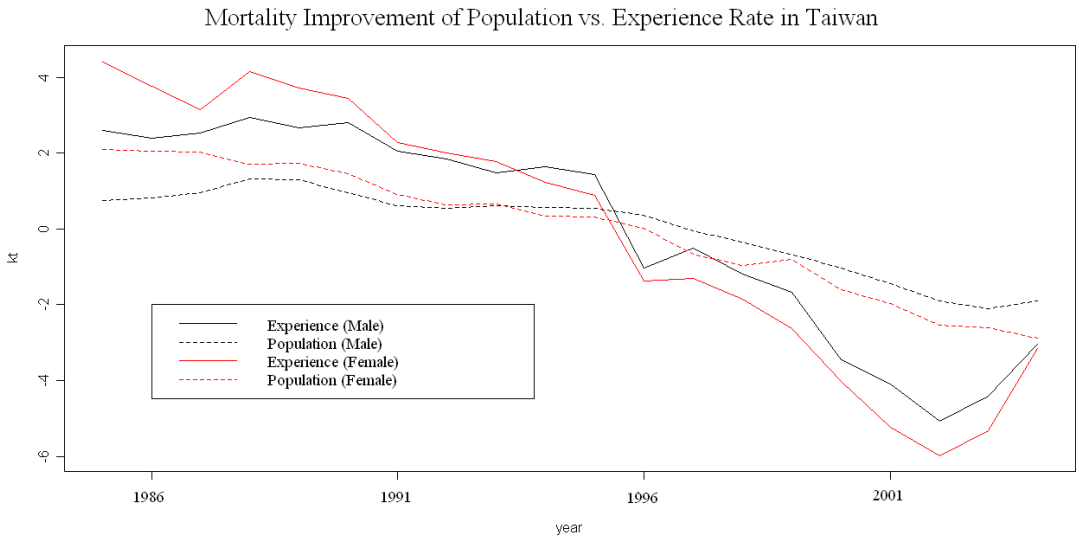

Figure 6. Mortality Improvement of Population vs. Experience (Taiwan)

In addition to the annual improvement rate, we can also check the improvement

rate of each age group. Figure 7 is the comparison of annual improvement rate for each age group, or $\beta_x \kappa_t$ in Equation (1). For both the male and female, the differences of population and experience data in improvement rates are larger for younger age groups. The gaps become smaller as the age increases and there are no differences for age 70 and above, in which the annual improvement is about 2% (or 2% reduction rate). The female has better mortality improvement than the male, and the rates are higher for the younger groups.

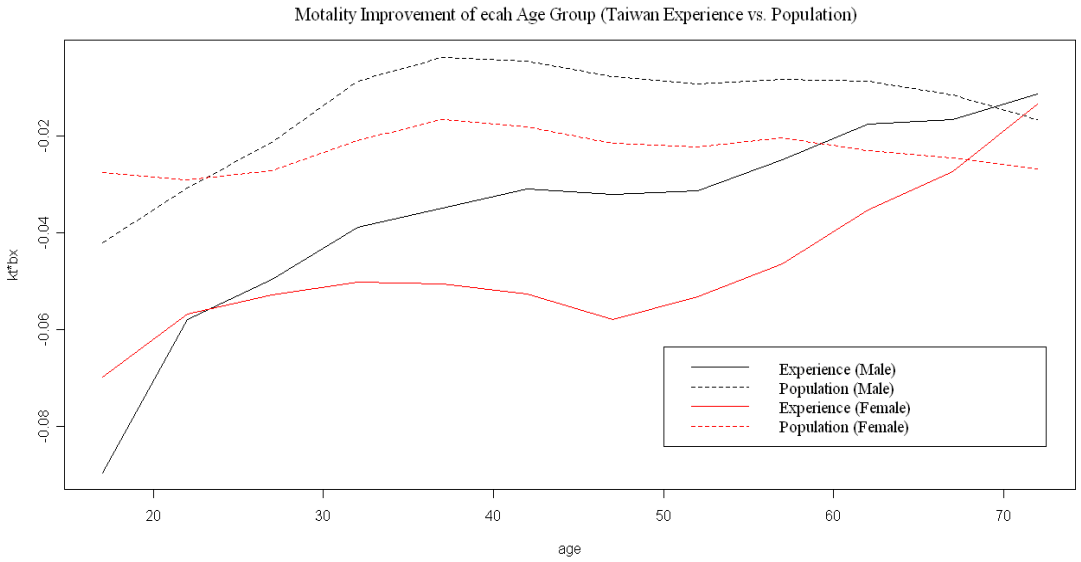

Figure 7. Mortality Improvement of Population vs. Experience (by Age Group)

For the rest of this section, we will use the experience data, based on the results of applying the Lee-Carter model, to evaluate the pricing insurance products. In particular, we will calculate the pure premiums of whole life, annuity, and endowment products, and check the differences of using the regular period life tables and cohort life table. The period life table considered are 2002 TSO (also known as the 4th Taiwan Standard Ordinary Experience Mortality Table), 2002 Annuity Table, and 1999-2001 Taiwan Complete Life Table (or 9th Taiwan Period Life Table; 9th TPL).

Currently, the 2002 TSO is used to calculate the premium and reserves for life insurance products in Taiwan. The male mortality rates are used to demonstrate the differences among these life tables, as shown in Figure 8. The experience data (data period: 2004-2008) apparently have the smallest mortality rates, and other life tables share similar results. Note that the 2002 annuity table is used to price the annuity products in Taiwan.

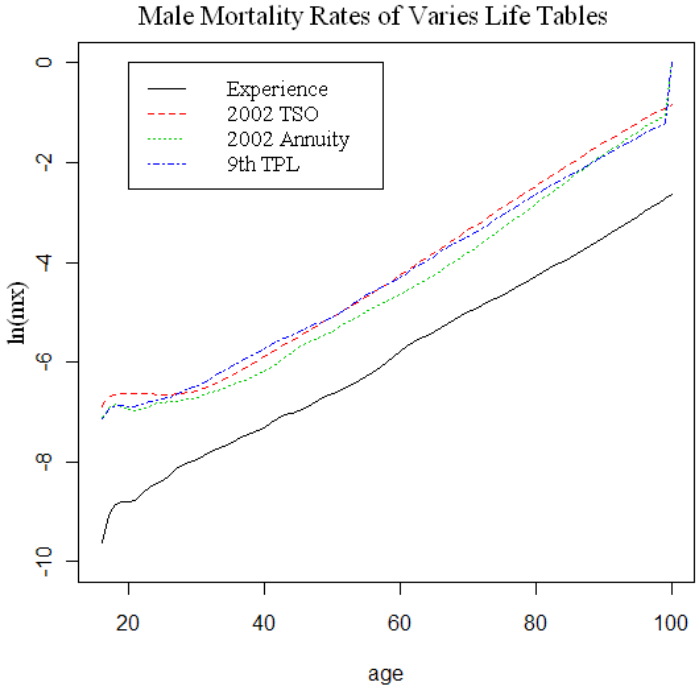

Figure 8. Male Mortality Rates of Different Life Tables

Table 5. Percentages of Over-estimate in Whole Life

Issue Age		20	30	40	50
2002 TSO	Male	54.6%	47.0%	39.4%	31.7%
	Female	90.6%	86.7%	81.6%	75.1%
9^{th} TPL	Male	54.1%	46.6%	38.5%	30.1%
	Female	90.6%	86.8%	81.7%	75.2%

Since both 2002 TSO and 9^{th} TPL do not include mortality improvement, the

pure premiums of life insurance products will be over-estimated. Table 5 lists the percentages of overestimates for the whole life policy at different issue ages if comparing these period tables to the cohort life table based on the experience data. The interest rate is assumed to be 3% and the ultimate age is 100 year-old (i.e., no individuals will survive beyond year 100).

The overestimates are more obvious for the female, same as in Figure 7, and are larger for younger ages (up to 90%). Even for the least difference, i.e., a policy issued for male 50, the overestimate is at least 30%. (The differences will be even larger for the term life, according to our calculations.) Because the overestimate of the pure premium is non-negligible, many life insurance products offer the option of returning the over-paid premium if the observed mortality rates are lower than a pre-defined value (namely, participating policy or with-profit policy).

Table 6. Percentages of Under-estimate in Annuity (Male)

Deferred period/Age		20	30	40	50
2002 Annuity	0	8.2%	9.5%	10.9%	12.0%
	10	26.7%	27.9%	29.3%	30.6%
	20	33.3%	36.6%	41.6%	49.8%
9^{th} TPL	0	10.9%	13.4%	16.1%	18.8%
	10	35.1%	38.4%	42.1%	46.9%
	20	44.4%	51.2%	61.3%	77.9%

Table 7. Percentages of Under-estimate in Annuity (Female)

Deferred period/Age		20	30	40	50
2002 Annuity	0	8.8%	11.7%	15.7%	21.3%
	10	32.4%	37.7%	45.2%	56.6%
	20	39.8%	48.7%	63.2%	90.3%
9^{th} TPL	0	9.9%	13.3%	18.0%	24.5%
	10	36.2%	42.5%	51.5%	65.3%
	20	44.8%	55.5%	72.9%	106.1%

We calculate the pure premiums for the annuity products as well, and the annuity products considered are immediate and deferred annuity. Again, the interest rate is 3% and the ultimate age is 100. We see from Table 6 and 7 that the overestimates are significant, and more obvious, much larger for the female. For example, Table 7 shows that currently the underestimate of insurance companies in Taiwan is 63.2% for a 20-years-deferred whole life annuity issued for a female aged 40.

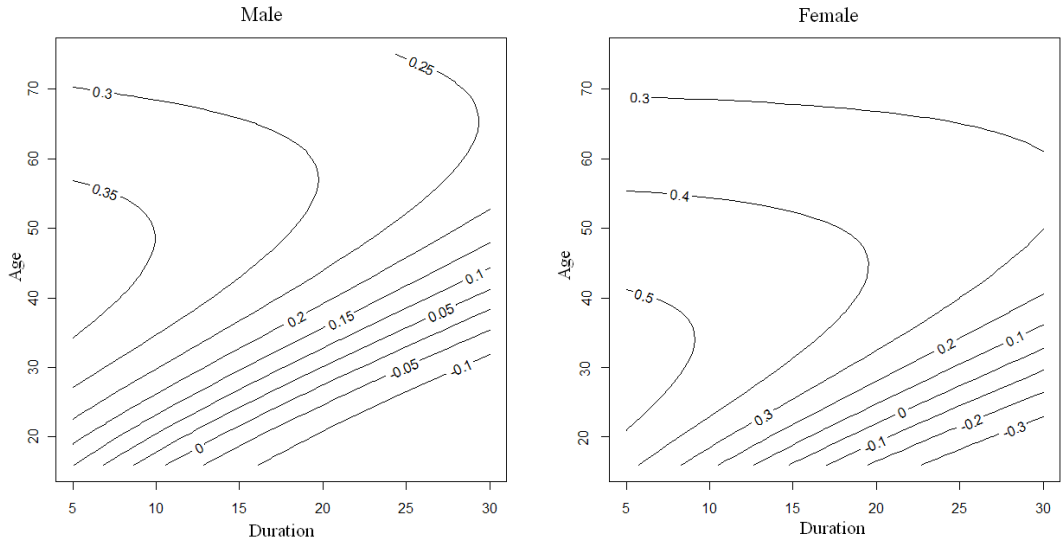

Figure 9. Underestimate of Endowment Policy (2002 TSO vs. Experience)

We found from Table 5 that insurance companies will make a profit by issuing a life insurance policy since they overestimate the premium. However, an endowment is a combination of a pure life coverage and a pure endowment. Insurance companies will overestimate the premium for the part of pure life coverage and underestimate the part of pure endowment. Figure 9 shows that currently insurance companies in Taiwan can underestimate more than 30% for a 30-years-endowment issued for a female aged 20. Because the endowment is categorized as life insurance policy, insurance companies may think that they will always make a profit due to mortality improvement by issuing life insurance policies. But, in fact, insurance companies are

also possible to be in deficit (more than 30%) by issuing the endowment policies. This is an important finding, especially for Taiwan, because endowment policies are very popular in the Taiwan insurance market.

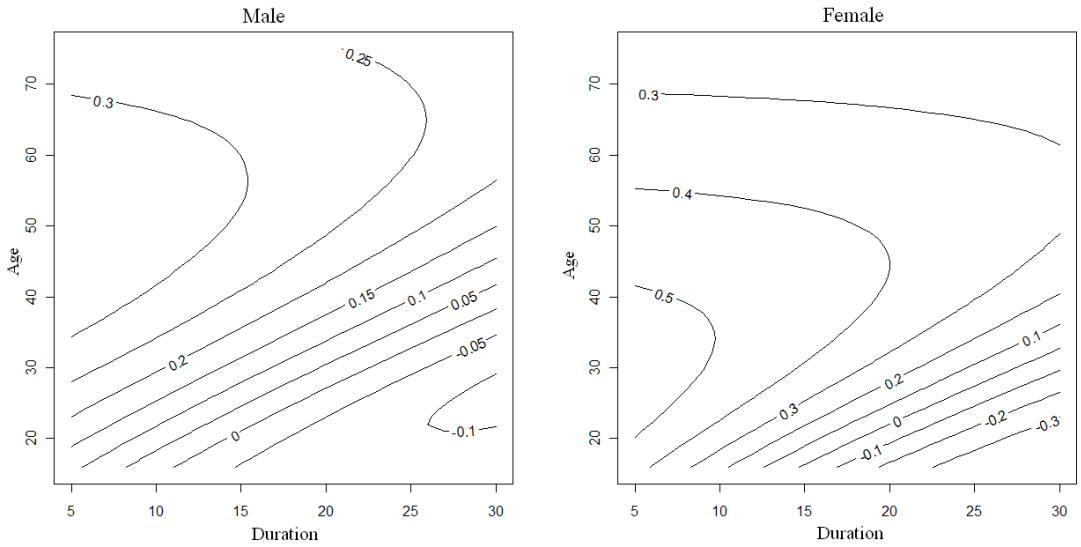

Figure 10. Underestimate of Endowment Policy (9th TPL vs. Experience)

5. DISCUSSIONS

Prolonging life and continuing mortality improvement are common phenomenon in many countries, and many believe that the life expectancy will continue to increase. The longer life has changed our living arrangement, especially after retirement, and the pension products become more popular. However, because the mortality rates are likely to decline in the future, this makes annuity pricing very difficult and especially difficult for countries do not have enough historical data. In this study, we use the experience data from Taiwan insurance companies to explore the mortality profile of life insurance industry and to investigate potential problems.

There are three types of life insurance policies: term life, endowment, and whole life. Intuitively, the mortality rates of term life are likely to be higher than those of

whole life, but, beyond our expectation, the mortality rates of three types of policies do not differ a lot. Instead, we found four factors which are more correlated to the mortality rates than the policy type. Among these factors, the principal repayment probably is quite unique in Taiwan and the policy with this option seems to have smaller mortality rates. Also, the middle size companies have smaller mortality rates, comparing to the large size companies. Policies with health exam and larger benefit amount also have smaller mortality rates. This suggests that the consumer's behaviors in Taiwan might be different from those in other countries. (For example, the term life policies are not popular in Taiwan.) The insurance companies need to be careful about introducing new products into Taiwan.

As for comparing the experience data and population data in Taiwan, we found that their mortality improvement rates are quite different. The differences are especially significant for younger age groups and not so obvious for older age groups. This indicates that using the population data to construct experience life table is feasible, but needs to be careful at the younger age groups.

Since the mortality improvement is very significant in Taiwan, using the traditional period life table to calculate the pure premiums of insurance policy is no longer valid, and using the cohort life table maybe is inevitable. The overestimate of pure premiums in life insurance products can be offset by the option of mortality bonus, i.e., a participating policy. But the underestimate of pure premiums in annuity products is difficult to handle, and the problem is more severe than in U.S. and western countries (Figure 1). Unfortunately, neither the Taiwan government nor the life insurance companies work hard in dealing with the longevity risk.

In addition to the findings from data analysis, we also found other serious problems in Taiwan's life insurance industry. Perhaps the history of life insurance in

Taiwan is not long, and the experience data are not fully explored. Almost all insurance companies do not have their own experience tables, and everyone relies on the same experience tables (2002 TSO and 2002 Annuity Table) except for the largest companies. This would make small and middle size companies difficult to compete with large companies, based on the same mortality rates. As we can see in Figure 4, the middle size companies have smaller mortality rates, in order to compete with the large size companies.

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