

Long Term Accumulation of Wealth.

The Case of a Small Health Insurance Company.

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Abstract

Behind every company's creation is the goal of a long term accumulation of wealth. Actuarial models have traditionally been used by insurance companies to set appropriate reserves, adequately price products, determine product longevity and profitability, and to predict claim patterns of products in the runoff. In this paper we will share how a small health insurance company may be able to create and successfully maintain its wealth through careful actuarial model considerations used in calculating reserves.

1 Introduction

Why do some newly created insurance companies apparently thrive at first but later close their doors, while others keep on generating wealth for their agents, employees and stockholders as well as protection for their insureds? The answer could be glimpsed through the company's attitude toward financial challenges that constantly arise in the normal course of business.

When problems arise, be it an unexpectedly large series of claims or a significant reduction of the inforce, an insurance company could choose to continue doing "business as usual" thus hoping that the situation would improve on its own. While this attitude of patiently waiting and weathering the storm has its place (most notably, as one of the investment strategies), in the insurance industry it may only postpone the inevitable crisis and sink the company deeper into financial trouble.

On the other hand, a company could choose to address financial problems immediately by being timely in their rate increases and conservative in their reserve estimates. This may mean temporary restraint in reported earnings, but may also

save the company's future and keep it at an even keel throughout the ordeal. What keeps companies from choosing this approach in the first place? The threat of lower reported earnings that are tied to financial interests of companies' decision makers.

In this paper we explain how a small health insurance company could create and successfully maintain its wealth through careful actuarial model considerations used in calculating reserves. It may start with a healthy principle of patient planning and sound accountability and transform itself into a sober look at the reserve calculations.

We will call this company ABC.

2 Seven Principles of Insurability

Like a typical insurance company, when deciding whether to insure its risks, ABC may follow the seven principles of insurability. These principles are described in [1] and we will list them here as well.

1. The first principle of insurability is the principle of the **Large number of similar exposure units**. Since insurance operates through pooling resources, the majority of insurance policies are provided for individual members of large classes, allowing insurers to benefit from the law of large numbers in which predicted losses are similar to the actual losses.
2. The second principle of insurability is the principle of **Definite loss**. The loss takes place at a known time, in a known place, and from a known cause. The classic example is death of a person with a life insurance policy. Fire, automobile accidents, and worker injuries may all easily meet this criterion. Other types of losses, such as occupational disease, may only be definite in theory.
3. The third principle of insurability is the principle of **Accidental loss**. The event that constitutes the trigger for a claim should be *unexpected*, or at least outside the control of the beneficiary of the insurance. The loss should be pure, in the sense that it results from an event for which there is only the opportunity for cost. Events that contain speculative elements, such as ordinary business risks or even purchasing a lottery ticket, are generally not considered insurable.
4. The fourth principle of insurability is the principle of **Large loss**. The size of the loss must be meaningful from the perspective of the insured. Insurance premiums need to cover both the expected cost of losses, plus the cost of issuing and administering the policy, adjusting losses, and supplying the capital needed

to reasonably assure that the insurer will be able to pay claims. For small losses these latter costs may be several times the size of the expected cost of losses.

5. The fifth principle of insurability is the principle of **Affordable premium**. If the likelihood of an insured event is so high, or the cost of the event so large, that the resulting premium is large relative to the amount of protection offered, it is not likely that the insurance will be purchased. Further, the premium cannot be so large that there is no reasonable chance of a significant loss to the insurer.
6. The sixth principle of insurability is the principle of **Calculable loss**. There are two elements that must be at least estimable, if not formally calculable: the probability of loss, and the attendant cost. Probability of loss is generally an empirical exercise, while cost has more to do with the ability of a reasonable person in possession of a copy of the insurance policy and a proof of loss associated with a claim presented under that policy to make a reasonably definite and objective evaluation of the amount of the loss recoverable as a result of the claim.
7. The seventh, and the final, principle of insurability is the principle of **Limited risk of catastrophically large losses**. Insurable losses are ideally independent and non-catastrophic, meaning that the losses do not happen all at once and individual losses are not severe enough to bankrupt the insurer; insurers may prefer to limit their exposure to a loss from a single event to some small portion of their capital base. This may be done through the reinsurance market.

To conform with the principles of insurability, ABC finds constant experience monitoring to be essential. It allows the company to maintain adequate rates, and make timely decisions regarding its rate increases as well as keep adequate reserves for payment of its claims.

While all of the principles of insurability are important for ABC in insuring the risks associated with its business, the principles of the *Accidental loss* and of the *Large number of similar exposure units* are found to be the most challenging.

2.1 Accidental Loss

Unlike the property casualty insurance industry, where a decision to insure a burning or a flooded building would be easy to make, the concept of a *pre-existing condition* in the health insurance industry is the subject of intense debate.

Typical comprehensive health insurance is different from any other type of insurance in that it gives its insured a protection from high medical costs. Its claims are initiated, for the most part, by regularly incurred events rather than accidental occurrences beyond the insured's control. For example, any child goes through a round of sinus and ear infections, stomach aches, bumps and scratches, some of which require a doctor's attention. Similarly, although one can not predict when and if they will be subject to a so called *dreaded* disease, such as heart failure, cancer or diabetes, their family history and life style are somewhat predictive of these kind of events.

Thus, health insurance has more of an element of a pre-paid warranty than a traditional insurance. It is a risk management tool that ensures individuals and their families have access to the healthcare they need, when they need it, without causing a tremendous financial burden [2].

2.2 Large Number of Similar Exposure Units

The principle of the *Large number of similar exposure units* blends neatly with the principle of the *Accidental Loss*, when the exposure gets smaller. ABC pays particular attention to experience to avoid a situation known as the *death spiral* when relatively large rate increases on a product could cause a more healthy mix of insureds to leave the group that in turn would cause a more unhealthy mix to stay. This would leave the company to administer more claims on the product coming from a more unhealthy mix. In addition, as the exposure becomes smaller, the experience becomes more variable. Each round of such rate increases would make this situation worse and would ultimately make the product uninsurable.

Compared to individual health insurance, group health insurance companies may benefit more from the law of large numbers. Exposure is often limited through annual underwriting and simplified process of disposing of unwanted risk. Maintaining the *Large number of similar exposure units* principle may be somewhat harder for individual health insurance where claims have longer tails and often require more careful preventive practice and consideration.

Our sample company has the majority of its business in individual market and thus faces additional risks typical for the individual health insurance industry. To battle these risks, the company determines that its three primary goals are to:

- adequately price its products;
- choose appropriate actuarial models to estimate its reserves and liabilities, and

- initiate timely and suitable rate increases without foregoing or postponing any.

3 Health Insurance Coverage Offered by ABC

ABC offers its insureds a number of different types of health insurance coverage designed to meet the needs and budget of a variety of individuals, small businesses and associations.

3.1 Individual Coverage, Group Coverage and Credit

Health insurance coverage is generally split into three categories: Individual Coverage, Group Coverage and Credit. ABC offers all three categories of insurance, albeit at an uneven distribution. The majority of its business is individual coverage, followed by the group coverage. Credit constitutes the smallest part of its business. The main characteristics of each category is described in [2] which we partly quote below.

- ABC sells *Individual Health Insurance* coverage to individuals or families with the policyholder as the insured, and benefits provided directly to the insured or their family members. This coverage is also individually underwritten through medical questionnaires.
- In addition, ABC sells *Group Health Insurance* coverage to groups of employees, associations or trusts. The policyholder is the plan sponsor, usually the employer, and benefits are provided to a certificate holder. This insurance is particularly characterized by an efficient delivery. It uses economy of scale and thus typically has a lower cost per individual since a large pool is insured.
- A small percentage of business sold by ABC is *Credit insurance*. It repays some or all of a loan when certain circumstances arise to the borrower such as unemployment, disability, or death.

3.2 Indemnity and Managed Care Plans

The insurance protection sold by ABC offers both indemnity (fee-for-service) and managed care.

Indemnity Plans, or reimbursement plans as they are sometimes called, reimburse the insured for medical expenses regardless of which provider they used.

The amount of reimbursement in these indemnity plans is determined through three common practices:

- *Reimbursement of actual charges* is a method where ABC reimburses the insured for the actual cost of their medical care regardless of the cost.
- *Reimbursement of a percentage of actual charges* is a method where ABC pays a set percentage of the actual charges on covered procedures and services, regardless of the cost, and the insured paid the difference.
- *Indemnity* is a method where ABC pays a specified amount per day for a predetermined number of days regardless of the actual cost of care. The reimbursements, however, are never more than the reasonable and customary amounts predetermined by the company.

Examples of indemnity plans sold by ABC are a Major Medical (typically individual) plan and a hospital indemnity coverage (e.g., \$300/day in a hospital).

In addition to indemnity plans, ABC sells **Managed Care Plans**. They are different from indemnity plans in several ways. The three different types of managed care plans are:

- *Health Maintenance Organization (HMO)* plans that provide treatment on a prepaid basis, so the members of the HMO pay a set monthly fee regardless of the amount of medical care needed. In exchange for the fee, the HMOs provide a wide variety of services ranging from office visits to surgery. In most cases, HMO members have to receive their medical treatment from providers in the network.
- *Preferred Provider Organization (PPO)* plans are plans through organizations made up of doctors and hospitals (known as preferred providers) that only serve a specific group or association. PPO members generally pay for services as they receive and are reimbursed for the cost of the treatment less their co-payment. Sometimes the service provider bills ABC directly, in which case ABC pays the provider and the insured has to pay the co-payment to the provider. In a PPO arrangement, the price of certain services is determined in advance, and that is the price charged for the duration of the agreement with providers.
- *Point of Service (POS) Plans* are unique because the insured does not pay a deductible and usually only pays a minimal co-payment when using a provider in the network. POS programs generally require a member to choose a primary care physician (PCP) who made referrals to other providers in the network,

such as specialists, as needed. Generally, if members use a provider outside the network, they have to pay a deductible and a co-payment which can be a substantial amount.

These managed care plans are similar in nature, but the programs are different. The main commonality of these three types of managed care plans is that they have an arrangement between ABC and a network of selected health care providers. They offer financial incentives to the insured to encourage them to use the providers in the network. They usually have specific guidelines regarding the selection of providers and formal procedures that have to be followed.

Indemnity and managed care plans differ in their basic approach. The major differences concern choice of providers, out-of-pocket costs for covered services, and how bills are paid. Usually, indemnity plans offer more choice of doctors (including specialists, such as cardiologists and surgeons), hospitals, and other health care providers than managed care plans. Indemnity plans pay their share of the costs of a service only after they receive a bill.

3.3 Medical Coverages Offered by ABC

ABC offers typical health insurance coverages to its insureds such as Life, Medical, Prescription Drug, Disability, Dental, and Medicare Part D insurance.

Some types of medical coverage offered include Major Medical, Hospital Indemnity Coverage, PPO, HMO and POS.

Other medical coverages that are Consumer-Directed Health Care plans (CDHPs) that are high-deductible plans, Short-Term Medical plans (e.g. plans purchased by students), Critical Illness Plans, also called *dreaded disease* coverage (e.g. covering cancer, diabetes, or heart disease), Medicare Supplements (Parts A - hospital, B - physician and D - pharmacy) and Group Conversions.

4 Actuarial Models Used by ABC

Actuarial models are used to identify, assess, measure, manage, and mitigate risks. They rely on estimated measures of the probability of future contingent events.

Many authors hail the advantages of using actuarial models. In his paper on identifying and assessing adverse selection Kane mentions that "actuarial models are robust because each observation does not have much influence on the estimates.

Transparency makes them easy to audit. If a forecast goes sour, an investigator may pinpoint what went wrong in the model and correct the situation” [3].

The selection of an actuarial model is a matter of professional judgement to fulfill the goal of properly estimating its reserves and liabilities and to adequately price its products.

Many actuaries have preferences concerning which models to use to accomplish particular analyses. It is not uncommon for two actuaries to select two different models to perform the same or a similar task, and for both models to reflect generally accepted actuarial practice. It is quite common for many actuarial modeling approaches, different in the underlying details of their construction, to be designed to satisfy the requirements of a particular task and for each to provide results that fall within an acceptable range of plausible future financial outcomes.

In its work on the the roles of the actuary in the selection and application of actuarial models [4], the American Academy of Actuaries Committee on Professional Responsibility states that actuarial models are *simulations* and, by their very nature, are simplified representations of reality. The Committee defines the various types of models as follows:

- **A scientific model** is an abstract and simplified representation of a given phenomenon.
- **A mathematical model** is a scientific model in which the representation is expressed in mathematical terms.
- **A stochastic model** is a mathematical model in which the representation is expressed in terms of probabilities.
- **A dynamic stochastic model** is a stochastic model that incorporates a systematic process for revising the model in response to observed results.
- **A deterministic model** of a phenomenon is a stochastic model in which a given event is assumed to occur with certainty.

ABC’s actuaries use both deterministic and stochastic models in their work. These models provide framework for analysis, allowing to project probable outcomes based on past experience adjusted for known material changes in circumstances.

In each model the choice of assumptions is important. ABC’s actuaries build models that use their analysis of rates of disability, morbidity, mortality, fertility and other contingencies. The effects of consumer choice and the geographical distribution of the utilization of medical services and procedures, and the utilization of drugs and therapies, is also of great significance.

5 Reserves and Liabilities Estimated by ABC

Before we describe what reserves and liabilities are estimated by ABC actuaries, let us give a general note on the use of these two terms in the healthcare industry. It is expressed particularly well in [5], which we quote here.

”Actuaries and others in the healthcare industry are somewhat lax in their use of the word ”reserves”. It is common to refer to ”reserves” as a broad collection of balance sheet entries technically representing a combination of both ”reserves” and ”liabilities”. The distinction relates to statutory classifications of *liabilities* as entries related to claim events that have already occurred, but for which a payment has not yet been made. Such claims have costs that have already been accrued. *Reserves* are classified as entries for amounts that the company has become obligated to pay, but for which the reimbursable event has not yet occurred. These costs will accrue in the future. While general usage applies ”reserving” to both sets of entries, the term is technically applied to future contingent payments.”

Among typical ABC’s Liabilities and Reserves are:

- Premium Liabilities
- Contract Reserves
- Claim Reserves
- Provider Liabilities (liabilities to doctors and hospitals)
- Premium Deficiency Reserves
- Contingency Reserves
- Retired Life Reserves
- Experience Refund Liabilities

Here we will speak to more degree about Premium Liabilities and Claim Reserves.

5.1 Premium Liabilities

ABC’s Premium Liabilities are split into three categories: Advance Premiums, Unearned Premiums, and Due and Unpaid Premiums (generally regarded as an asset).

- *The Advance Premiums* are premiums paid before valuation date that are due after valuation date.

- *The Unearned Premiums* are premiums that are due before the valuation date, but are earned after the valuation date.
- *The Due and Unpaid Premiums* are the premiums that are made late. When that occurs, some or all of that premium is expected to be received, and some credit was taken on the financial statement (as an asset) for such premiums. There is a limit put on this and such an asset is not taken beyond what might reasonably be expected to be collected.

5.2 Claim Reserves

ABC's Claims Reserves and Liabilities can be logically categorized based on the nature of claims costs and their status as they progressed toward final payment.

- *Due and Unpaid* are liabilities for claims that had been reported, adjudicated, and processed, but for which final payments had not been recorded as of the valuation date. These amounts are typically fairly small in relation to overall reserves.
- *In Course of Settlement (ICOS)* are liabilities for claims reported and received, but not yet adjudicated and paid as of the valuation date.
- *Incurred but not Reported (IBNR)* are liabilities for claims that were anticipated to have occurred but had not been reported to the carrier as of the valuation date. Probably the widest range of estimation techniques is applied to estimate this liability. Most methods attempt to project liabilities by using existing payment data to develop average expected claims or claims payment patterns. Once the estimation process have projected fully incurred claims, paid claims are subtracted to estimate the unpaid claims liability.
- *Loss Adjustment Expenses (LAE)* are liabilities for the administrative costs associated with the adjudication of unpaid claims. This reserve is developed as a percentage of the claims liability.
- *Present Value of Amounts Not Yet Due (PVANYD)* is reserve that covers claims that were incurred on or before the valuation date which have not accrued as of the valuation date. Examples are a disability claim of \$500 per month incurred on December 1 with a 14-day elimination period or a disability claim incurred several years earlier. The estimation of this reserve is most commonly done on a seriatim basis.

- *Resisted Claims* are claims for which a known litigation situation existed. For example, claims for which a lawsuit is pending at the time of the valuation. Given their nature, these are usually valued on a seriatim basis, but are reported in aggregate.

Claim Reserves constitute the largest portion of each period's reserves. The following methods or a combination of methods are used for their estimation:

- Claim Runout/Completion
- Average Per Member Per Month (PMPM) Cost
- Tabular Methods (Disability Income claims for which a claims event triggered a sequence of payments)
- Case Reserves (for example, large hospital claim)
- Loss Ratio
- Stochastic Approaches

5.3 Financial Reporting Requirements

As any health insurance company providing health coverage to its consumers, ABC complies with the financial reporting requirements, promulgated by the NAIIC. Determination of its reserves and liabilities is one of the important aspects of financial reporting.

ABC's reserve approach may be based on the traditional reserve calculation model which we now describe.

6 Traditional Reserve Calculation Model

The general approach to calculating *claim reserves* is based on the definition of the difference between *projected incurred claims* and *paid claims*. Since paid claims in each period are known, the goal is to estimate the incurred claims.

6.1 Incurred Claims

By definition, the *Incurred Date* is the date on which an obligation to pay was established relative to a claim.

When incurred claims (or reserves) are estimated, the time line of when the claims incurred is usually split between two periods: *most recently incurred periods* (typically 3 to 5 most recent periods), also called *non-credible* periods, and *not most recently incurred periods* (the periods beyond most recent 3 to 5 time periods), also called *credible* periods. ABC's valuation periods are months.

The definition of an incurred date as well as the length of non-credible time period depend on the nature of the claims typical for a particular product.

Group insurance claims typically have shorter tails and the incurred date is typically defined to be the service date which required a smaller number of non-credible months. ABC finds three months to suffice.

Most of the ABC's business are individual insurance products. Claims are first considered on the *original incurred date* bases as is appropriate for longer-tail claims. The *credible* period is established at five months.

To better reflect the nature of the claims and the business being sold, on most products a decision is made to change from considering claims on the original incurred date basis to considering claims on *modified incurred date* basis. For each claim payment, the modified incurred date is determined based on the original service date and either the length of time elapsed between the following consecutive service dates or how far the original or modified incurred date is from the paid date.

Some of the approaches for projecting incurred claims are the Development, or Triangulation, method, and the Loss Ratio method that could be per member per month (PMPM), or Pure Premium Projection. For most of its products ABC's actuaries use a combination of the Development method and Loss Ratio method (also known as the Modified Development method).

6.2 Modified Development Method

The Modified Development Method could be separated into four steps:

1. Develop a claim triangle of paid claims by period of incurral and payment.
2. Develop claim completion ratios and factors.
3. Apply claim completion factors to paid claims to determine complete claims.
4. Modify recent months based on the loss ratio or claim cost method.

These steps are demonstrated below.

A given a set of paid payments is sorted into the period incurred (called *incurred date* or *loss date*) and period paid. These payments form a *claim triangle*:

Table 1: Payments per Period

Period	Paid In	Incurred Period				
		t_1	t_2	t_3	\dots	t_n
1	t_1	p_{11}				
2	t_2	p_{21}	p_{22}			
3	t_3	p_{31}	p_{32}	p_{33}		
\vdots	\vdots	\vdots	\vdots	\vdots		
n	t_n	p_{n1}	p_{n2}	p_{n3}	\dots	p_{nn}

where $t_1 < t_2 < \dots < t_n$

Here t_k are the calendar dates, t_1 being the oldest.

Paid claims are accumulated for each incurred period by duration from incurred period. These amounts are called the *cumulative payments* and they form a *lag*, also called a *payment lag*, or a *claim runoff*.

Table 2: Cumulative Payments

Period	Paid Thru	Incurred Period				
		t_1	t_2	t_3	\dots	t_n
1	t_1	P_{11}				
2	t_2	P_{21}	P_{22}			
3	t_3	P_{31}	P_{32}	P_{33}		
\vdots	\vdots	\vdots	\vdots	\vdots		
n	t_n	P_{n1}	P_{n2}	P_{n3}	\dots	P_{nn}

where, for the first incurred month, $P_{11} = p_{11}$; $P_{21} = p_{11} + p_{21}$;

$$P_{31} = p_{11} + p_{21} + p_{31}; \quad P_{i1} = \sum_{k=1}^i p_{k1};$$

for the second incurred month $P_{32} = p_{22} + p_{32}$; $P_{i2} = \sum_{k=2}^i p_{k2}$,

and, in general, $P_{ij} = \sum_{k=j}^i p_{kj}$, $1 \leq i, j \leq n$

Completion ratios are calculated by taking the ratio of cumulative paid through one period to the cumulative paid through the next month for each incurred period. These ratios are also called *age-to-age development factors* or *completion percentage*.

Table 3: Completion Ratios

Ratio of Period	Incurred Period				
	t_1	t_2	\cdots	t_{n-2}	t_{n-1}
1 to 2	r_{11}	r_{12}	\cdots	$r_{1(n-2)}$	$r_{1(n-1)}$
2 to 3	r_{21}	r_{22}	\cdots	$r_{2(n-2)}$	
\vdots	\vdots	\vdots			
$(n-2)$ to $(n-1)$	$r_{(n-2)1}$	$r_{(n-2)2}$			
$(n-1)$ to n	$r_{(n-1)1}$				

where $r_{ij} = P_{ij}/P_{i+1j}$, $1 \leq i, j \leq n-1$

An average of the above calculated ratios is computed over a period of time (typically 3, 6, or 12 months). These averages are called *chain-link* or *chain-ladder average completion ratios*. Typical averaging techniques include arithmetic mean, sum-of-the-digits, squared sum-of-the-digits, constantly declining percent weighting, harmonic means, geometric means. At this stage an actuary could adjust for "bumps" or "shock" claims.

Table 4: Average of Ratios

Ratio of Period	Incurred Period					Average
	t_1	t_2	\dots	t_{n-2}	t_{n-1}	
1 to 2	r_{11}	r_{12}	\dots	$r_{1(n-2)}$	$r_{1(n-1)}$	r_1
2 to 3	r_{21}	r_{22}	\dots	$r_{2(n-2)}$		r_2
\vdots	\vdots	\vdots				\vdots
$(n-2)$ to $(n-1)$	$r_{(n-2)1}$	$r_{(n-2)2}$				r_{n-2}
$(n-1)$ to n	$r_{(n-1)1}$					r_{n-1}

where $r_i = ave_{1 \leq j \leq (n-i)}(r_{ij})$, $1 \leq i \leq (n-1)$.

The duration after incurral period when claims are 100% complete is determined. The product of ratios calculated above is taken starting at that duration and moving closer to the period of incurral to determine *completion factors*.

Table 5: Completion Factors

Ratio of Period	Completion Factor
1 to n	cf_1
2 to n	cf_2
\vdots	\vdots
n-1 to n	cf_{n-1}

where $cf_i = \prod_{k=i}^{n-1} r_k$ for $i = 1, 2, \dots, n-1$ and $cf_n = 1$

Cumulative paid claims for each incurred period shown in Table 8 are divided by factors in the previous step to get total incurred claims by incurred period.

For incurred periods with low completion factors from Table 11, incurred claims calculated this way are replaced by incurred claims calculated using alternative methods (e.g., Loss Ratio Method, Per Member Per Month Method).

Cumulative paid claims through the valuation date are subtracted from incurred claims for each period and then the results by period are summed to get the total liability.

Table 6: Reserves

(1) Incurred Period	(2) Paid and Incurred Claims	(3) Completion Factor	(4)=(2)/(3) Estimated Incurred Claims (IC)	(5)=(4)-(2) Estimated Reserve (R)
t_1	P_{n1}	cf_n	P_{n1}/cf_n	$R_1 = IC_1 - P_{n1}$
t_2	P_{n2}	cf_{n-1}	P_{n2}/cf_{n-1}	$R_2 = IC_2 - P_{n2}$
t_3	P_{n3}	cf_{n-2}	P_{n3}/cf_{n-2}	$R_3 = IC_3 - P_{n3}$
\vdots	\vdots	\vdots	\vdots	\vdots
t_n	P_{nn}	cf_1	P_{nn}/cf_1	$R_n = IC_n - P_{nn}$
Total	$\sum_{j=1}^n P_{nj}$		$\sum_{i=1}^n IC_i$	$\sum_{i=1}^n R_i$

Appropriate margin to add to the liability is determined based on credibility of data, volatility of experience, medical inflation, and other factors deemed appropriate.

6.3 An Example of Applying Modified Development Method

To illustrate the described approach let us consider a numerical example. Assume that a period is one month.

Suppose we have the following set of four monthly payments:

Table 7: Monthly Payments (Num. Ex.)

Period	Paid In	Incurred Month			
		200909	200910	200911	200912
1	200909	10			
2	200910	60	20		
3	200911	20	50	10	
4	200912	10	20	60	20

Calculating the Cumulative Payments, or payments-to-date, we obtain:

Table 8: Cumulative Payments (Num. Ex.)

Period	Paid Thru	Incurred Month			
		200909	200910	200911	200912
1	200909	10			
2	200910	70	20		
3	200911	90	70	10	
4	200912	100	90	70	20

Then, completion ratios are:

Table 9: Completion Ratios (Num. Ex.)

Ratio of Period	Incurred Month		
	200909	200910	200911
1 to 2	0.143	0.286	0.143
2 to 3	0.778	0.778	
3 to 4	0.900		

with 200909 incurred completion ratios being

$$r_{11} = 10/70 = 0.143, r_{21} = 70/90 = 0.778, r_{31} = 90/100 = 0.9$$

Calculating the (arithmetic) averages of ratios computed in the previous step, we obtain:

Table 10: Average of Ratios (Num. Ex.)

Ratio of Period	Incurred Month			Average
	200909	200910	200911	
1 to 2	0.143	0.286	0.143	0.191
2 to 3	0.778	0.778		0.778
3 to 4	0.900			0.900

$$\text{with } r_1 = \text{ave}\{0.143, 0.286, 0.143\} = 0.191$$

Then, the completion factors are:

Table 11: Completion Factors (Num. Ex.)

Ratio of Period	Completion Factor
1 to 4	0.134
2 to 4	0.700
3 to 4	0.900

$$\text{with } cf_1 = 0.191 \cdot 0.778 \cdot 0.900 = 0.134$$

The reserves are be calculated as follows:

Table 12: Reserves (Num. Ex.)

(1) Incurred Month	(2) Paid and Incurred Claims	(3) Completion Factor	(4)=(2)/(3) Estimated Incurred Claims (IC)	(5) Modified Inc. Claims	(6)=(5)-(2) Estimated Reserve (R)
200909	100	1.000	100	100	0
200910	90	0.900	100	100	10
200911	70	0.700	100	100	30
200912	20	0.134	149.25	100	80
Total	280		449.25	400	120

Note that the completion factor in the last incurral period (0.134) is too small to be used to reasonably predict incurred claims. Other methods, including actuarial judgment, could be used to estimate the incurred claims in the last several non-credible incurral months. Here the actuaries modified the incurred claims to be more in line with the rest of the estimated incurred claims.

7 Conservative Reserve Calculation Model

Taking the Modified Development method as the basic approach to estimating the reserves in the credible months, ABC applies further considerations in the most recent incurral months. These considerations show some conservatism, but prove to be better aligned with company's goal of long term preservation of wealth.

In the credible months completion factors are developed and applied to paid claims to calculate total expected incurred claims by product. These factors are based on actual history of groupings of similar products.

In the five most recent incurred months the claim liabilities are estimated using additional estimation techniques, such as modified loss-development method and modified loss ratio estimates. To develop the incurred claim estimate the highest of the following three calculations is used:

- The expected ultimate target loss ratio determined when the product was last priced or analyzed;
- The average loss ratio for the twelve months prior to the most recent incurral months, and
- Application of the completion factor from the month prior to the most recent incurral months.

An example below illustrates this three-way approach.

Suppose we are given the following information:

Table 13: Claims Development Table (3-way test ex.)

Dur	(1) Inc Mo	(2) Earned Prem	(3) Paid Clms	(4) Compl Factor	(5)= (3)/(4) Est Inc Clms	(6)= (5)/(2) Loss Ratio	(7) Ave LR (12 mo)	(8) Antic LR (Pricing) (ALR)
9+	200904	185,618	185,637	0.8315	223,255	1.20	58.8%	
8	200905	187,383	153,896	0.8055	315,203	1.68	69.0%	
7	200906	187,959	42,959	0.7769	55,295	0.29	69.2%	
6	200907	184,260	171,375	0.7368	232,593	1.26	77.7%	
5	200908	181,164	83,178	0.6763	122,990	0.68	74.9%	74.0%
4	200909	178,552	316,016	0.5955	530,673	2.97	93.0%	75.0%
3	200910	177,734	40,247	0.4718	85,306	0.48	89.7%	76.0%
2	200911	176,926	5090	0.2829	17,992	0.10	89.6%	77.0%
1	200912	171,294	1293	0.0287	45,068	0.26	90.2%	78.0%

Here the average loss ratio (column (7)) is estimated as the ratio of the sum of the Incurred Claims to the sum of the Earned Premiums over the last 12 months: $\sum(IC)/\sum(EP)$.

In Method A the Modified Incurred Claims in the five most recent incurral months are calculated as a product of Earned Premium and Anticipated Loss Ratio, which is the expected ultimate target loss ratio determined when the product was last priced. This calculation follows the intuitive definition of a Loss Ratio being a ratio

of Incurred Claims to Earned Premium. This is the essence of the Loss Ratio method of reserve calculation.

Table 14: Method A

	(1)	(2)	(3)	(8)	(9)= (2)*(8)	(10)= (9)-(3)
Dur	Inc Mo	Earned Prem	Paid Clms	Antic LR (ALR)	Mod IC	Est Res
5	200908	181,164	83,178	74.0%	134,061	50,883
4	200909	178,552	316,016	75.0%	133,914	(182,102)
3	200910	177,734	40,247	76.0%	135,078	94,830
2	200911	176,926	5090	77.0%	136,233	131,143
1	200912	171,294	1293	78.0%	133,610	132,316

In Method B the Modified Incurred Claims in the five most recent incurral months are calculated as a product of Earned Premium and the average loss ratio for the twelve months *prior* to the most recent incurral months. As in Method A, this calculation follows the intuitive definition of a Loss Ratio being a ratio of Incurred Claims to Earned Premium, only here it is applied loosely for a 12-month average loss ratio.

Table 15: Method B

	(1)	(2)	(3)	(7)	(9) = (2)*((7)@ 200907)	(10)= (9)-(3)
Dur	Inc Mo	Earned Prem	Paid Clms	Ave LR (12 mo)	Mod IC	Est Res
6	200907			77.7%		
5	200908	181,164	83,178		140,769	57,581
4	200909	178,552	316,016		138,730	(177,286)
3	200910	177,734	40,247		138,094	97,847
2	200911	176,926	5090		137,466	132,377
1	200912	171,294	1293		133,091	131,797

In Method C the Modified Incurred Claims in the five most recent incurral months are calculated as a ratio of Paid Claims to the completion factor from the month *prior* to the most recent incurral months. This calculation follows the intuitive definition of an Incurred Claim being a ratio of a Paid Claim to a completion factor.

Table 16: Method C

Dur	(1) Inc Mo	(3) Paid Clms	(4) Compl Factor	(9)= (3)/((4) @ 200907) Mod Inc Clms	(10)= (9)-(3) Est Res
6	200907		0.7368		
5	200908	83,178		112,891	29,713
4	200909	316,016		428,903	112,887
3	200910	40,247		54,625	14,377
2	200911	5090		6908	1818
1	200912	1293		1755	462

Note that this is the essence of the Development reserve calculation method and it is precisely this method that is used for all *credible* months in this calculation. For example, the incurred claims for duration seven (200906) are $42,959/0.7769=55,295$. Taking the maximum between three calculations, (A), (B), and (C), we obtain:

Table 17: Conservative Reserve Estimate for Non-Credible Months

Dur	Inc Mo	Paid Clms	Method A	Method B	Method C	Mod Inc Clms
5	200908	83,178	134,061	140,769	112,891	140,769
4	200909	316,016	133,914	138,730	428,903	428,903
3	200910	40,247	135,078	138,094	54,625	138,094
2	200911	5090	136,233	137,466	6908	137,466
1	200912	1293	133,610	133,091	1755	133,610

Finally, the Modified Incurred Claims (column (9)) and Estimated Reserves (column (10)) are:

Table 18: Reserves (3-way test ex.)

	(1)	(2)	(3)	(4)	(5)= (3)/(4)	(6)= (5)/(2)	(7)	(8)	(9)	(10)=
Dur	Inc Mo	Earned Prem	Paid Clms	Compl Factor	Est Inc Clms	Loss Ratio	Ave LR (12 mo)	Antic LR (Pricing) (ALR)	Mod Inc Clms	Est Res
9+	200904	185,618	185,637	0.8315	223,255	1.20	58.8%		223,255	37,619
8	200905	187,383	153,896	0.8055	315,203	1.68	69.0%		315,203	61,307
7	200906	187,959	42,959	0.7769	55,295	0.29	69.2%		55,295	12,336
6	200907	184,260	171,375	0.7368	232,593	1.26	77.7%		232,593	61,218
5	200908	181,164	83,178	0.6763	122,990	0.68	74.9%	74.0%	140,769	57,581
4	200909	178,552	316,016	0.5955	530,673	2.97	93.0%	75.0%	428,903	112,887
3	200910	177,734	40,247	0.4718	85,306	0.48	89.7%	76.0%	138,094	97,847
2	200911	176,926	5090	0.2829	17,992	0.10	89.6%	77.0%	137,466	132,377
1	200912	171,294	1293	0.0287	45,068	0.26	90.2%	78.0%	133,610	132,316

Comparing the final results in the most recent incurral months, we can make the following observations:

1. Modified incurred claims calculated by Method A contributed to the final answer in duration 1. This method usually plays the role when the recent experience is better than that anticipated by the pricing model.
2. Modified incurred claims calculated by Method B contributed to the final answer in durations 2, 3, and 5. This method usually plays the role when the recent experience is better than that in the most recent 12 credible months.
3. Modified incurred claims calculated by Method C contributed to the final answer in duration 4. This method usually plays a role when the recent experience is worse (i.e. paid claims are much higher) than anticipated by the model used to develop completion factors for a particular product. In our example, paid claims in September of 2009 were \$316,016, significantly higher than normal, indicating possibility of an unusually large claim.
4. Method C will usually result in an inadequate estimate but not as inadequate as the other estimates.

8 Conservative Bornhuetter-Ferguson Method

For some products with certain characteristics, ABC uses a modified Bornhuetter-Ferguson approach which blends a completion factor estimate with the 3-way test, using the completion factor as the weight for the completion factor estimate.

In general, the Bornhuetter-Ferguson method is an actuarial technique for developing claims to estimate their ultimate amount used when the data is thin and volatile, or for an unusual line with a long tail, or with a new line. It is typically used by small and medium size insurers [6].

The conservative Bornhuetter-Ferguson method is based on a traditional Bornhuetter-Ferguson method. An amount for expected unpaid claims (derived using the reciprocal of the loss development factor) is added to actual paid claims to obtain the estimated ultimate claims for a given incurred period. The technique is most useful when actual paid claims for an incurred year are a poor indicator of future incurred but not reported (IBNR) claims for the same incurred year, as is often the case when there is a low frequency of claims but a very high potential severity.

A traditional Bornhuetter-Ferguson method combines the estimated loss ratio with a projection method. It blends a completion factor incurred claim estimate with the Estimated Loss Ratio incurred claim estimate, using the completion factor as the weight for the completion factor estimate. Since a completion factor incurred claim estimate is a ratio of Paid Claims to the completion factor, multiplying it by the weight of the completion factor, leaves us with Paid Claims. Thus, a traditional Bornhuetter-Ferguson method could be described as the sum of the Paid Claims and the Estimated Loss Ratio incurred claim estimate (Method A above) weighted by one minus the completion factor:

$$IC_{BF} = IC_{CF} * cf + (1 - cf) * IC_{LR} = PC + (1 - cf) * EP * ALR,$$

where IC is the incurred claims estimate, PC is the Paid Claim, EP is the Earned Premium and ALR is the Anticipated (or Estimated) Loss Ratio. Using our example above, the Traditional Bornhuetter-Ferguson method calculation in the last five months would look like:

Table 19: Traditional Bornhuetter-Ferguson

	(1)	(2)	(3)	(4)	(8)	(9)	(10)=	(11)=
Dur	Inc Mo	Earned Prem	Paid Clms	Compl Factor	Antic LR (ALR)	(2)*(8) Mod IC	(3)+(1-(4))*(9) Ult IC	(10)-(3) Est Res
5	200908	181,164	83,178	0.6763	74.0%	134,061	126,574	43,396
4	200909	178,552	316,016	0.5955	75.0%	133,914	370,184	54,168
3	200910	177,734	40,247	0.4718	76.0%	135,078	111,595	71,348
2	200911	176,926	5090	0.2829	77.0%	136,233	102,783	97,693
1	200912	171,294	1293	0.0287	78.0%	133,610	131,068	129,775

where, for example, for duration 3, the Ultimate Incurred Claims are calculated as follows:

$$40,247 + (1 - 0.4718) \cdot 177,734 \cdot 0.76 = 40,247 + (1 - 0.4718) \cdot 135,078 = 111,595$$

In the Conservative Bornhuetter-Ferguson approach the Ultimate Incurred Claims are estimated as the sum of the Paid Claims and the conservative incurred claim estimate obtained by the 3-way test weighted by one minus the completion factor:

$$IC = PC + (1 - cf) * IC_{3\text{-way test}},$$

Using our example above, the conservative Bornhuetter-Ferguson method calculation in the last five months would look like:

Table 20: Conservative Bornhuetter-Ferguson

	(1)	(2)	(3)	(4)	(8)	(9)	(10)=	(11)=
Dur	Inc Mo	Earned Prem	Paid Clms	Compl Factor	Antic LR (ALR)	Mod IC	(3)+(1-(4))*(9) Ult IC	(10)-(3) Est Res
5	200908	181,164	83,178	0.6763	74.0%	140,759	128,742	45,564
4	200909	178,552	316,016	0.5955	75.0%	428,903	489,507	173,491
3	200910	177,734	40,247	0.4718	76.0%	138,094	113,189	72,941
2	200911	176,926	5090	0.2829	77.0%	137,466	103,667	98,577
1	200912	171,294	1293	0.0287	78.0%	133,610	131,068	129,775

where, for example, for duration 4, the Ultimate Incurred Claims are calculated as follows:

$$316,016 + (1 - 0.5955) \cdot 428,903 = 489,507$$

Note that due to the nature of the Conservative Development method used by ABC which results in more conservative estimations of the incurred claims and the reserves, the Conservative Bornhuetter-Ferguson method also shows more conservatism.

9 Conclusion

In this paper we presented and compared a traditional and a conservative approaches to calculating the reserves for a health insurance company. The conservative approach was found particularly useful when estimating reserves for an individual health insurance company with numerous product lines each relatively small in volume. It could prove to be the right approach for this company and could allow it to successfully preserve its wealth while faithfully and conscientiously serving its insureds, agents, employees and stockholders.

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