

On Actuarial Assessment of China's Work-related Injury Insurance

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Abstract

Work injury insurance fund depends on insured number and contribution rate. The payment amount is subject to the compensation types and level made from work injury insurance. This paper intends to explore the factors affecting work injury insurance payment, analyze the work injury insurance fund payment and evaluate the temporary disability compensation benefit

Keywords

work injury insurance, actuarial estimation, payment of medical fees.

1. Introduction

work injury means the employ's mandatory liability insurance. Not only do its compensation benefit items cover unintentional injury, occupational diseases, and medical and rehabilitation expenses due to work injury, but also it includes disposable compensation expenses causing disabilities and death, regular living allowance of injuries and disabilities and regular allowance for family dependents of the deceased. Meanwhile, the probability of work injury occurrence and extent of damage would directly be affected by the developmental level of society, economy and medical science, as well as the occupational safety development level. Work injury fund income is subject to the insured number and contribution rate. The payment amount is subject to the compensation types and level made from work injury insurance. Work injury insurance fund payment is divided as temporary disability compensation, permanent disability payment, work injury and allowance for family dependents of the deceased, and medical expense payment, one-time work injury, occupational death allowance and other item payment.

2. Income of work injury insurance fund

The income of work injury insurance fund mainly comes from enterprises' payment and interests. Enterprises pay insurance expenses on the basis of total wage bill of total amount as per the unified rate or industrial difference rate. In China, work industrial injury insurance premium implements discriminating rate as per the injury risk degree and the scope of occupational hazard. Meanwhile, rate fluctuation is implemented as per the safety performance of enterprises. The insurance classification and difference rate standard of work-related injury are measured according to the injury accidents of labor administration departments and the statistics of occupational diseases. Under the financing mode of cash collecting and cash payment, the industrial annual income of work injury insurance equals the continued product of number of employees, work injury coverage, average salary and contribution rate. The annual total income of work-related injury insurance is the sum of annual revenues of all industries.

Annual revenue of work injury insurance premium= Σ (occupational employees of industries \times work injury insurance coverage rate of industries \times employee's average salary of industries \times contribution rate of industries)

Similar to other items of social insurance, to maintain the stability of expense rate within some period. It is required to measure the contribution rate within a long period. In accordance with the balancing formula between the income cash value and payment cash value, on the basis of long-term annual revenue and annual payment estimation, the contribution rate of long-term balance can be estimated.

3. Factors affecting the work injury insurance payment

If the management expenses are not considered, the payment of work injury insurance shall be affected by the coverage of system, treatment types, treatment level of work injury insurance commitment, probability and level of work injury insurance and investment returns of accumulated fund of work injury insurance. Work injury compensation not only includes medical and recovery expenses, one-time compensation and regular living allowance, but also one-time compensation and regular living allowance of family dependents of the deceased due to duty-related death. The work injury insurance of some countries is related to some work injury preventing expenses and occupational safety educational expenses.

4. Temporary disability compensation

Temporary disability benefit compensation refers to the compensation amount obtained for insured employees from the date suffered work injury to the date of recovery. As for the medical expenses of temporary disability benefit, China's current system regulates that, the items which belongs to *Diagnosis Items of Work Injury Insurance, Dialogue of Medicine and Inpatient Service Standard and Auxiliary Assistive Tools* shall be paid in the work injury insurance fund. The traveling expense, board and lodging expenses occurred during the work injury inpatient period, the salary welfare benefits approved for salary-keeping period of suspension within two years shall be paid by the working unit of work injury. The payment of work injury insurance fund shall not include part directly paid by the insured unit.

The temporary disability payment amount within a regular period depends on the number of temporary disability, payment period of average disability compensation and average compensation amount. It is expressed by the following formula.

$$B(t)=N(t)\times M(t)\times K(t)$$

In the formula, B(t) represents to temporary disability payment within t years. N(t) represents the number of getting temporary disability benefit compensation within t years. M(t) represents the per capita getting days. K(t) stands for the average everyday compensation payment. N(t) represents the product of occurrence probability of temporary disability and the insured number against work injury. Considering that the temporary disability payment within t years not only includes the payment compensation within t years for disabilities in that period, but also includes the payment of the disability at the current years occurred during t years. Thus, the number of payment compensation getting personnel, days of getting per capital and annual compensation payment per capital.

In order to explain the significance of all variables in formula more clearly, the different influence of work injury accidents on payment compensation accrued at different stages shall be differentiated. Internationally, the estimation process of temporary disability payment compensation in the future can be divided as two stages according to the accidents occurring time, that is, the temporary disability payment compensations occurred before and after the estimation year.

5. The disability payment compensations occurred before the estimation year

Provided that the temporary disability maximum getting year is n, the difference between appraisal year and accident occurring year is d, the difference between estimation year and appraisal year is t, then if the hypothesized estimation year is "0" year, then in the "t" year, that is, in the year of "d+t" year of accident occurring, the temporary disability payment compensation $B_1(t)$ caused by work-injury accident occurred before the estimation year shall be as follows.

$$B_1(t) = \sum_{d=0}^{n-1-t} N_d(0) \square P(d, t) \square M(d+t) \square K(0) \square f(t)$$

In the formula, “ $N_d(0)$ ” stands for the “ d ” year before the estimation years of accidents happening, the number of accepting payment compensation within estimating year $0 \leq d \leq n-1$; $P(d, t)$ represents the ratio between the number accepting payment benefit compensation “ d ” years later from accidents and the number still accepting payment compensation in the “ $d+t$ ” year. If $d+t \geq n$, then $P(d, t)=0$. “ $M(d+t)$ ” stands for the per capital payment days of “ $d+t$ ” year for accepting payers upon the accidents occurring. “ $K(0)$ ” stands for the per capital payment each day within the appraisal year. “ $f(t)$ ” stands for the exponential increasing factor of average payment in the “ t ” year. In it, “ N ” and “ K ” are the statistical data obtained from the estimation year. “ $P(d, t)$ ” and “ $M(d+t)$ ” requires reasoning and hypothesis according to the past experience made by actuary.

If the empirical data used for estimation is not sufficient big, it is difficult to make independent estimation on the number of payment getting personnel and per capital getting days upon accidents occurring. Then it is possible to make joint estimation on these two vector quantities, so as to obtain the distribution of accidental payment days changing with years upon accidents occurring, with the specific formula as follows, $0 < t < n-1$

$$B_1(t) = \sum_{d=0}^{n-1-t} I_d \square D(d+t) \square K(0) \square f(t)$$

In it, “ I_d ” represents the number of new accidents occurred in the “ d ” year before the estimation year, $0 \leq d \leq n-1$. “ $D(d+t)$ ” refers to the per capital payment days within “ $d+t$ ” year accepting payers upon accident occurring. In it, “ I ” and “ K ” are the statistical data obtained from the estimation year. “ $D(d+t)$ ” requires reasoning and hypothesis according to the past experience made by actuary.

6. The disability payment compensations occurred after the estimation year

The payment compensation in a coming year not only includes the continuing payment caused by work injury accidents occurred before the estimation year, but also include the accidents of continuing payment occurring after estimation year and before estimation year and the first-year payment of accidents occurred within the predicting year. The calculating formula of temporary disability payment compensation from disabled accidents occurred after a year is estimated as follows.

$$B_2(t) = \sum_{j=\max(1, t-n+1)}^t I_j \square D(t-j) \square K(j) \square f(t-j)$$

In the formula, “ j ” represents the difference between accidents occurring year and estimation year; “ t ” represents the difference between predicting year and estimation year; “ n ” refers to the temporary disability payment years; “ I_j ” stands for the new accident number occurred after estimating year in the “ j ” year; $D(t-j)$ represents the per capital payment days within “ $t-j$ ” year upon accident happening of accepting payers; $K(j)$ stands for the average payment each day each person after estimating year in the “ j ” year; “ $f(t-j)$ ” refers to the exponential growth factor of average payment with “ $t-j$ ” year. The number of new accidents occurred after estimating year in the “ j ” year depends on the hypothesis of labor force coverage rate and changing conditions of accident rate. A relatively reasonable estimation formula “ I_j ” is stood as follows.

$$I_j = W(0) \times (1+g)^j \times F(0) \times (1+v)^j$$

In the formula, “ $W(0)$ ” stands for the number of work injury insurance planning coverage during the prediction in the previous year; “ g ” stands for the increasing rate of population number; “ $F(0)$ ”

represents the accident occurring rate of the previous year during the prediction period; “v” represents the increasing rate of accident occurring frequency; “W(0)” stands for the known statistical data. Other variables require hypothesis or estimation. The selection of “g” or “F(0)” can be estimated by the past empirical data matching suitable economic social development indicator hypothesis. The annual increasing rate “v” of accident frequency is complex. The potential influence on accidents from the change of measures on occupational health and safety protection shall be considered.

7. Permanent disability payment compensation and allowance for family dependents of the deceased

All kinds of regular payment allowance in permanent disability payment and allowance of duty-related death are the annual premium getting human living of conditions. Annual payment compensation represents the product of annual number getting payment and corresponding payment level.

Annual pension payment for total disabilities = Σ (number of employees \times probability of all kinds of disabilities \times average salary of employees \times proportion of all kinds of total disabilities of pensions in salary)

Annual pension payment for partial disabilities = Σ (number of employees \times probability of partial disabilities \times loss of average salary of disabilities \times proportion of all kinds of total disabilities of pensions in salary).

Payment of nursing expenses = Σ (number of employees \times probability of all kinds of disabilities \times nursing proportion at all levels \times average salary of employees \times proportion of all kinds of nursing expenses in salary).

Pension payment of the family dependents of the deceased = Σ (number of employees \times probability of all kinds of duty-related death \times the number of family dependents of the deceased of average each duty-rated death \times average salary of employees \times proportion of pension for family dependents in salary)

Total amount of annual payment of all kinds of regular payment = annual payment of pensions for total disabilities + annual pension payment for partial disabilities + nursing expense payment + pension payment for family dependents of the deceased.

While estimating this payment of part, the methods of implementing respective estimation may be adopted as per the accident-occurring time. The core thought is similar to the estimation of payment while confronting disability payment, but the meaning of specific variable in the formula is different. The hypothesis of “d” and “t” are the same as the above section, respectively standing for the difference between the estimation year and accident occurring year, and the difference between predicting year and estimation year. The present value estimation formula of annuity payment in the future caused by work injury accidents before estimation year at “t” moment is estimated as follows.

$$PINA_x(t) = \sum_{d=0}^{m-t} I_d \square LT_x(d+t) \square K_x(0) \square f(t) \square NAA_x \quad (t \leq m)$$

In the formula, $PINA_x(t)$ represents the present value of all payment amount at “t” moment which accident happened before estimating year and starts accepting from the “t” year. “ I_d ” stands for the number of new accidents occurred during “d” years before the estimating day; “ $LT_x(d+t)$ ” represents the ratio between the number accepting payment benefit compensation within the “d” year later from accidents occurred before estimating date and the number still accepting payment compensation within the “d+t” year. “ $K_x(0)$ ” stands for the monthly payment level of estimation year; “ $f(t)$ ” represents the payment level change index during the years upon estimation. “ NAA_x ” represents the annual cash value taking monthly payment as “1”. “m” represents the maximum cash value making “ $LT_x(u)$ ” larger than zero.

The annuity payment in the future caused by work injury accidents after the estimating years under the present value at “t” moment may be estimated as follows.

$$FINA_x(t) = \sum_{j=\max(1,t-m)}^t I_j \cdot LT_x(t-j) \cdot K_x(j) \cdot f(t-j) \cdot NAA_x$$

In the formula, “ I_j ” stands for the number of new accidents occurred in “j” year before estimation date; $LT_x(t-j)$ represents the ratio between the number accepting payment benefit compensation within the “j” year later from accidents occurred after estimating date and the number still accepting payment compensation within the “t-j” year. “ $K_x(j)$ ” is the monthly payment level in the “j” year upon estimation year. “ $f(t-j)$ ” stands for the payment level change index during the year of “t-j”. The formula of “x, NAA_x and m” has the same meanings as above.

Within the hypothesis within the annual payment even distribution, the calculating formula of NAA_x shall be as follows.

$$NAA_x = 12 \sum_{t=1}^{w-x} p_x \times (1 - 1/24 q_{x+t-1}) \times f(t-1) \div (1+i)^{t-\frac{1}{2}}$$

In the formula, “ ${}_{t-1}p_x$ ” represents surviving probability of x-aged person at the age of “x+t-1” after “t-1”, that is, the probability of obtaining annuity. “ q_{x+t-1} ” represents the ending probability of annuity “t” years later. “ $f(t-1)$ ” stands for the annuity changing index during “t-1” year (if it is the equivalent annuity, then this item is zero). “i” stands for nominal interest rate; “w” stands for the age upper limit which the surviving probability is larger than zero; “w-x” represents the annuity obtaining age limit of the future.

8. Payment of medical expenses

In China, there has not been statistical data accumulation meeting the demand. The work-injury rank appraisal is lack of reasonable legal standard. Medical distribution law falls on work-injury treatment in different degrees or the required medical expenses during the recovery period, which is determined by work-injury types and medical prices. The medical price changes with the economic development and medical technology. It is difficult to make long-term prediction, requiring adjustment according to the varying conditions. The living subsidies within the medical period depends on the subsidy standard during the medical period and system regulations. While making actual measurement and calculation, the distribution data during the medical period is required to estimate the average medical period.

The estimation on work injury probability and estimation method of medical expense are similar to the medical insurance cost discussed above mentioned. On the basis of the above data, the medical cost of each employee averagely each year stands for the sum of average employees’ medical cost and industrial employees’ number. The living subsidy during the medical period represents the work-injury medical employees’ number multiplying average salary of work-injury employees and average medical period. Thus, the total cost during the work-injury medical period is expressed as follows.

Total cost of industrial medical treatment = Σ (work-injury probability of different industries at different grade \times number of corresponding industrial employees \times average medical expenses required by different stage of work injuries.

Living subsidies during the medical period = Σ (work-injury probability of different industries at different grade \times number of corresponding industrial employees \times annual average salary of work-injury employees \times number of years of average subsidy)

Total cost during medical injury period = Total cost of industrial medical treatment + living subsidy during the medical treatment period

While estimating the future payment and actuarial liabilities in the future, methods estimating as per the accidents happening may be adopted.

9. One-time occupational injury and payment of death allowance

Probability of injuries and disabilities and probability of death determine the payment of one-time work injuries and duty-related death. One-time work injury payment is calculated by the staff number in some year multiplying probability of work injuries and disabilities and work-injury payment compensation. The work injury standard takes the salary before work injury as the foundation, varying from levels of work injuries. The payment standard of Chinese presents different work injury levels from level 1 to level 10 for the past paid salaries for 6 months and 24 months. The payment standard of neighboring level has two months in difference. The detailed statement refers to the above text.

One-time work injury payment = Σ (staff number \times work injury probability at all levels \times month number of previous salary of payment levels at different grades \times staff average monthly salary) .

One-time work injury payment = staff number \times work injury probability \times work injury payment

One-time death payment = staff number \times month number of previous salary of payment levels at different grades \times staff average monthly salary

One-time work injury and death payment = One-time work injury payment + one-time death payment

10. Payment of other items

With the development of work injury insurance, the payment used for work-injury prevention in work injury insurance fund is increased. According to the possibility of work injury insurance development target and work injury insurance fund, under certain payment quota hypothesis, other work injury payment including working injury prevention payment can be estimated. For example, provided that the work-injury payment apart from compensatory payment accounts for $g\%$ in the proportion in the total payment, then the compensatory payment of the current-year work injury insurance is B and other project expenditure volume is $Bg\% / (1-g\%)$.

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