VARIABLE ANNUITIES AND VARIABLE LIFE INSURANCE:

ACTUARIAL DESIGN, RESERVES AND ASSET-LIABILITY

MANAGEMENT

Jens Vischer

192 Pages August 2002

A description of variable annuities, their features and how they work, the market situation, and issues in reserving and asset-liability management.

APPROVED :

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Date Krzysztof M. Ostaszewski, Chair

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Date Hans Joachim Zwiesler

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Date James M. Carson

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Variable annuities are currently one of the most popular insurance products in the United States. They combine the potential of the stock markets with the advantages of a traditional fixed annuity. They have become a highly demanded investment for retirement savings.

Chapter I gives the different types of annuities and their advantages and disadvantages. The various variable annuity product features including guaranteed annuity payments and death benefits, as well as embedded fees and charges are described in chapter II.

Chapter III gives an overiew over current market data of the United States for both variable life insurance and variable annuities. It shows the properties and purposes of consumers that buy or own variable annuities and of the companies selling them.

Chapters IV and V describe the process of reserving for fixed and variable annuities. The Commissioners Annuity Reserve Valuation

Method, which applies for traditional fixed, and in some way for variable annuities is explained in detail. Considerations in pricing a variable annuity and an important actuarial model, the unit value concept, are presented in chapter VI. Asset investments of life insurance companies and the regulatory environment they have to follow can be found in chapter VII. In addition, the assets invested within a variable annuity are classified into their objectives.

Chapter VIII gives an overview over asset-liability management strategies and techniques that are used by insurance companies. The mathematical background of one of these techniques is described in detail. The chapter also contains issues in risk management for variable annuities. Two representative product samples of variable annuities are presented in chapter IX.

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JENS VISCHER

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Fullfillment of the Requirements
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ABBREVIATIONS

AOMR	Actuarial Opinion and Memorandum Regulation
ASOP	Actuarial Standards of Practice
CARVM	Commissioners Annuity Reserve Valuation Method
CD	Certificate of Deposit
GAAP	Generally Accepted Accounting Principles
GIC	Guaranteed Investment Contract
GMAB	Guaranteed Minimum Accumulation Benefit
GMAF	Guaranteed Minimum Annuity Floor
GMDB	Guaranteed Minimum Death Benefit
GMIB	Guaranteed Minimum Income Benefit
GRA	Guaranteed Return Annuities
GRIB	Guaranteed Retirement Income Benefit
GRIP	Guaranteed Retirement Income Program
IRS	Internal Revenue Service
MVA	Market Value Adjustment Annuity
NAIC	National Association of Insurance Commissioners
NAVA	National Association for Variable Annuities
RBC	Risk Based Capital
SPDA	Single Premium Deferred Annuity
SVL	Standard Valuation Law
TIAA-CREF	Teachers Insurance and Annuity Association College Retirement Equities Fund
VAGLB	Variable Annuity with Guaranteed Living Benefits

CHAPTER I

DIFFERENT TYPES OF ANNUITIES

What is an Annuity?

An *annuity* is a contract between the customer (the annuitant) and an insurance company designed to provide the customer with income in the future. The customer invests a certain amount of money (*the premium*) in order to receive future payments. Therefore the company offers him to invest customer´s money and to pay it back in the desired way at the time stated in the contract. A *traditional fixed annuity* is a financial instrument offering the following features (WM. Baker Associates, 1997):

- Interest rates paid to the customer (*credited rates*) that are usually higher than the ones offered by a bank account, or at least competitive when compared with alternative investments with similar risk characteristics;
- Guaranteed principal and interest income;
- A guarantee of a lifetime income (*life annuity*), or a guarantee of income over a specified period of time during which the annuity

payments are not contingent on the annuitant being alive (*annuity certain*) (Black and Skipper, 1999);

- Tax-deferred earnings (interest earned by the consumer within the annuity contract is not taxable to that consumer until the annuity payments start, and investment income earned by the insurance firm offering the annuity is not treated as income to such insurance firm as long as the said investment income is credited to the account of the customer).

When is an Investment in an Annuity appropriate?

For the consumer, an annuity represents a form of an investment of consumer's savings, only one of many alternatives available. A very natural question to ask before investing in an annuity is: why would this financial instrument be chosen over the other ones available in the marketplace?

There are several reasons why to invest money in an annuity (WM. Baker Associates, 1997):

- *To use it as a retirement planning vehicle*

Annuities meet almost all requirements of customers that look for a long term, safe capital asset that guarantees competitive rates of

return. Therefore they are well qualified for the use in pension plans, and for any conservative investment.

- *Whenever there is an importance of safety of principal desired from the investor*

A life insurance company has to meet certain legal constraints, which provide guarantees to the consumers. An insurance company must hold appropriate reserves as established by the actuary. These reserves must, at all times, be equal to, or greater than, the withdrawal value of the annuity policy. In addition to reserves, state insurances also require certain levels of capital and surplus to be held by the insurance firm, to further increase policyholder protection. Furthermore, states provide guarantee funds in case of an insolvency of an insurance company.

- *When a tax deferred accumulation of interest is appropriate*

The investment income earned by the annuity is not taxable until the beginning of the payout phase. Then the investor might be in a lower tax bracket and therefore pay less taxes than he otherwise would during the accumulation phase. Also, ability to reinvest income without having it reduced by taxes substantially increases long-term benefits of compounding of interest to the annuity holder.

- *To get a specific level of interest for a long period of time without risking the principal of the investment*

As already mentioned above, annuities guarantee a specific interest rate.

- *To get an investment with an income stream that cannot be outlived*

The payments provided by an annuity, if not stated otherwise in the contract, are made as long as the customer lives. This feature is unique to life annuities, in fact it defines life annuities, and is a source of competitive edge for insurance firms in the retirement market. Of course, one must remember that in the United States, life annuities are also provided with Social Security social insurance system (Old Age Security and Disability Income), and those government-provided annuities are inflation-adjusted, unlike annuities offered in the private sector.

- *To receive a monthly income that is equal to or higher than other conservative investments*

The alternatives to investing in an annuity are for example mutual funds or guaranteed investment contracts (GIC). Those instruments generally do not offer income guarantees, and, at the same level of risk, rarely offer interest rates competitive to those offered by annuities.

- *As an alternative or replacement to a monthly or other periodic investment plan*

In times of low stock returns or low interest rates the investment in an annuity still provides the guaranteed rate, whereas the value of another investment may decrease.

Advantages and Disadvantages

As it is true with any investment, there are several advantages and disadvantages to investing in an annuity. Investment feature that may be an advantage to one person may be a disadvantage to another. Depending on the situation of an investor, there may be other advantages and/or disadvantages than presented below (WM. Baker Associates, 1997).

Advantages:

- *An annuity can be used to protect and build the customer´s cash reserve*

Due to its conservative characteristics, an annuity is a safe investment that provides competitive rates of return.

- *The insurance company guarantees (with the exception of variable annuities) the principal.*

- *Earned interest rates from single premium deferred annuities are adjusted, usually on an annual basis, to increase or decrease in line with current market interest rates.*

For example even if the company earns a 7% gross interest rate during a year, it only pays out 6% for this year, before deducting for expenses etc. If the rates in the next year decrease and the company only earns 4%, it may still pay the customer 5% and therefore be more attractive than another investment.

- *After retirement, an annuity can provide the customer with a fixed monthly income with lifetime guarantees.*
- *With an annuity one can "time" the receipt of income and shift it into tax years where the income is taxed at a lower rate.*

For example a consumer that is now 25, single, would have to pay more taxes today than when he is 65, married and has children.

- *Annuity interest rates are usually equal or higher than the ones offered by other fixed income investments like bank certificates of deposits (CDs)*

For example the rates of Conseco Bank certificates of deposits (rates effective: 5/21/2002 – 5/28/2002):

Table 1: Rates of Conseco Bank Certificates of Deposits

(Source: Conseco, Inc., 2002)

Term	Rate	APY
6 months	2.23%	2.25%
12 months	2.86%	2.90%
18 months	3.25%	3.30%
24 months	3.73%	3.80%

Whereas the Conseco Simple Index Annuity offers a guaranteed interest rate of 9% for five years (Conseco, Inc., 2002).

- *As compared to a taxable investment, with an equivalent interest rate, such as a CD, an annuity will produce capital more quickly since the effective yield after-tax will be higher*

Due to its tax-deferred characteristics, the investor´s money compounds more quickly since he can earn interest on money that have otherwise been paid to the IRS.

Disadvantages:

- *If one chooses at retirement to receive a lump sum distribution instead of a fixed monthly income there may be a significant tax burden*

In this case the whole accumulated account is suddenly taxable. When choosing the monthly income, this taxation is split over the period of the payments.

- *Cash withdrawals from an annuity prior to age 59-1/2 are generally subject to a 10 percent penalty tax with certain exceptions.*

Exceptions are made by disability, unremembered medical expenses, death, higher education expenses, first time homebuyer.

- *If it is necessary for the investor to liquidate the annuity during the early years of the contract, there may be certain fees and costs applicable.*

  Most annuities include a withdrawal or surrender charge.

- *An annuity (with the exception of variable annuity) is a conservative investment and does not offer the flexibility and liquidity offered by certain other investments.*

Different Types of Annuities

The large number of annuity products on the market today can make understanding them difficult. But in fact, there are only a handful of different types of annuities. There are three primary considerations when thinking about annuities (Cornerstone Financial Products, 2002):

- Timing of payout: immediate or deferred

- Investment type: fixed or variable
- Annuities with or without withdrawal penalties

Immediate Annuities

In an immediate annuity, the investor begins to receive payments immediately upon investing. This is for investors that need immediate income from their annuity. By purchasing an immediate annuity one can choose between payments for a certain period of time (typically five to twenty years). This period is called *period certain*, the payments during this period are guaranteed. The other choice are payments for the rest of one´s life and/or one´s spouse's life, or any combination of the two. The customer can even choose between a fixed payment that doesn't vary or a variable payment that is based on market performance. Immediate annuities are often used after retirement when investing a large amount of money in order to receive fixed payments for the rest of lifetime (Cornerstone Financial Products, 2002).

Deferred Annuities

In a deferred annuity, one receives payments starting at some later date, usually at retirement. With a deferred annuity a consumer can invest either a lump sum all at once, or make periodic payments, either

fixed or variable. Those funds grow tax-deferred until he/she is ready to begin receiving payments.

Fixed Annuities

Assets supporting fixed annuities are invested primarily in government securities, and high-grade corporate bonds. All investment decisions are made by the company, and the customer has no influence on the investment strategy. Fixed annuities offer a guaranteed rate of return, typically over a period of one to ten years. There are two basic types of fixed annuities: the *Guaranteed Return Annuities* (GRA) is a fixed annuity that offers a guarantee that the costumer can never receive less than 100% of his investment - no penalties or fluctuations in the interest rate market can impact the principal should he/she surrender. The *Market Value Adjustment Annuity* (MVA) works much like the GRA, but there is no guarantee of the principal if rates rise and one surrenders his contract. This may be the case if the customer surrenders the policy and the insurance company has to sell investments before their maturity date. The risk that interest rates rise and policy loans and surrenders increase or maturing contracts do not renew at anticipated rates of renewal is on the customer. This risk is called *disintermediation risk*. MVAs work like a bond and often pay more than a GRA due the risk of

rising rates being transferred to the customer (Cornerstone Financial Products, 2002).

Variable Annuities

Variable annuities, defined more accurately in chapter II, enable a customer to invest in a selection of funds, called sub-accounts. These sub-accounts are tied to market performance, and often have a corresponding managed investment after which they are modeled, such as a mutual fund. Available choices range from the most conservative, such as money market, guaranteed fixed accounts, and government bond funds, to more aggressive such as growth, small cap, mid cap, large cap, capital appreciation, aggressive growth, and emerging markets funds. Some have as many as 40 or more fund choices with ten or more managers, and allow customers to switch between them.

One special type of variable annuity is the living benefit annuity, also known as a GRIB (*Guaranteed Retirement Income Benefit*) or GRIP (*Guaranteed Retirement Income Program*). The best living benefit annuities guarantee at least a 5% return over seven years, or the highest attained value on each anniversary during the surrender period, whichever is greater. It also guarantees an amount of annuity payments for the lifetime of the annuitant or for a period stated in the contract. In

exchange for this living guarantee, the living benefit annuity has a surrender charge, or penalty for early withdrawal, no up-front bonus, and a slightly higher annual fee. It is based on more conservative assumptions, therefore the income guaranteed may be less than the income provided under the regular contract.

Annuities with Withdrawal Penalties

Some annuities allow consumers to withdraw either their interest earnings or up to 15% per year without a penalty, although any withdrawal from an annuity may be subject to taxes and a 10% federal penalty if taken prior to 59½ years of age. This is stated in the Internal Revenue Code, interest earnings are subject to ordinary income taxes, the 10% penalty is called *Premature Distribution*. The idea behind it is to make sure that people do not abuse the money they accumulated for their retirement. Beyond that, most annuities have a surrender charge - a penalty for making an early withdrawal above the free withdrawal amount. Typically this surrender charge disappears over a seven-year period (Cornerstone Financial Products, Inc., 2002).

Why would one choose an annuity with a withdrawal penalty? Some annuities with surrender charges reward the investor by offering a „bonus": the insurance company adds on average 3% to 5% to the

amount of the principal. For example, if one invests $10,000 in a bonus annuity the insurance company will add $300 to $500 to the annuity immediately. The trade-off is that with a bonus annuity the surrender period is usually longer (eight to nine years in most cases versus the typical seven-year surrender). But bonuses are rare, companies prefer to offer an attractive credited interest rate.

Annuities without Withdrawal Penalties

For investors who may need spur-of-the-moment access to their money, there are annuities without surrender charges (no-surrender or level load annuities) - these annuities have no penalty or charge for early withdrawal. But even with a no-surrender annuity investors under the age of 59 ½ are subject to the 10% federal excise tax as well as ordinary income taxes on any gains. The investor can avoid any taxes or penalties, however, by making a 1035 Tax-Free Exchange (see chapter II) to another annuity, regardless of age. No-surrender annuities do not come with bonuses, and some insurance companies charge higher fees for their no-surrender charge products (Cornerstone Financial Products, 2002).

CHAPTER II

WHAT IS A VARIABLE ANNUITY?

A *variable annuity* is an annuity insurance policy that provides for annuity benefits that vary according to the investment experience of a separate account or accounts maintained by the insurer (American Academy of Actuaries, 1998a).

A variable annuity offers a range of investment options. The value of the investment will vary depending on the performance of the investment options chosen. The investment options for a variable annuity are typically mutual funds that invest in stocks, bonds, money market instruments, or some combination of the three. A more detailed description of the investment options is given in chapter VII.

Although variable annuities are typically invested in mutual funds, variable annuities differ from mutual funds in several important ways (U.S. Securities and Exchange Comission, 2002):

First, variable annuities provide *periodic payments* for the rest of the customer´s life (or the life of the spouse or any other person designated). This feature offers protection for the customer against the possibility that, after one retires, one outlives one´s assets.

Second, variable annuities have a *death benefit***.** If one dies before the insurer has started making payments, the beneficiary stated in the contract is guaranteed to receive a specified amount – typically at least the amount of the purchase payments premiums. The beneficiary will get a benefit from this feature if, at the time of the death of the contract holder, the account value is less than the guaranteed amount.

Third, variable annuities are *tax-deferred*. That means the customer pays no taxes on the income and investment gains from the annuity until he/she withdraws his/her money. These earnings, unlike money in a savings account, a mutual fund, a certificate of deposit, are not taxed in the year in which they are earned. They can continue to grow and compound tax-free until withdrawal. The customer may also transfer his/her money from one investment option to another within a variable annuity without paying tax at the time of the transfer. When the customer takes money out of a variable annuity, however, he/she will be taxed on the earnings at ordinary income tax rates rather than lower capital gains rates. Capital gains tax rates for long term investments (assets held for more than one year) are 10% for the 15% tax bracket, and 20% for the other tax brackets (these tax rates are likely to change over time).

Table 2: Federal Personal Income and Capital GainTax Rates for 2001 (Source: Internal Revenue Service, 2001)

Filing Status and Taxable Income Level				
Single	Married filing jointly or Qualifying Widow(er)	Married filing separately	Head of household	Tax Rate
Up to $27,050	Up to $45,200	Up to $22,600	Up to $36,250	15%
$27,051- $65,550	$45,201- $109,250	$22,601- $54,625	$36,251- $93,650	27.5%
$65,551- $136,750	$109,251- $166,500	$54,626- $83,250	$93,651- $151,650	30.5%
$136,751- $297,350	$166,501- $297,350	$83,251 - $148,675	$151,651- $297,350	35.5%
$297,351 or more	$297,351 or more	$148,676 or more	$297,351 or more	39.1%

Capital Gains Tax Rates for 2001			
Tax Bracket	Short Term Rate (under one year)	Long Term Rate (up to 7 years)	Ultra Long Term Rate (more than 7 years)
15 %	15 %	10 %	8 %
27.5 %	27.5 %	20 %	18 %
30.5 %	30.5 %	20 %	18 %
35.5 %	35.5 %	20 %	18 %
39.1 %	39.1 %	20 %	18 %

How a Variable Annuity works

As any other (deferred) annuity, a variable annuity has two phases: an *accumulation phase* and a *payout phase*. During the accumulation phase, the customer pays premiums, which can be allocated by the said customer to a number of investment options. For example, one could designate 40% of the purchase payments to a bond fund, 40% to a U.S. stock fund, and 20% to an international stock fund. The money that is allocated to each investment option will increase or decrease over time, depending on the fund's performance. In addition, variable annuities often allow the customer to allocate part of his purchase payments to a fixed account. A fixed account, unlike a mutual fund, pays a fixed rate of interest whereas the value of a mutual fund in the worst case may decline. The insurance company may reset this interest rate periodically, but it will usually provide a guaranteed minimum (*e.g.*, 3% per year) (U.S. Securities and Exchange Comission, 2002).

> Example: (U.S. Securities and Exchange Comission, 2002) One purchases a variable annuity with an initial purchase payment of $10,000. One allocates 50% of that purchase payment ($5,000) to a bond fund, and 50% ($5,000) to a stock fund. Over the following year, the stock fund has a 10% return, and the bond fund has a 5% return. At the end of the year, the account has a value of $10,750 ($5,500 in

the stock fund and $5,250 in the bond fund), minus fees and charges (discussed below).

During the accumulation phase, one can typically transfer money from one investment option to another without paying tax on investment income and gains, although one may be charged by the insurance company for transfers. However, if the customer withdraws money from his account during the early years of the accumulation phase, he may have to pay *surrender charges*, which are discussed below. In addition, he may have to pay a 10% federal tax penalty if he withdraws money before the age of 59½. This is a special tax levied for taking money from the qualified account too early. This special tax is levied at the same rate, no matter what the other taxes are.

At the beginning of the payout phase, usually when the customer retires, he/she may receive his/her purchase payments plus investment income and gains (if any) as a lump-sum payment, or he/she may choose to receive them as a stream of payments at regular intervals (generally monthly).

If one chooses to receive a stream of payments, there may be a number of choices of how long the payments will last. Under most annuity contracts, one can choose to have the annuity payments last for a period that one has set (such as 20 years) or for an indefinite period

(such as lifetime or the lifetime of the customer and his spouse or other beneficiary). During the payout phase, the annuity contract may permit the choice of receiving payments that are fixed in amount or payments that vary based on the performance of the investment options. The amount of each periodic payment will depend, in part, on the time period that is selected for receiving payments. Some annuities do not allow withdrawals from the account once one has started receiving regular annuity payments.

Features of a Variable Annuity

A common feature of variable annuities is the death benefit. If the customer dies, a person that he selected as a beneficiary (such as his spouse or child) will receive the greater of:

(i) all the money in the account, or

(ii) some guaranteed minimum (such as all purchase payments minus prior withdrawals).

Example: (U.S. Securities and Exchange Comission, 2002) A consumer owns a variable annuity that offers a death benefit equal to the greater of account value or total purchase payments minus withdrawals. He/she has made purchase payments totaling $50,000. In addition, he/she has

withdrawn $5,000 from his/her account. Because of these withdrawals and investment losses, the account value is currently $40,000. If he/she dies, the designated beneficiary will receive $45,000 (the $50,000 in purchase payments the customer put in minus $5,000 in withdrawals).

Some variable annuities allow a choice of a *stepped-up death benefit*. Under this feature, the guaranteed minimum death benefit may be based on a greater amount than purchase payments minus withdrawals. For example, the guaranteed minimum might be the account value as of a specified date, which may be greater than purchase payments minus withdrawals if the underlying investment options have performed well. The purpose of a stepped-up death benefit is to „lock in" the investment performance already achieved and to prevent a later decline in the value of the account from eroding the amount that one expects to leave to the heirs. This feature carries a charge, a premium must be paid for it, and this, in turn, will reduce the account value.

Variable annuities sometimes offer other optional features, which also incur extra charges. One common feature, the *guaranteed minimum income benefit* (GMIB), guarantees a particular minimum level of annuity payments, even if there is not enough money in the account (perhaps because of investment losses) to support that level of payments. In fact,

all early annuities were completely guaranteed, and one can thus view this feature as an addition of a very traditional fixed annuity to a variable one (U.S. Securities and Exchange Comission, 2002).

Another quite similar option is the *guaranteed minimum annuity floor* (GMAF), which is a floor on a variable annuity payout. It guarantees that the monthly or annual payments will never be less than some amount. The difference to the guaranteed minimum income benefit is that it is determined at annuitization, whereas the GMIB is determined at issue.

Some products offer so called *guaranteed minimum accumulation benefits* (GMAB). This option provides a minimum account value after a waiting period. However, the choice of funds may be controlled by the insurance company under this feature.

Other features may include long-term care insurance. This covers a person against the costs of home health care, community-based care (assisted living, etc.) and nursing home care. These costs are dramatically high and generally not covered by Medicare, which only pays up to 100 days of long-term care. For qualified beneficiaries of course, long-term care insurance can be purchased on a stand-alone basis, and therefore this feature amounts to bundling of another insurance policy with the annuity.

Sometimes it is possible that the spouse of the annuitant may choose to continue the contract after the death of the policyholder. It is also offered by some companies that the annuity payments are made for both, the annuitant and his/her spouse. This means that if the annuitant dies, the spouse still gets annuity payments until his/her death.

Variable Annuity Charges

A customer investing in a variable annuity must pay various charges. This is unlike in a traditional fixed annuity, where the insurance firm receives a premium and only pays such benefit that provides the insurance firm with compensation for its expenses, and with appropriate profit margin. In a variable annuity, the customer receives the investment performance of the underlying investment options, and this leaves no room for any flow of funds to the insurance firm. Instead, insurance company´s costs and profits are obtained as direct charges to the customer.

There exist a variety of charges when investing in a variable annuity:

- *Surrender charges*: If one withdraws money from a variable annuity within a certain period after a purchase payment (typically within

six to eight years, but sometimes as long as ten years), the insurance company usually will assess a "surrender" charge, which is a type of sales charge. This charge is used to pay the financial professional a commission for selling the variable annuity to you. Generally, the surrender charge is a percentage of the amount withdrawn, and declines gradually over a period of several years, known as the *surrender period*. For example, a 7% charge might apply in the first year after a purchase payment, 6% in the second year, 5% in the third year, and so on until the eighth year, when the surrender charge no longer applies. Often, contracts will allow withdrawal of part of the account value each year – 10% or 15% of the account value, for example – without paying a surrender charge.

> Example: (U.S. Securities and Exchange Comission, 2002) One purchases a variable annuity contract with a $10,000 purchase payment. The contract has a schedule of surrender charges, beginning with a 7% charge in the first year, and declining by 1% each year. In addition, one is allowed to withdraw 10% of his/her contract value each year free of surrender charges. In the first year, one decides to withdraw $5,000, or one-

half of the contract value of $10,000 (assuming that the contract value has not increased or decreased because of investment performance). In this case, one could withdraw $1,000 (10% of contract value) free of surrender charges, but one would pay a surrender charge of 7%, or $280, on the other $4,000 withdrawn.

- *Mortality and expense risk charge*: This charge is equal to a certain percentage of the account value, typically in the range of 1.25% per year. This charge compensates the insurance company for insurance risks it assumes under the annuity contract. Profit from the mortality and expense risk charge is sometimes used to pay the insurer's costs of selling the variable annuity, such as a commission paid to the financial professional for selling the variable annuity.

  Example: (U.S. Securities and Exchange Comission, 2002) A variable annuity has a mortality and expense risk charge at an annual rate of 1.25% of account value. The consumer´s average account value during the year is $20,000, so he/she will pay $250 in mortality and expense risk charges that year.

- *Administrative fees*: The insurer may deduct charges to cover record-keeping and other administrative expenses. This may be charged as a flat account maintenance fee (perhaps $25 or $30 per year) or as a percentage of the account value (typically in the range of 0.15% per year).

  Example: (U.S. Securities and Exchange Comission, 2002) A variable annuity charges administrative fees at an annual rate of 0.15% of account value. The customer´s average account value during the year is $50,000. He/she will pay $75 in administrative fees.

- *Underlying Fund Expenses*: The customer will also indirectly pay the fees and expenses imposed by the mutual funds that are the underlying investment options for the variable annuity.
- *Fees and Charges for Other Features*: Special features offered by some variable annuities, such as a stepped-up death benefit, a guaranteed minimum income benefit, or long-term care insurance often carry additional fees and charges.

Other charges, such as initial sales loads, or fees for transferring part of the account from one investment option to another, may also apply (U.S. Securities and Exchange Comission, 2002).

Tax-Free 1035 Exchanges

Section 1035 of the U.S. tax code (Internal Revenue Code) allows a customer to exchange an existing variable (or fixed) annuity contract for a new annuity contract without paying any tax on the income and investment gains in the current variable (or fixed) annuity account. These tax-free exchanges, known as *tax-free 1035 exchanges*, can be useful if another annuity has features that one prefers, such as a larger death benefit, different annuity payout options, or a wider selection of investment choices.

One may, however, be required to pay surrender charges on the old annuity if one is still in the surrender charge period. In addition, a new surrender charge period generally begins with the exchange into the new annuity. This means that, for a significant number of years (as many as 10 years), one typically will have to pay a surrender charge (which can be as high as 9% of the purchase payments) if one withdraws funds from the new annuity. Further, the new annuity may have higher annual fees and charges than the old annuity, which will reduce the returns.

Bonus Credits

Some insurance companies are now offering variable annuity contracts with „bonus credit" features. These contracts promise to add a

bonus to the contract value based on a specified percentage (typically ranging from 1% to 5%) of purchase payments.

> Example: (U.S. Securities and Exchange Comission, 2002) A customer purchases a variable annuity contract that offers a bonus credit of 3% on each purchase payment. He/she makes a purchase payment of $20,000. The insurance company issuing the contract adds a bonus of $600 to his/her account.

This benefit cannot be, of course, free. The customer pays for it in some other form. Typically, insurers will charge the customer for bonus credits in one or more of the following ways:

- *Higher surrender charges:* Surrender charges may be higher for a variable annuity that pays a bonus credit than for a similar contract with no bonus credit.
- *Longer surrender periods:* The purchase payments may be subject to surrender charges for a longer period than they would be under a similar contract with no bonus credit.
- *Higher mortality and expense risk charges and other charges:* Higher annual mortality and expense risk charges may be deducted for a variable annuity that pays a bonus credit. Although the difference may seem small, over time it can add up. In

addition, some contracts may impose a separate fee specifically to pay for the bonus credit.

Example: (U.S. Securities and Exchange Comission, 2002) One makes purchase payments of $10,000 in Annuity A and $10,000 in Annuity B. Annuity A offers a bonus credit of 4% on the purchase payment, and deducts annual charges totaling 1.75%. Annuity B has no bonus credit and deducts annual charges totaling 1.25%. Let's assume that both annuities have an annual rate of return, prior to expenses, of 10%. By the tenth year, the account value in Annuity A will have grown to $22,978. But the account value in Annuity B will have grown more, to $23,136, because Annuity B deducts lower annual charges, even though it does not offer a bonus.

A bonus may only apply to the initial premium payment, or to premium payments made within the first year of the annuity contract. Further, under some annuity contracts the insurer will take back all bonus payments made within the prior year or some other specified period if one makes a withdrawal, if a death benefit is paid to the beneficiaries, or in other circumstances.

Example: (U.S. Securities and Exchange Comission, 2002) A customer currently holds a variable annuity with an account value of $20,000, which is no longer subject to surrender charges. He/she exchanges that annuity for a new variable annuity, which pays a 4% bonus credit and has a surrender charge period of eight years, with surrender charges beginning at 9% of purchase payments in the first year. His/her account value in this new variable annuity is now $20,800. During the first year the customer holds the new annuity, he/she decides to withdraw all of the account value because of an emergency situation. Assuming that the account value has not increased or decreased because of investment performance, he/she will receive $20,800 minus 9% of his/her $20,000 purchase payment, or $19,000. This is $1,000 less than he/she would have received if he/she had stayed in the original variable annuity, where he/she was no longer subject to surrender charges.

CHAPTER III

THE MARKET SITUATION IN THE UNITED STATES

Life Insurance

In 1992, about 85% of all married couples in the United States, both with and without children, owned some type of life insurance policy to protect their family. The need for life insurance protection continues to grow: Americans purchased $2.7 trillion of new life insurance coverage in 2000, a 7% increase from 1999 (American Council of Life Insurers, 2001).

There are three types of life insurance policies dominating the market: individual life, group life, and credit life policies. Individual insurance is underwritten separately for each individual who is protected by the policy. Group insurance is underwritten on the basis of a group of people as a whole, for example the employees of a company. Credit insurance guarantees the payment of some credit, for example a mortgage, in case the insured person dies. It can be bought either on individual or on group basis.

Regarding the total amount of life insurance coverage in the United States, there was an increase of $457 billion, or 3%, by the end of 2000 over 1999.

The number of policies sold rose for individual policies by 1% between 1999 and 2000. 59% of all policies in force in 2000 were individual policies, or $9.4 trillion of protection (American Council of Life Insurers, 2001).

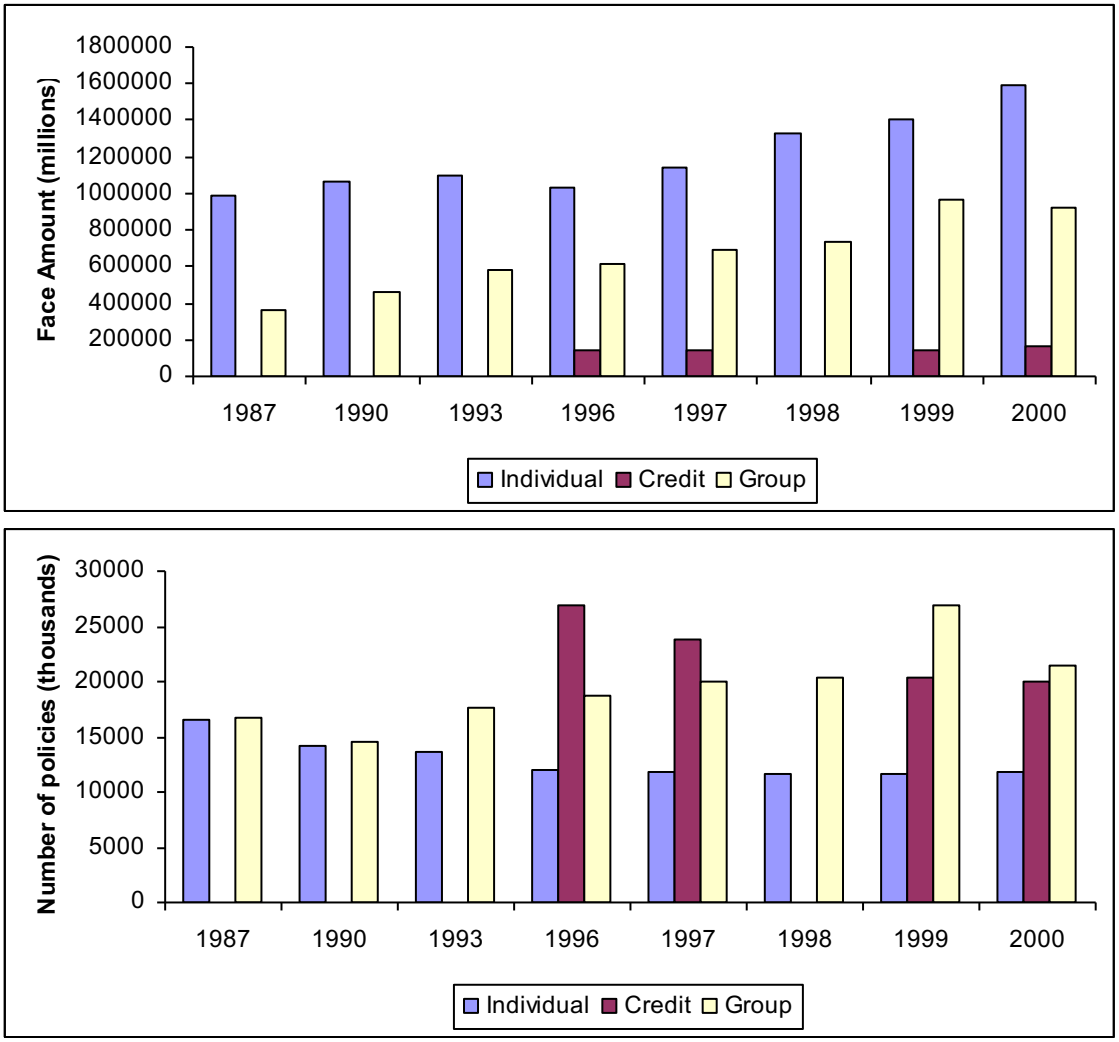

Figure 1: Purchases of Life Insurance

(Source: American Council of Life Insurers, 2001)

Data for credit life policies in 1987 and 1990 is not available.

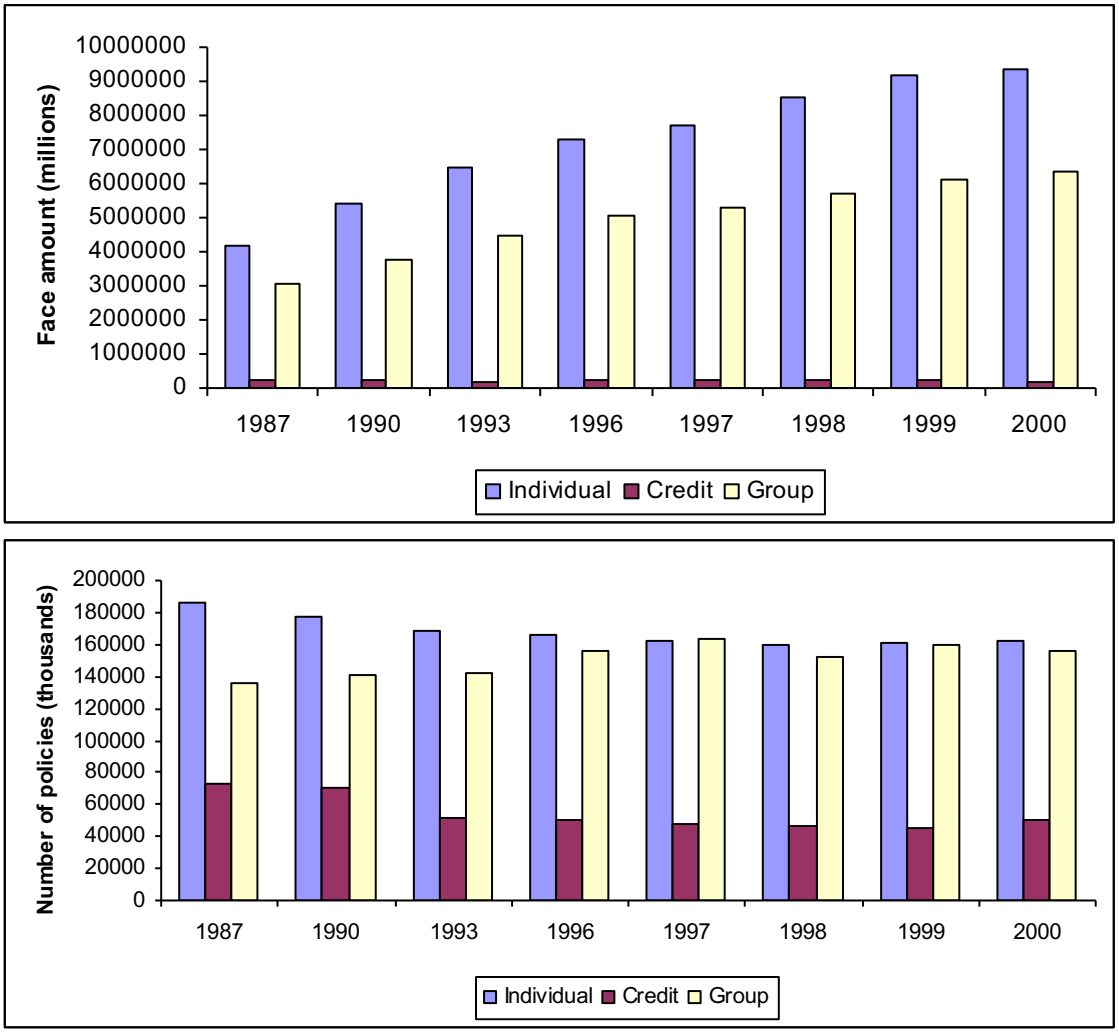

Figure 2: Life Insurance in Force

(Source: American Council of Life Insurers, 2001)

One distinguishes between term insurance and whole life insurance. Term insurance covers the insured for a specific time stated in the contract. *Whole life* (permanent life) insurance provides protection for as long as the insured person lives. In 2000, whole life insurance constituted about 52% of the issued life policies and 43% of the total face amount issued. 77% of all individual policies and 58% of the corresponding face amount, regarding life insurance in force, were whole life in 2000 (American Council of Life Insurers, 2001).

Whole life insurance products can be separated into three types: *Variable life*, *Universal life* and *Variable-universal life*.

Variable life insurance benefits depend on the performance of the investments connected to the policy. By the end of 2000, $85 billion of variable life insurance was in force in the United States. Over $21 billion of this amount was purchased in this year.

Universal life is a flexible premium policy allowing the customer to change the death benefit from time to time. It also allows the policyowner to vary the amount or time of the premium payments. About $1.9 trillion of universal life insurance was in force at the end of 2000, sales in 2000 totaled $146 billion (American Council of Life Insurers, 2001).

A combination of these two types is the variable-universal life insurance. It offers the premium flexibility of a universal life policy combined with the variation of the death benefit as known from a

variable policy. At the end of the year 2000, about $1.3 trillion of variable-universal life insurance was in force, $337 billion of this amount was purchased during 1997.

The trend shows that both, variable and universal policies, are being replaced by variable-universal policies. The number of sold variable policies declined between 1999 and 2000 by 38.5% from 140,000 to 86,000. The same happened to the face amount purchased with variable life insurance, it decreased from $22602 in 1999 to $20595 in 2000 (in millions). Only 978,000 universal policies were purchased in 2000 compared to 1,249,000 in 1999. The number of variable policies in force in 2000, 850,000, was 22.7% less than in 1999. Variable-universal life insurance policies in force increased by 47.2% to 9,365,000 at the end of 2000 (American Council of Life Insurers, 2001).

However, the dominating type of life insurance is still the universal life. The number of universal policies in force in 2000 was more than twice as much as the number of variable and universal-variable life combined (24,487,000) (American Council of Life Insurers, 2001).

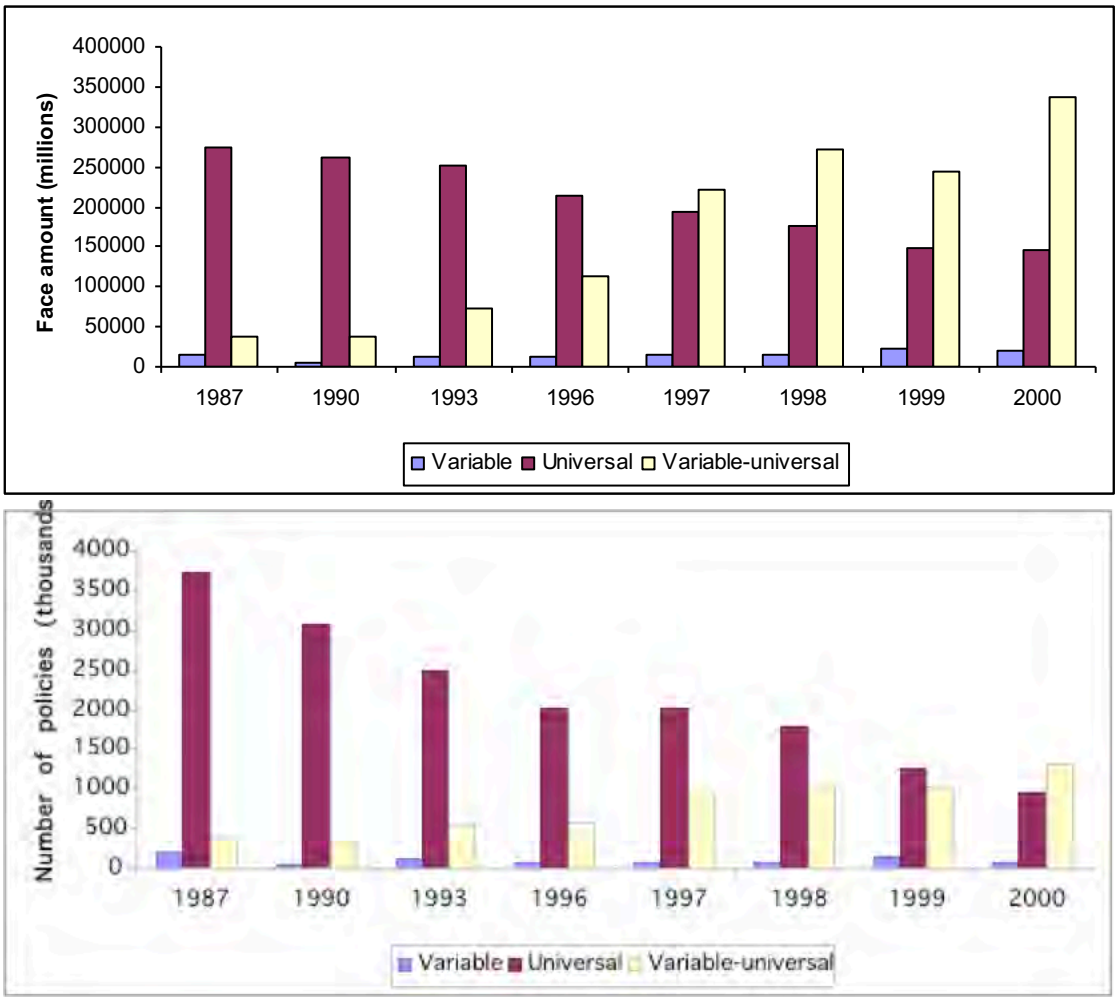

Figure 3: Purchases of Life Insurance

(Source: American Council of Life Insurers, 2001)

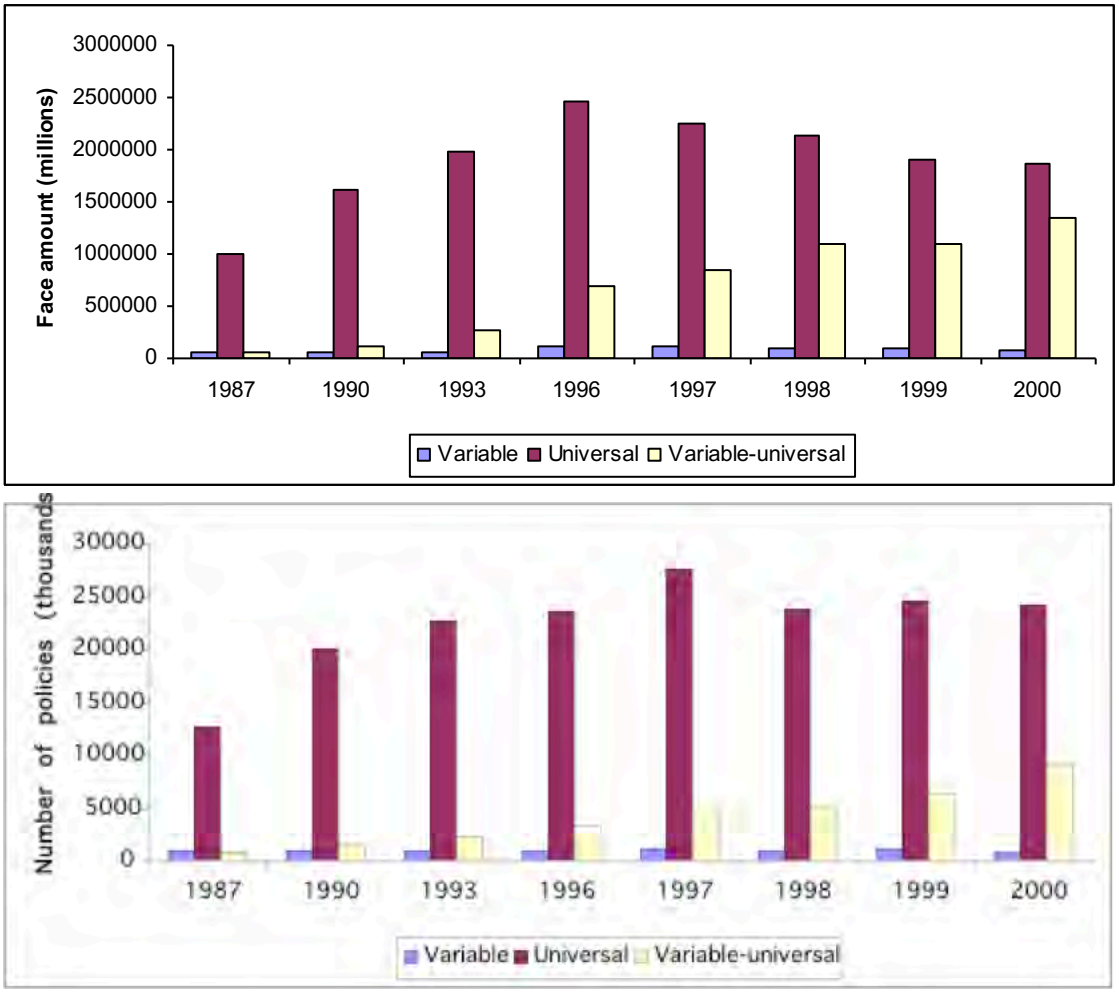

Figure 4: Life Insurance in Force

(Source: American Council of Life Insurers, 2001)

Annuities

Annuities in the United States are used in pensions, other retirement plans, structured settlements, and directly by customers to provide for their own retirement security. The US pension market is very large. Half of all full-time workers in US commerce and industry and

three-fourths of all government civilian personnel are enrolled in retirement plans other than Social Security (the U.S. Social Insurance System for retiremment and disability benefits). The number of participants is estimated at more than 50 million. (American Council of Life Insurers, 1998).

There are two different types of retirement plans, those that qualify for full pension tax treatment (*tax-qualified* or *qualified*), and plans that do not (*non-qualified*).

Another classification of retirement plans is either *defined benefit* or *defined contribution* plan. A defined benefit plan provides a specified benefit, the contributions needed to realize this benefit may vary. Defined contribution plans define the amount of contribution instead, for example a percentage of the income. In this case, the resulting benefit is not specified.

Most retirement plans are sponsored by employers. These plans include traditional defined benefit pensions, profit-sharing plans, 401(k), 403(b). In 1995 73% of the assets for tax-qualified plans were sponsored by employers. Individual plans made up the remaining 27% (American Council of Life Insurers, 1998).

Today, most contributions go to defined contribution plans. In 1994, 40.3 million people participated in defined contribution plans, 24.6 million in defined benefit plans. However, defined benefit plans still had a

larger share of the assets, $1.2 trillion in 1994 compared to $1.1 trillion in assets for defined contribution plans.

The largest share of life insurance reserves is comprised by *group annuities*. Under an unallocated group annuitiy contract, payments made to the insurer by the employer or plan trustee are not immediately applied to the purchase of annuities. They are credited to a bookkeeping account under the contract. In 1997, $316 billion of reserves in group annuities were hold by life insurers. That equaled 21.8% of all pension plan reserves (American Council of Life Insurers, 1998).

403(b) plans are retirement vehicles classified under section 403(b) of the Internal Revenue Code for employees of a public school system or qualified charitable organization. These plans are the second-largest category of pension holding among life companies. Reserves held by life insurers in 1997 totaled $251 billion, or 17.3% of all pension plan reserves.

The third component of life company reserves for pension plans are *401(k) plans*, an employer-sponsored retirement savings program. Hereby employees are allowed to set aside and invest pretax dollars that often are matched by employers. Employers usually provide a portfolio of funds in which employees can invest. At the end of 1997, $210.7 billions were reserved for 401(k) plans, or 14.5% of total reserves in pension plans (American Council of Life Insurers, 1998 & 2001).

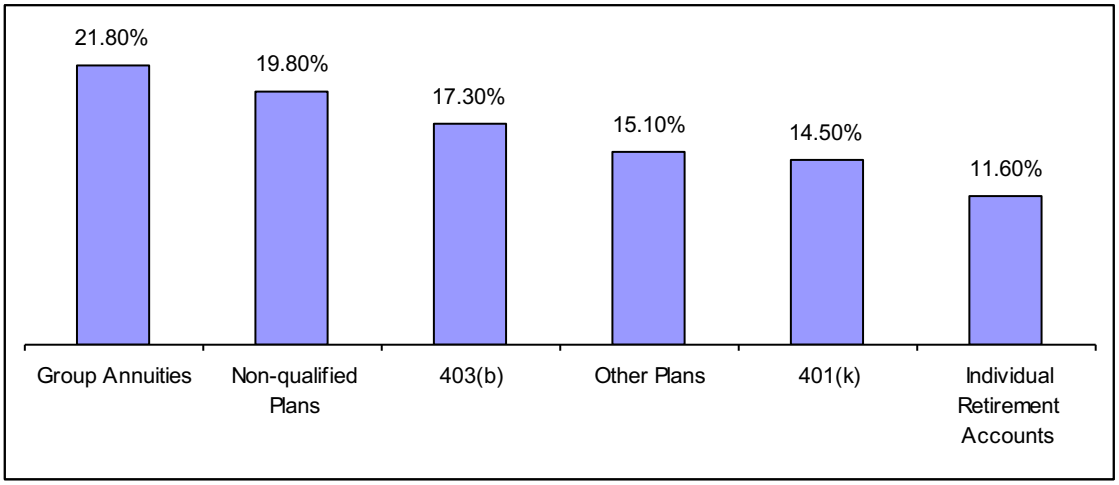

Figure 5: Private Pension Plan Reserves 1997

(Source: American Council of Life Insurers, 1998)

Not all annuities are used in retirement plans. In 1997, 3.8 million individual annuities, both retirement plan annuities and non-retirement annuities, were sold. 95% of these were deferred annuities, not including variable annuities. At the end of 1997, about 29 million individual annuities were in force. Group contracts totaled 322,594 and covered nearly 16 million certificate holders (American Council of Life Insurers, 1998).

Variable annuities are getting more and more popular. At year end 2000, about 30 million people were covered by variable annuities. Between 1987 and 1997, annuity premiums and considerations for variable plans have increased by 27%. Fixed annuities covered about 40 million persons at that time. The trend, however, shows clearly a

tendency towards variable annuities. The premium and annuity considerations for both, individual and group variable plans, increased from $5 billion in 1990 to $140 billion in 2000, the same figures for fixed plans increased in the same period from $120 billion to $144 billion (American Council of Life Insurers, 2001).

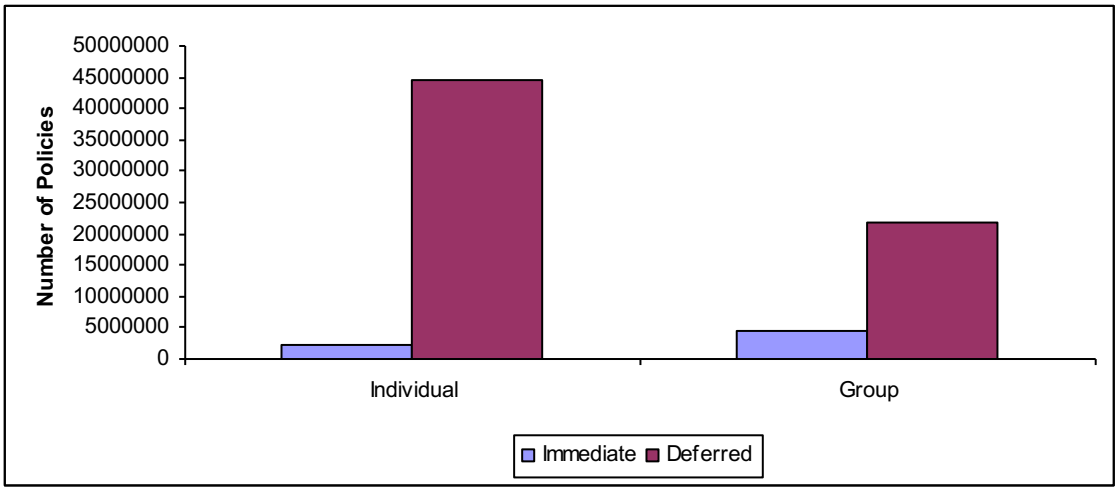

Figure 6: Immediate and Deferred Annuities 2000

(Source: American Council of Life Insurers, 2001)

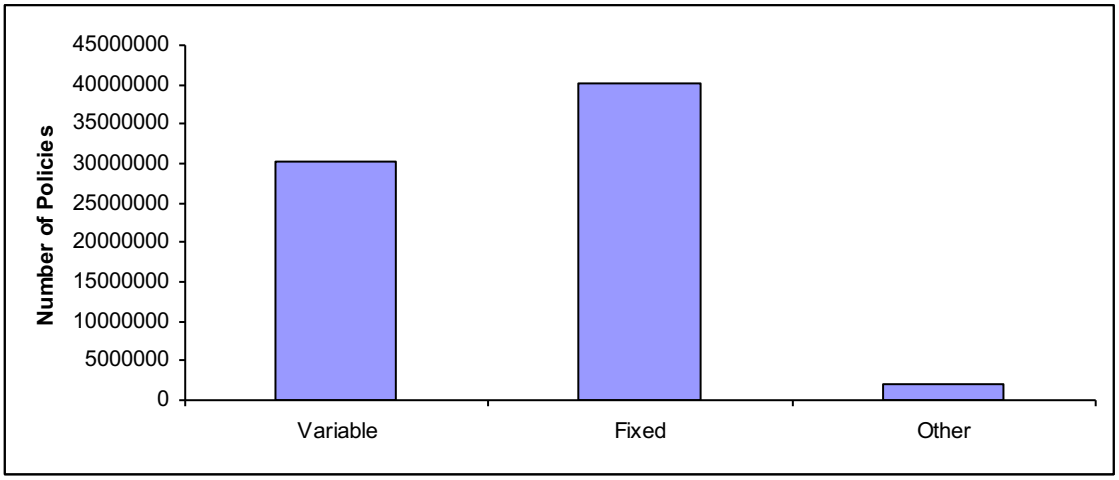

Figure 7: Variable and Fixed Annuities 2000

(Source: American Council of Life Insurers, 2001)

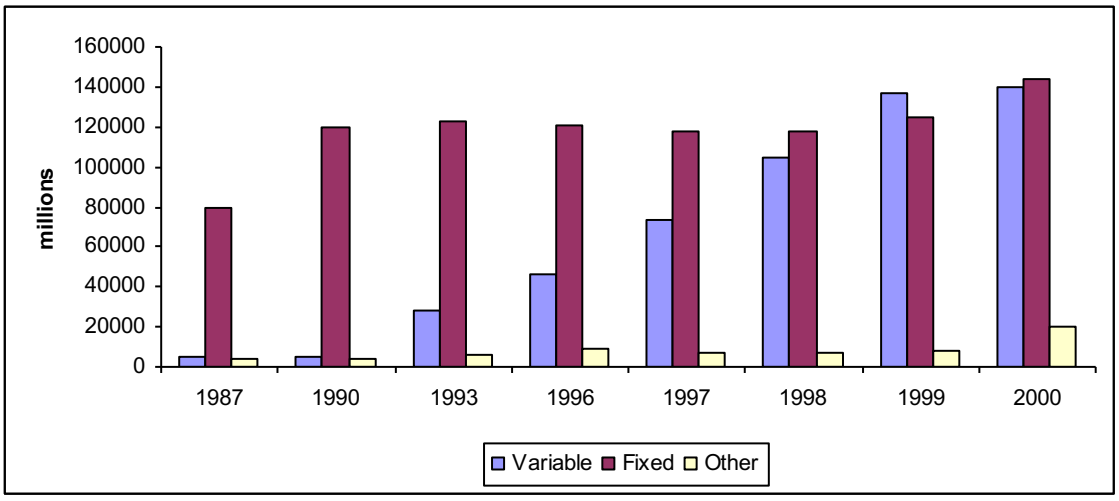

Figure 8: Annuity Considerations

(Source: American Council of Life Insurers, 2001)

In 2001, about $113 billion were spent for variable annuities, compared to only $4.5 billion in 1985 (American Council of Life Insurers, 2001).

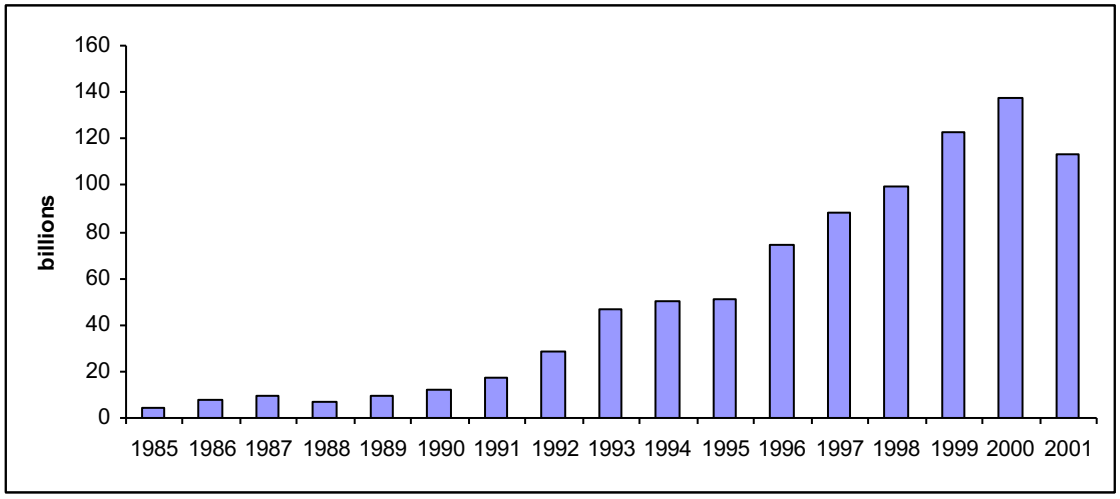

Figure 9: Annual Variable Annuity Sales

(Source: American Council of Life Insurers, 2001)

Variable Annuities Consumers

After observing that variable annuities are the future in the market for annuities, one asks, who buys them and why? At the National Association for Variable Annuities 2001 Marketing Conference, Eric T. Sondergeld, corporate vice president and director of the Retirement Research Center at LIMRA International, presented the following survey data:

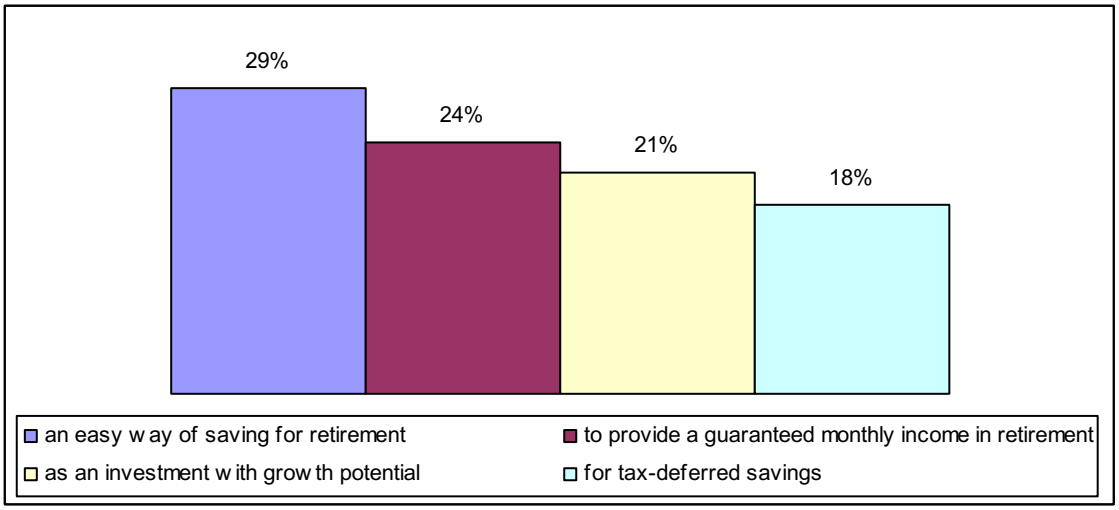

Figure 10: Why do Consumers buy Variable Annuities

(Source: Sondergeld, 2001)

The consumers prefer an easy way of investing their money for retirement. It is also desired to have a guaranteed monthly income. The advantage of tax-deferred saving seems not to be as important as the other reasons.

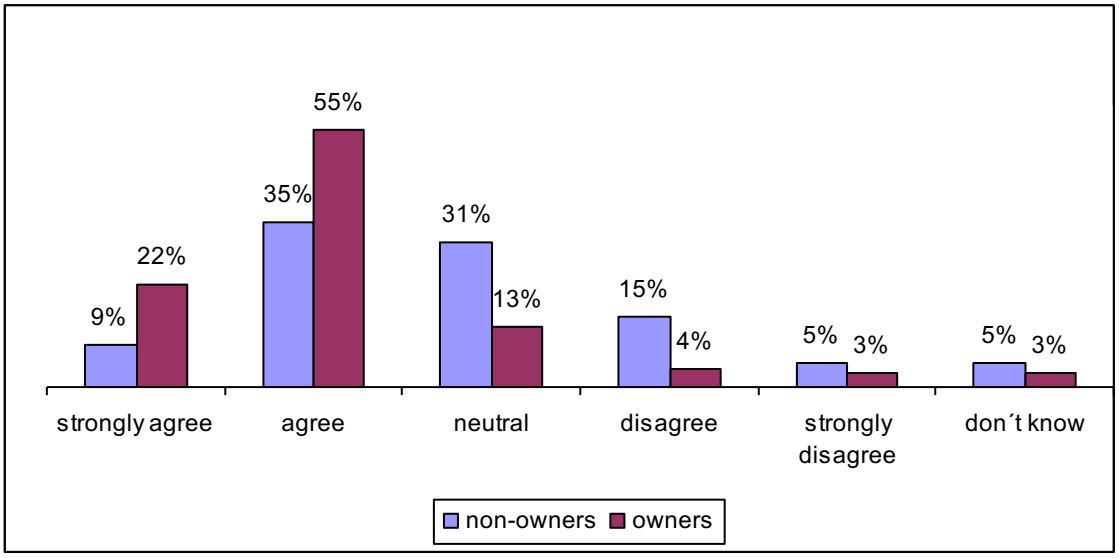

Figure 11: I understand how Annuities work

(Source: Sondergeld, 2001)

People who own an annuity pretend to understand it mostly. This may lead to the conclusion that customers really do some research before investing their money in an annuity.

The older the consumers are, the more they understand and therefore care about annuities. 58% of persons aged 55-64 understand how annuities work. This result should not be surprising.

When regarding the income, customers with a higher income know more about annuities than customers with less. This may be caused by the fact that these people have more to invest and hence do research about ways of investing their money.

The knowledge about annuities also increases by the increase of the level of education.

Figure 12: I understand how Annuities work (Source: Sondergeld, 2001)

The following data was obtained by a survey by *Gallup* for the Committee of Annuity Insurers, 1999 and presented by Mathew Greenwald, 2001:

Annuities are mostly owned by married customers. For these people, variable annuities are more popular than fixed annuities. Fixed annuities are more owned by widowed consumers, probably due to the fact that a lot of people over the age of 65 own them already for a long time.

Approximately 50% of the customers buy their first annuity before age 50. In this area, variable annuities are more often sold than fixed annuities. This trend changes when considering customers of age 65 or older. Almost a quarter of the people that first buy a fixed annuity are older than 65.

The same observation as before can be made regarding the age of current annuity owners. Variable annuities are more widespread among younger people. Fixed annuities are mostly hold by customers of age 72 or older.

There is no big difference between owners of variable and fixed annuities in the level of their education. Variable annuities are slightly more popular for higher educated people.

Almost two-thirds of the fixed annuities are owned by retired consumers whereas only about half of the variable annuities are owned

by this type of customer. Full time working people prefer variable annuities.

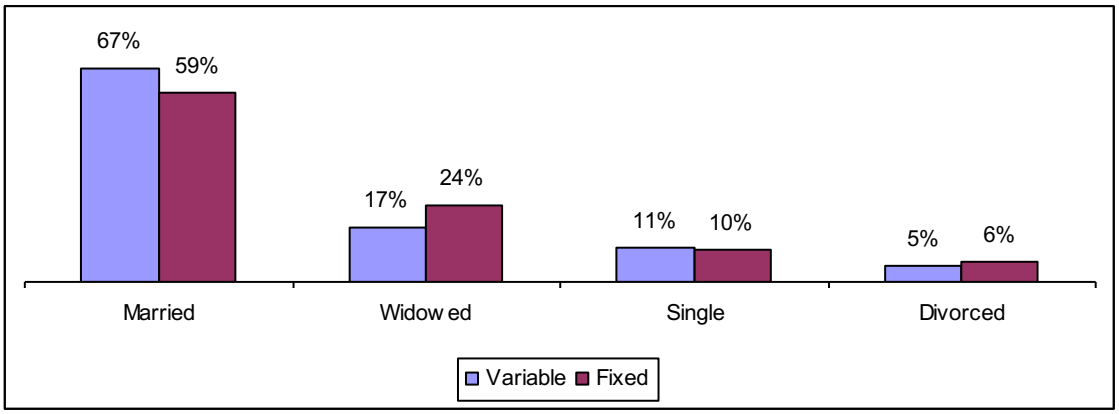

Figure 13: Marital Status of Annuity Owners 1999

(Source: Greenwald, 2001)

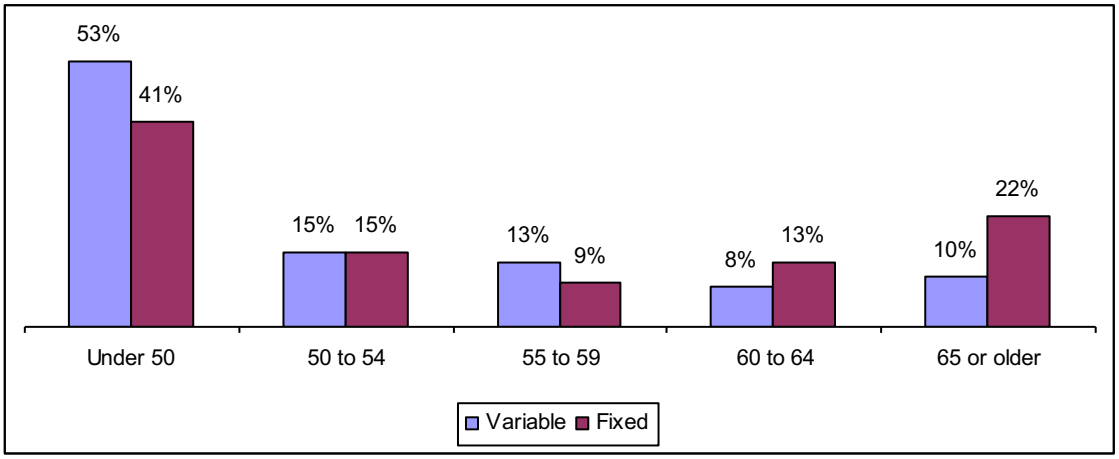

Figure 14: Age when first purchased an Annuity 1999

(Source: Greenwald, 2001)

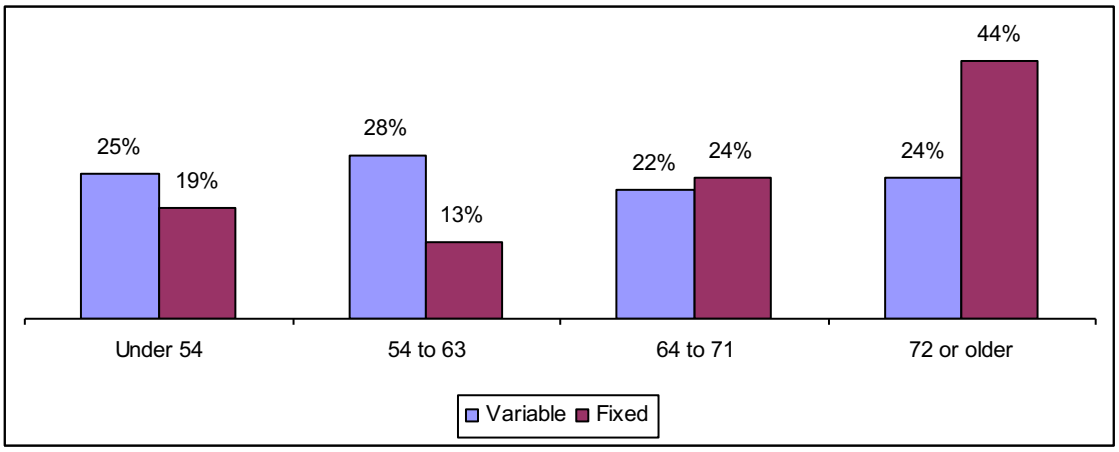

Figure 15: Age of current Annuity Owners 1999

(Source: Greenwald, 2001)

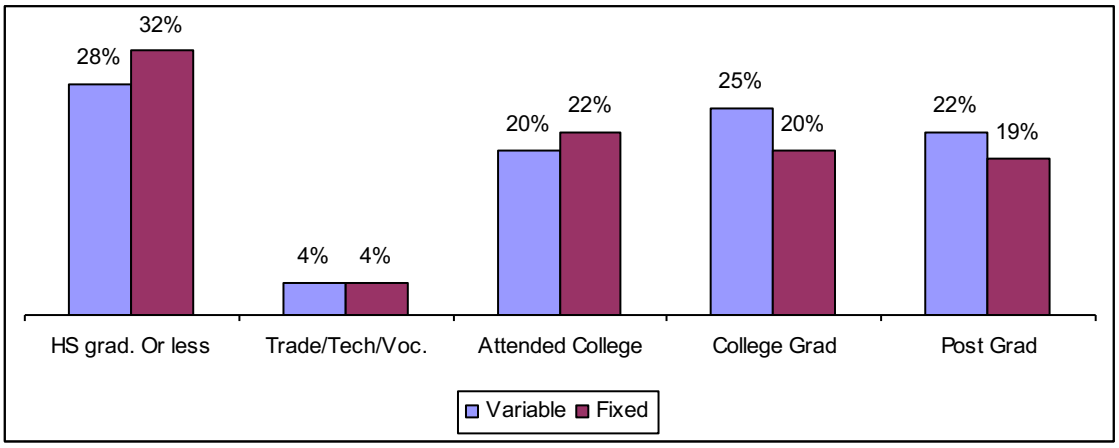

Figure 16: Level of Education of Annuity Owners 1999

(Source: Greenwald, 2001)

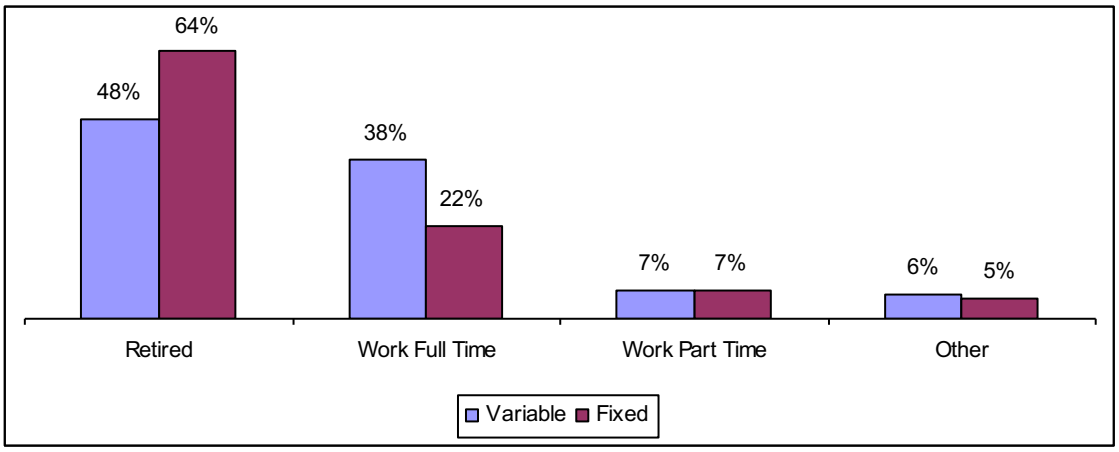

Figure 17: Employment Status of Annuity Owners 1999

(Source: Greenwald, 2001)

Companies offering Variable Annuities

Most life insurance and annuity contracts in the United States are sold by US life insurance companies. Fraternal organizations, federal government agencies, and savings banks sell smaller amounts of life insurance and annuities. Also, certain Canadian life insurers have US legal reserves and are allowed to do business in the United States directly from their Canadian offices.

At the end of the year 2000, 1,268 life insurance companies were doing business in the United States. 91% of these companies were stock companies owned by their stockholders. Mutual companies made 8%. A mutual company is owned by its policyholders. (American Council of Life Insurers, 2001)

About 89% of new variable annuity sales between year-end 2000 and the end of the second quarter in 2001 were made by 25 issuers. Hartford Life Insurance Company totaled $5,035 billion new sales, a market share of 9.12%. 8.62% of the market was shared by Teachers Insurance and Annuity Association College Retirement Equities Fund (TIAA-CREF), sales for this company totaled $4,970 billion. Nationwide Life Insurance Company was third with a share of 5.65% and new sales totaling $2882 billion.

Table 3: Variable Annuity Issuer Sales 01/01/01 to 06/30/01

(Source: Info-One, 2001)

Issuer	New Sales (millions)	Market Share
Hartford Life Ins Co	$5,035	9.12%
TIAA-CREF	$4,970	8.62%
Nationwide Life Ins Co	$2,882	5.65%
American General Corp	$2,485	5.28%
ING Group of Companies	$2,943	5.17%
Equitable Life Assurance Society of the U.S.	$2,731	4.77%
American Skandia Life Assurance Corp	$2,124	3.82%
Travelers Life and Annuity Co	$2,177	3.79%
Lincoln National Life Ins Co	$1,804	3.77%
Pacific Life Ins Co	$2,164	3.75%
AIG/Sun America Companies	$2,118	3.70%
Metlife	$1,952	3.40%
Manulife Financial	$1,838	3.32%
Sun Life Assurance Co of Canada (U.S.)	$1,625	2.92%
IDS Life Ins Companies	$1,511	2.88%

The largest variable annuity issuer by variable annuity assets in the same period was TIAA-CREF. It held a market share of 27.92% or total variable annuity assets of $254 billions. Hartford Life had a share of 8.55%, or $77 billions. The third largest company in this ranking was Lincoln National Life Insurance Company, which shared 4.88% of the market, holding $44 billions of variable annuity assets (Info-One, 2001).

Table 4: Variable Annuity Assets by Issuer 06/30/01

(Source: Info-One, 2001)

Issuer	Assets (millions)	Market Share
TIAA-CREF	$254,014	27.92%
Hartford Life Ins Co	$77,774	8.55%
Lincoln National Life Ins Co	$44,377	4.88%
ING Group of Companies	$38,472	4.23%
Nationwide Life Ins Co	$37,330	4.10%
Equitable Life Assurance Society of the U.S.	$36,914	4.06%
American General Corporation	$30,706	3.37%
Metlife Inv	$28,554	3.14%
IDS Life Ins Companies	$27,416	3.01%
American Skandia Life Ins Corporation	$28,647	2.03%
AIG/Sun America Companies	$24,987	2.75%
Aegon Ins Group	$19,895	2.19%
Travelers Life and Annuity Co	$19,010	2.09%
The Prudential Ins Co of America	$18,496	2.03%
Sun Life Assurance Co of Canada (U.S.)	$17,464	1.92%

Variable Annuity Performance

The best three year annualized return for the quarter ending 06/30/2001, based on *the VARDS Report* by Info-One, was obtained by Lincoln National´s American Legacy III contract with 8.87%. Second best contract return held Conseco´s MaxiFlex with 8.62%, followed by Janus Capital/WRL´s Retirement Advantage totaling 5.83%. The following table shows the top 15 variable annuity contract returns in this period.

Table 5: Three-year annualized Return

(Source: Info-One, 2001)

Three-year Annualized Return for Quarter Ending 06/30/2001 (pre expenses)		
Contract	Issuer	Contract Return
American Legacy III	Lincoln National	8.87%
Conseco MaxiFlex	Conseco	8.62%
ICAP II	Sun America	6.65%
Symphony	IDS	6.57%
Janus Retirement Advantage	Janus Capital/WRL	5.83%
Director	Hartford	5.51%
WRL Freedom Attainer	Western Reserve	5.00%
Trillium	Canada Life	4.92%
Independence Plus	VALIC	4.67%
Commodore Americus	Annuity Investors	4.44%
Top Plus	Ohio National	4.44%
WRL Freedom Bellwether	Western Reserve	4.42%
Members Variable Annuity	CUNA Mutual	4.36%
Equi-Select	ING	3.99%
Masters Plus Variable Annuity	Fortis	3.92%

CHAPTER IV

RESERVING RULES FOR FIXED ANNUITIES IN THE UNITED STATES (COMMISSIONERS ANNUITY RESERVE VALUATION METHOD)

In order to produce meaningful financial statements and balance sheets, each business needs accurate periodic assessments of its assets and liabilities. Since over 85% of the liabilities of the typical life insurance company are life, health, or annuity reserves, a relatively small change in their value could significantly affect both earnings for a period and the equity value of the company. Therefore the valuation and certification of these liabilities are among the more important actuarial functions for the typical life insurance company. (Tullis, Polkinghorn, 1996)

Actuarial reserves are liabilities for amounts an insurance company is obligated to pay in accordance with an insurance policy or annuity contract. The amounts are usually uncertain or contingent as to the exact amount and/or the time of payment (an exception being a reserve for an annuity-certain).

Claim reserves or *loss reserves* are reserves that are held because the insured event has already happened, but the exact amount of the claim is not known yet or the claim has not been reported yet.

If the event insured against has not yet happened, but the insurance company is obligated to pay for it as soon as it does happen, we talk about policy reserves.

The mathematical principle behind the calculation of reserves is the Law of Large Numbers due to the use of probabilities of future events. Therefore, reserves only show true significance when considering blocks of policies. Although a reserve can also be calculated for an individual contract, the principles of calculation only hold for a large portfolio of policies. (Tullis, Polkinghorn, 1996)

Different Types of Valuations

- Statutory Valuations

This kind of valuation is performed to report the financial situation of an insurance company to the insurance regulators. It uses conservative assumptions and techniques and therefore creates larger liabilities than other methods. The main purpose behind it is the assurance of solvency.

The Standard Valuation Law (American Academy of Actuaries, 1998a) states explicitly what assumptions are to be made and what methodology has to be used. Due to its conservative nature, a statutory valuation is often thought of as a worst case scenario.

All states require companies licensed to do business in their respective states to file a financial report at least annually (and in some states quarterly). The annual statement and the accompanying instructions and guidelines are published by the National Association of Insurance Commissioners (NAIC).

As a result of the increase of interest rates in the 1970s, more and more annuities were sold. With the increase in annuity reserves in the 1970s, the NAIC felt it necessary to formalize the basis of minimum reserves for such policies. The *Commissioners Annuity Reserve Valuation Method (CARVM)* was developed (American Academy of Actuaries, 1998a, Tullis, Polkinghorn, 1996).

- GAAP Valuations

Generally Accepted Accounting Principles (GAAP) valuations are required for companies that are publicly traded in the United States or if the company is owned by a publicly traded company. It utilizes less conservative assumptions than statutory valuations with the objective to allocate accurately the income to the period in which it is earned.

U.S. statutory accounting may give an inaccurate view of the actual financial situation of a company, particularly with respect to trends. For example, if a company were to stop writing new business in a given year, its statutory profits would typically increase over the prior year. Therefore a lot of companies, which are not required to report GAAP financial statements, produce „GAAP-like" reports for the internal use (Tullis, Polkinghorn, 1996).

- Gross Premium Valuations

Gross premium valuation is used when it is desired to get a best estimate value of the liabilities of a company. It might use even less conservative assumptions than the GAAP valuation, and it is generally performed with „best estimate assumptions". Unlike the two methods above, gross premium valuation uses the gross premium in order to calculate the present value of future premium income. This effects that most or all future profits or losses are reflected in the equity of a gross premium valuation balance sheet as of the date of valuation.

Gross premium valuations are mostly used for internal purposes of the insurance company, and when it is necessary to determine the value of a company. Another reason is when a company is examined in order to determine its solvency (Tullis, Polkinghorn, 1996).

- Tax Reserve Valuations

This type of valuation is performed in order to calculate the reserve liability for purposes of determining taxable income. It requires the use of the highest interest rate and most recent mortality table allowed by at least 26 states, or, if greater, a prescribed tax interest rate. Tax reserve valuations do not allow deficiancy reserves (Tullis, Polkinghorn, 1996).

Valuation Requirements in the United States

According to the NAIC Standard Valuation Law (American Academy of Actuaries, 1998a),

„Every life insurance company doing business in this state shall annually submit the opinion of a qualified actuary as to whether the reserves and related actuarial items held in support of the policies and contracts specified by the commissioner by regulation are computed appropriately, are based on assumptions that satisfy contractual provisions, are consistent with prior reported amounts and comply with applicable laws of this state. The Comissioner by regulation shall define the specifics of this opinion and add any other items deemed to be necessary to its scope."

The statement of actuarial opinion should list the items and amounts for which the actuary expresses an opinion. A company may have separate opinions for separate blocks of business; for example one actuary may sign an opinion relating to group insurance items, while

another signs an opinion relating to individual life insurance, and a third actuary signs an opinion relating to individual health insurance items. However, the opinion is on the adequacy of reserves in aggregate, and it is possible for deficiencies in individual components of the reserves to be offset by margins in other items (Tullis, Polkinghorn, 1996).

The statement of actuarial opinion frequently indicates reliance on others. For example, it may indicate reliance on others within the company for the accuracy and completeness of the basic records, and reliance on actuaries with other companies for items such as reinsurance assumed. The statement of actuarial opinion should indicate the relationship of the actuary with the company, and the scope of the actuary´s work (Tullis, Polkinghorn, 1996).

The statement reserves as filed in any particular state, in the aggregate, must satisfy the laws of that state, and presumably also satisfy the regulations of that particular insurance department. This may lead to practical problems because there exist different interpretations of the law in different states.

It is also required by the Standard Valuation Law to analyze the reserves and assets in order to prove if the reserves hold under seven interest scenarios. These seven interest scenarios are described in the following table:

Table 6: Required Interest Scenarios by SVL

(Source: Tullis, Polkinghorn, 1996)

Scenario	Description
1	Level
2	Uniformly increasing 5% over 10 years and then level
3	Uniformly increasing 5% over 5 years, then uniformly decreasing 5% over the next 5 years and then level
4	A 3% pop-up and then level
5	Uniformly decreasing 5% over 10 years and then level
6	Uniformly decreasing 5% over 5 years, then uniformly increasing 5% over the next 5 years and then level
7	A 3% pop-down and then level

The Comissioners Annuity Reserve Valuation Method (CARVM)

The CARVM is defined in the following paragraph of the Proceedings of the NAIC, 1977:

„Reserves according to the commissioners annuity reserve method for benefits under annuity or pure endowment contracts, excluding any disability and accidential death benefits in such contracts, shall be the greatest of the respective excesses of the present values, at the date of valuation, of the future guaranteed benefits, including guaranteed nonforfeiture benefits, provided for by such contracts at the end of each

respective contract year, over the present value, at the date of valuation, of any future valuation considerations derived from future gross considerations, required by the terms of such contract, that become payable prior to the end of such respective contract year. The future guaranteed benefits shall be determined by using the mortality table, if any, and the interest rate, or rates, specified in such contracts for determining guaranteed benefits. The valuation considerations are the portions of the respective gross considerations applied under the terms of such contracts to determine nonforfeiture values."

CARVM defines the minimum US standard for individual annuities, and also for group annuities that are issued neither to a qualified pension plan nor to an Individual Retirement Account.

CARVM for Single Premium Deferred Annuities

According to the definition above, it is first necessary to project the annuity fund balance forward at the guaranteed basis in the policy. Then this projected fund balance is used to calculate the future guaranteed benefits under the policy. Guaranteed benefits include all benefits streams guaranteed under the contract, these are mostly annuity benefits, death benefits, and nonforfeiture benefits. For each guaranteed future benefit one has to calculate its present value, as of the date of

valuation, and then subtract the present value of future considerations, which are the required payments under the contract. All present values are taken at the valuation basis of mortality and interest. The CARVM reserve is the greatest of the net present values calculated this way. Hence, CARVM can be seen as a worst case valuation method, the reserve calculated for a particular policy takes into account the scenario which maximizes the liability (Tullis, Polkinghorn, 1996).

CARVM uses two separate rates of interest, the accumulation rate of interest and the valuation basis of interest (and mortality) under CARVM. The accumulation rate is used when calculation of the future guaranteed benefits since it may be necessary to accumulate the policy fund and apply it at various times in the future. For example when benefits are guaranteed as a percentage of the fund value. These benefits need to be discounted to the date of valuation. The calculation uses the valuation basis of interest, and, where appropriate, the valuation basis of mortality.

Example: (Tullis, Polkinghorn, 1996)

Single premium deferred annuity

Single premium: $10,000

No front end load

Guaranteed Interest: 10% in years 1 to 5, 4% thereafter

Surrender charge:

Policy Year	Percent of Fund
1	7%
2	6%
3	5%
4	4%
5	3%
6	2%
7	1%
8 and later	0

Valuation interest rate: 8%

Death benefit equal to cash surrender value

The following table shows the guaranteed fund accumulation value and the cash surrender value at the end of each of the first 10 policy years.

Table 7: The Fund and Cash Value (Example)

(Source: Tullis, Polkinghorn 1996)

Policy Year	Fund	Cash Value
0	10,000	9,300
1	11,000	10,230
2	12,100	11,374
3	13,310	12,645
4	14,641	14,055
5	16,105	15,622
6	16,749	16,414
7	17,419	17,245
8	18,116	18,116
9	18,841	18,841
10	19,594	19,594

The present value at 8% as of the issue date (policy year of valuation 0) and as of each of the first five policy anniversaries of each future cash surrender value is shown in table 8 (Tullis, Polkinghorn, 1996).

Table 8: Development of CARVM Reserves (Example)

(Source: Tullis, Polkinghorn, 1996)

Future Policy Year	Cash Value	Policy Anniversary of Valuation					
		0	1	2	3	4	5
0	9,300	9,300					
1	10,230	9,472	10,230				
2	11,374	9,751	10,531	11,374			
3	12,645	10,038	10,841	11,708	12,645		
4	14,055	10,331	11,157	12,050	13,014	14,055	
5	15,622	10,632	11,483	12,401	13,393	14,465	15,622
6	16,414	10,344	11,171	12,065	13,030	14,072	15,198
7	17,245	10,062	10,867	11,737	12,676	13,690	14,785
8	18,116	9,788	10,571	11,416	12,329	13,316	14,381
9	18,841	9,425	10,179	10,994	11,873	12,823	13,849
10	19,594	9,076	9,802	10,586	11,433	12,348	13,335

For each of the first five years, the cash value which produces the largest present value occurs in the row of policy year 5. For example, at the end of the third policy year, the present value of the third year-end cash value is 12,645. The present value of the fourth year-end cash value is 13,014, and the present value of the tenth year-end cash value is 11,433. Since surrender benefits and death benefits are equal, discounting is ignoring mortality. The cash surrender value at the end of the 5^{th} year always produces the greatest present value for valuations on each of the first five policy years. Hence, the CARVM reserve at the third

policy year-end would be 13,393, the present value of the 5th policy year value (Tullis, Polkinghorn, 1996).

One can proof for this example, that the 5th year cash value has the greatest present value by calculating the 4th, 5th , and 6th year effective interest rates:

$$4\quad \frac{4\quad 3}{3}\quad \frac{14{,}055\ 12{,}645}{12{,}645}\quad 11.15\%$$

$$5\quad \frac{5\quad 4}{4}\quad \frac{15{,}622\ 14{,}055}{14{,}055}\quad 11.15\%$$

$$6\quad \frac{6\quad 5}{5}\quad \frac{16{,}414\ 15{,}622}{15{,}622}\quad 5.07\%$$

The 4th and 5th year effective interest rates exceed the valuation rate of 8%, and so do all other previous years. Starting with the 6th year effective interest rate, all rates of the following years are less than the valuation rate. Therefore the 5th year cash value will produce the greatest present value for the first 5 years. After the 5th year, the largest present value is produced by the current cash value (Tullis, Polkinghorn, 1996).

In general, the following considerations apply for an SPDA:

1 If guaranteed annuity purchase rates are calculated on a less liberal basis than the valuation basis, and if the cash surrender

value is used to determine the guaranteed annuity payments, then the future guaranteed annuity payments will never enter into the CARVM calculation, because the present value of the guaranteed annuity payments will always be less than the cash value at the date of annuitization.

2 For a contract with no surrender charges, if the guaranteed fund accumulation rate is less than the valuation interest rate, then the cash value which will generate the largest present value is the cash value at the valuation date. If such a contract has a guaranteed accumulation rate which is greater than the valuation rate for a number of years after the valuation date, and thereafter is less than or equal to the valuation rate, then the cash value which will generate the largest present value is the cash value at the end of the last year for which the accumulation rate is in excess of the valuation rate. If such a contract has guaranteed accumulation rates which are always in excess of the valuation interest rate, then the cash value which will produce the largest present value is the cash value at the latest possible maturity date.

3 For policies with surrender charges, if the combined effect of the guaranteed interest rate plus the reduction in the surrender

> charge exceeds the valuation rate for exactly n years, then the greatest present value will occur by discounting the cash value at the end of the n-th contract year. If the combined effect of the guaranteed rate plus the reduction in the surrender charge is sometimes greater and other times less than the valuation interest rate in an alternating fashion, then it will be necessary to discount the cash values at many points to find which has the greatest present value.

CARVM requires calculating present values based on benefits as of the end of each policy year. However, the following example shows that larger present values can be obtained by projecting to the beginning of each policy year:

> Example: (Tullis, Polkinghorn, 1996) Consider a contract with 5% initial surrender charge which declines by 1% for each full policy year. Assume that the projected guaranteed fund balance at the end of the second policy year is 10,000, producing a cash surrender value of 9,600. If one more day is projected, to the beginning of the third year, the cash value jumps to 9,700 (plus interest that may have accrued overnight). In this case, projecting

to the beginning of each policy year would produce a larger present value than discounting to the end.

The only state that pays attention to this fact is New York. Here the largest present value of any day is used to calculate the reserve. New York regulation defines CARVM as follows:

„(ii) The minimum reserve for contracts with unconditional surrender charges or with conditional surrender charges not considered to be meaningful shall be the greater of (1) the contract cash surrender value and (2) the greatest of the respective excesses of the present values, at the date of valuation, of the future cash surrender values provided for by the contract on any day of each respective contract year, over the present value, at the date of valuation, of any future valuation net considerations derived from future gross considerations, required by the term of the contract that become payable prior to such day of such respective contract year." (New York Regulations, Section 95.11(C)(5)(ii))

This interpretation, which is also called continuous CARVM, requires obviously more calculations, that can be done easily nowadays with the help of computers.

Application of CARVM to common Product Features

In practice, most SPDAs include a number of product features that have a remarkable influence on the CARVM. The most important ones are described below (Tullis, Polkinghorn, 1996):

Contingent Benefits

- Death benefit in excess of cash surrender value:

  A lot of SPDAs offer a death benefit during the accumulation period equal to the fund value before deduction of surrender charges. In addition, some SPDAs allow for a minimum death benefit equal to the premium paid. According to the definition of the CARVM, each benefit has to be considered in the calculation of the reserve. Most companies create a separate death benefit reserve and add it to the basic CARVM reserve. This additional reserve is calculated as the present value of the excess of the death benefit over the cash surrender value. A common approximation is to set this death benefit reserve equal to the sum of the present values of the cost of each of the future excesses of death benefit over cash surrender value, using the valuation interest rate and mortality for discounting. Another more exact approach is to calculate the mortality reserve as the sum of the present values of the cost of

excess death benefits only up to the end of the policy year which corresponds to the cash value accounting for the largest present value incorporated in the basic CARVM reserve. Again the valuation interest rate and mortality is used (Tullis, Polkinghorn, 1996).

- Nursing Home Waiver:

  Some companies offer a nursing home waiver. That means that if the customer enters a nursing home, the surrender charges are waived. An additional reserve to the basic CARVM reserve is calculated in the same way as the mortality reserve above.

Free Partial Withdrawals

Some SPDAs with surrender charge allow annuitants to withdraw a specified percentage of the accumulated fund value annually without paying the surrender charge. Sometimes it is allowed to withdraw all or part of the earned interest. These free partial withdrawals are often restricted to a period, for example 30 days, after each anniversary date. One way to handle this feature is the aggregate approach. It adjusts the surrender charges in the reserve calculation in order to reflect the free partial withdrawals. For example, if it is allowed to withdraw 10% of the fund on each anniversary, the effect of the free partial withdrawal would

be approximated by reducing each surrender charge by 10%. One would use for example 4.5% instead of the 5% surrender charge.

The other way used in practice is the *seriatim method*. Now each and every partial withdrawal which could be made is considered. Therefore a company projects such a policy to the next anniversary in both ways, assuming no partial withdrawal is made and assuming a full partial withdrawal is made. This generates a tree that is then used to calculate the CARVM reserve.

Valuation Mortality and Interest

Calculating reserves requires assumptions according to mortality and interest rates. The Standard Valuation Law does not define exactly, which mortality table has to be used:

„For individual annuity and pure endowment contracts issued on or after the 1976 NAIC amendments to the SVL, other than single premium immediate annuity contracts, excluding any disability and accidential death benefits in those contracts: the 1971 Individual Annuity Mortality Table or any individual annuity mortality table adopted after 1980 by the NAIC, that is approved by regulation promulgated by the commissioner for use in determining the minimum standard of valuation for those contracts, or any modification of these tables

approved by the commissioner, and five and one-half percent (5 ½ %) interest for single premium deferred annuity und pure endowment contracts and four and one-half (4 ½ %) interest for all other individual annuity and pure endowment contracts;" (NAIC, 1996).

The 1971 Individual Annuity Mortality table and the 1996 U.S. Annuity 2000 Basic table can be seen in Appendix A and B.

To determine the maximum valuation interest rate I under the SVL, one has to use one of the following formulas (American Academy of Actuaries, 1998a):

(A) $.03 \quad (_1 \quad .03) \quad \frac{}{2}(_2 \quad .09)$

(B) $.03 \quad (\quad .03)$

Where R_1 is the lesser of R and .09

R_2 is the greater of R and .09

R is the reference interest rate

W is the weighting factor

R is determined by Moody´s Corporate Bond Yield Average – Monthly Average Corporates as published by Moody´s Investors Services, Inc. The length and end of the averaging period depend on the type of contract.

One also has to distinguish between different guarantee durations. This is defined for annuities with cash settlement options as the number

of years for which the contract guarantees interest rates in excess of the calendar year statutory valuation interest rate for life insurance policies with guarantee duration in excess of twenty years. For other annuities it is the number of years from the date of issue or date of purchase to the date annuity benefits are scheduled to commence.

The weighting factors used in both formulas vary by plan type as determined by withdrawal privileges:

Plan Type A: At any time the policyholder may withdraw funds only:

1) With an adjustment to reflect change in interest rates or asset values since receipt of the funds by the insurance company, or
2) As an immediate life annuity, or
3) No withdrawal permitted.

Plan Type B: Before expiration of the interest rate guarantee, the policyholder may withdraw funds only:

1) With an adjustment to reflect changes in interest rates or asset values since receipt of the funds by the insurance company, or
2) Without such adjustment, but in installments over five years or more, or
3) No withdrawal permitted.

Plan Type C: The policyholder may withdraw funds before expiration of interest rate guarantee in a single sum or installments over less than five years either:

1) Without adjustment to reflect changes in interest rates or asset values since receipt of funds by the insurance company, or
2) Subject only to a fixed surrender charge stipulated in the contract as a percentage of the fund.

The valuation bases used in Illinois, in 1998, for example, are shown in the following table:

Table 9: Valuation Bases used in Illinois

(Source: American Academy of Actuaries, 1998a)

Individual Annuity and Pure Endowments			
Effective Date	Method	Table	Interest
9-8-77 to 12-30-83	CARVM	1971 Individual Annuity Mortality Table or any individual annuity mortality table adopted after 1980 by the NAIC that is approved by regulation promulgated by the director for use in determining the minimum standard of valuation for such contracts, or any modification of these tables approved by the director	4.5% 5.5% (SPDA or Pure End. Contracts) 7.5% (SPIA)
12-31-83 to 12-30-85	CARVM	No change	Dynamic
12-31-85 to	CARVM	1983 Table “A” Regulation 935	Dynamic

CHAPTER V

RESERVING FOR VARIABLE ANNUITIES

Applying traditional reserving methods to variable annuities causes problems. CARVM is based on future policy guarantees and it cannot be applied to variable annuities since variable annuities do not have future investment guarantees. All the investment risk is on the side of the contractholder. However, there are some implied guarantees in most variable annuity contracts that need to be considered in the CARVM calculation. For example, the surrender charge is guaranteed to be reduced, if the contract persists. Also, annuitization options are often guaranteed and those need to be looked at. Also, most variable products allow transfers between variable funds and between fixed and variable funds. The actuary does need to consider potential transfers and any underlying contractual guarantees that would be provided if the transfer actually occurred. In this regard, contractual guarantees would include the charge or fee structure in the contract or any contractually guaranteed interest rates or benefits.

Unfortunately, there is not much regulatory guidance in this area. As a result, industry practice varies. One regulatory guide is the NAIC

Model Variable Annuity Regulation (American Academy of Actuaries, 1998a), which states that the reserves „shall be established pursuant to the requirements of the Standard Valuation Law," and „recognize the variable nature of the benefits provided and any mortality guarantees." This could be interpreted to mean that since CARVM applies to fixed annuities from the SVL, then it should also apply to variable annuities.

What is done in practice? A survey by the Society of Actuaries (Society of Actuaries, 1995) showed that more than half of the insurers use CARVM, most of them use continuous CARVM as opposed to curtate. But again, the only state that requires continuous CARVM by law is New York. There may be other states, however, that are enforcing continuous CARVM through either letters or bulletins. The remaining insurers are split about half between holding the account value and the cash surrender value.

Applying CARVM to fixed annuities generally entails determining future guaranteed benefits by projecting the account value at the valuation date using the guaranteed interest rate. Since there are no explicitly guaranteed interest rates offered with variable annuities, many companies apply a similar methodology by using a projection rate equal to the appropriate regulatory specified valuation interest rate less some or all contract charges. They then hold the greatest present value of the

resulting guaranteed benefit streams. Companies who use this interpretation hold continuous CARVM reserves, where guaranteed benefits at all future points in time are considered, while others hold curtate CARVM reserves, where only guaranteed benefits available at the end of each contract year are considered.

The survey also asked what companies obtain when they applied CARVM to variable annuities. It was found that most companies have reserves that were equal to, or slightly greater than, cash surrender values. There are three reasons why reserves exceeded cash surrender value. The first is cliff surrender charges. This is where the surrender charge drops by more than 1% in any given year. One company that responded had a cliff as high as 5%. Second is recognition of free withdrawals, which is a withdrawal where the surrender charges are waived. The third reason is because of guaranteed annuitizations, especially those where surrender charges are waived on annuitization.

A second key consideration in variable annuity reserving is the valuation and accumulation rates that are used. According to the survey, the type A annuity rate is the most popular valuation rate for variable annuities. It was also found that both type C and, for one or two companies, type B are being used. For accumulation rates, most companies indicated they use a rate equal to the valuation rate less a

spread, which was made up of mortality and expense charges, administrative fees, or investment advisory fees. A small number of the responding companies use an accumulation rate equal to the interest rate they guarantee to the fixed-account option of the variable annuity, while at least one respondent accumulates at 0% interest.

It is important to note that where the reserve for the variable account portion of the contract is determined by using a projection rate equal to the valuation interest rate less some or all of the asset based charges, the spread between the projection rate and the valuation interest rate usually has a greater impact on reserves than the Plan type of the valuation interest rate. In addition, for many variable annuities designs, reserve levels for the variable account portion may actually be greater as the valuation interest rate increases (American Academy of Actuaries, 1999).

The most important fact is not necessarily the rates themselves, but rather the spread between the accumulation and the valuation rate. This ultimately represents the margin that is available to fund the increase in reserves due to changes in the surrender charge or any other reason. This is why companies have CARVM reserves that are greater than cash surrender value.

Another question is if maintenance expenses are included in the CARVM calculation for variable annuities. Actuaries that apply CARVM by projecting the account value using the valuation interest rate less some or all contract charges differ in their treatment of maintenance expenses. Some actuaries ignore maintenance expenses in the calculation, while others reflect them in varying degrees. The CARVM reserve methodology as set forth in the Standard Valuation Law does not include a specific provision for maintenance expenses. However, where the valuation actuary is required to opine on the adequacy of the assets supporting reserves, Actuarial Standards of Practice (ASOP) No. 22, *Statutory Statements of Opinion Based on Asset Adequacy Analysis by Appointed Actuaries for Life and Health Insurers* (Actuarial Standards Board, 1993), states that the analysis should take into account all anticipated cash flow, including expenses (American Academy of Actuaries, 1999).

Reserves for fixed account options are determined in the same ways as regular fixed annuities. Some actuaries project the fixed and separate account fund balances separately in order to determine the greatest present value of guaranteed future benefits, while other actuaries combine the guaranteed future benefits provided by the fixed

and variable fund balances before determining the greatest present value.

Variable Annuities with Guaranteed Minimum Death Benefits

Actuaries vary in how they reserve for additional benefits included in a variable annuity contract. Some integrate projected guaranteed benefit streams into the CARVM benefit streams, while others (particularly those that hold cash surrender value) hold an add-on reserve to cover these benefits. In addition, many actuaries (regardless of how they calculate reserves for additional benefits) hold guaranteed minimum death benefit (GMDB) reserves in the General Account.

The NAIC has adopted two Actuarial Guidelines, both with 12/31/98 effective dates, that address reserves for such benefits. One is the revision to *Actuarial Guideline XXXIII*, which interprets the application of CARVM to annuities with multiple benefit streams; the other is *Actuarial Guideline XXXIV*, which interprets the application of CARVM to GMDBs offered with variable annuities and would require GMDB reserves to be held in the General Account (American Academy of Actuaries, 1999).

The reserving principle for variable annuities with GMDB described in the *Actuarial Guideline XXXIV* by the American Academy of Actuaries,

which affects all contracts issued on or after January 1, 1981, is the following:

Two CARVM reserve calculations are involved in the valuation of reserves for GMDBs: a Separate Account Reserve and an Integrated Reserve. The integrated reserve represents the total reserve held by the company in support of the entire variable annuity contract. The additional reserve held for the GMDB equals the excess of the integrated reserve over the separate account reserve, but not less than zero. It is held in the general account of the insurer.

The separate account reserve is the reserve that would be held in the absence of the GMDB. The integrated reserve is a CARVM reserve determined using all contract benefits, including the GMDB. It is calculated as the greatest present value, as described in chapter IV, of future integrated benefit streams available under the contract. Integrated benefit streams include both, the base benefit streams of the contract discounted for survivorship and the GMDBs discounted for mortality.

The integration of the GMDB with other contract benefits in the determination of future integrated benefit streams is accomplished by combining three separate benefit streams A, B and C described below. These future integrated benefit streams are determined over all calculation periods, the periods for which the integrated benefit streams

are projected in the integrated reserve calculation, and are discounted at the valuation interest rate (American Academy of Actuaries, 1998a).

- A is the stream of projected net amounts at risk paid to those expected to die during the calculation period. These amounts are the excess of the GMDB over the projected reduced account value, including immediate drops for each asset class as described below. The calculation is based on valuation mortality.
- B is the benefit stream of projected unreduced account values paid to those expected to die during the calculation period. Now the projected account value is considered without immediate drops, the projection uses a rate based on the valuation rate less appropriate asset based charges.
- C is the base benefit streams provided during the calculation period, and is discounted for survivorship based on valuation mortality.

The greatest present value occurs in the calculation period in which the present value of the future integrated benefit streams is maximized. The benefit streams A, B and C are not individually maximized.

Immediate Drops and Assumed Returns

The projected net amount at risk is determined by assuming an immediate drop in the supporting asset values, followed by a subsequent recovery based upon a net assumed return. For example, the reduced account value after the immediate drop would equal the account value on the valuation date, multiplied by (1 – immediate drop percentage). The projected reduced account value n years later would equal the reduced account value multiplied by $(1 + \text{net assumed return})^n$. The projection should continue until the maturity of the contract.

To determine the immediate drop and net assumed return, the separate account funds supporting the variable annuity contracts on the valuation date should be allocated to the five asset classes as follows:

- Equity Class
- Bond Class
- Balanced Class
- Money Market Class
- Specialty Class

Detailed descriptions of these classes can be found in chapter VII. The ultimate determination of the appropriate fund classification, however, is the responsibility of the appointed actuary.

The immediate drop percentages and gross assumed returns for each asset class are shown in the following table:

Table 10: Immediate Drop Percentages and Gross Assumed Returns

(Source: American Academy of Actuaries, 1998a)

Asset Class	Immediate Drop Percentage	Gross Assumed Return
Equity	14.00%	14.00%
Bond	6.50%	9.50%
Balanced	9.00%	11.50%
Money Market	2.50%	6.50%
Specialty	9.00%	9.50%

The gross assumed returns do not include deductions for asset based charges. It is on the company to deduct its own asset based charges from those shown in the table to obtain the net assumed returns that are used in determining the projected reduced account values.

If included in the variable annuity contract, the fixed account, providing a guaranteed rate of return, should be projected as a separate asset class. Its immediate drop percentage equals to zero and the net assumed return equals the guaranteed rate.

The immediate drop for each contract is determined by taking the sum of the immediate drops for each asset class. The net assumed return for each contract is determined by taking the weighted average of the net assumed returns for each asset class, based upon the allocation of the total account value between the asset classes (American Academy of Actuaries, 1998a).

Variable Annuities with Guaranteed Minimum Annuity Floor

A guaranteed minimum annuity floor (GMAF) guarantees that one or more of the periodic payments will not be less than a minimum amount. Some actuaries interpret the guideline's application to GMAFs as follows (American Academy of Actuaries, 2001):

The reserve for the GMAF would be the difference of two CARVM reserves. One would include the effect of the GMAF in the universe of benefit streams that would be considered. This would be the integrated reserve. (The integrated reserve equals the greatest present value of future integrated benefit streams, which include VAGLBs available under the terms of the contract). The other would not include the GMAF in the benefit streams that are being considered (American Academy of Actuaries, 2001).

An integrated benefit stream combines two separate benefit streams, the projected net amounts at risk (the X stream) with the projected base contract values underlying the base benefit streams (the Y stream). In determining the X stream for a GMAF, gross returns are projected for each of the future years and all asset-based charges under the contract are deducted to obtain net assumed returns. The gross returns could be obtained from stochastic scenarios or representative scenarios as appropriate. The asset-based charges deducted from the gross returns to determine net assumed returns would include those for administration, fund charges, mortality and expense risks, and any asset-based charges for the guarantee of a minimum payment amount (American Academy of Actuaries, 2001).

Using these net assumed returns, the annuity income payments to be paid in the future would be calculated without the existence of the minimum guarantee. These are the projected contract values. The projected living benefits would also be determined using the net assumed returns. The net amount at risk is equal to the actual income payment that would be paid (the projected living benefit amount) less the income payment in the absence of the minimum guarantee (the projected contract value). Unlike many other VAGLBs, the projected net amount at

risk for a GMAF would generally be a series of numbers rather than a single number (American Academy of Actuaries, 2001).

The base benefit stream is a stream of projected benefit amounts, reflecting the projected base contract values and ignoring any VAGLBs in the contract. These contract values would be projected into the future using a return based on the valuation rate(s) less asset-based charges appropriate for this purpose (American Academy of Actuaries, 2001).

The integrated benefit stream and base benefit streams would be discounted using valuation interest and, where applicable, mortality.

The CARVM Allowance

Since the CARVM reserve calculation will often result in reserves that are less than the account value, many companies have assets in the separate account (which generally equals account value) in excess of policy reserves. Beginning in 1996, the *NAIC Annual Statement instructions* require that this excess, often referred to as the *CARVM allowance*, be shown in the general account as a net transfer from the separate account. The instructions also require the change in the CARVM allowance to be treated as income in the general account (American Academy of Actuaries, 2001).

In most situations, separate account assets that exceed contract reserves for variable annuities are available to support the liabilities of the general account. This is different from separate accounts that support certain group annuities and certain single policytholder life insurance and annuity contracts which may specifically provide for the insulation of separate account assets (i.e., assets are not available to support the liabilities of the general account). Since separate account assets that exceed contract reserves for variable annuities are available to support the liabilities of the general account, these assets are accounted for as amounts due to the general account.

The CARVM allowance represents the difference between separate account assets and reserves supporting variable annuities. As previously mentioned, the CARVM allowance is a general account asset that is available to support the liabilities of the general account. The CARVM allowance does not represent future cash flows from the separate account (such as fees, surrender charges and fund transfers). It represents assets that are invested in the funds that support the variable annuities. Since the investment of these assets is, in fact, controlled by variable annuity contractholders (as opposed to being owned by the contractholders), the assets may not be as liquid as other general account assets (American Academy of Actuaries, 1998b).

Valuation Mortality

The mortality basis used to discount projected death benefits is the 1994 Group Annuity Mortality Basic Table, increased by 10% for margins and contingencies, without projection.

CHAPTER VI

ACTUARIAL ASPECTS OF A VARIABLE ANNUITY

Pricing Considerations

Most variable annuities on the market guarantee a minimum amount payable upon the death of the policyholder. Regarding the guaranteed minimum death benefits (GMDB), this section intends to describe methods and ideas an actuary has to consider when modeling and pricing the variable annuity contract.

First of all, what are the reasons for offering these benefits? One reason is the customer´s concern about death when the account value is down. A GMDB also enhances persistency, customers may not consider a surrender knowing they still have the protection by the benefit. Another reason is to differentiate a variable annuity not only from other variable annuities, but also from other products such as mutual funds.

Offering a GMDB is not riskless for a company. Other than in a simple variable annuity contract where the insurer passes the whole investment risk to the policyholder, the company takes back some of that investment risk. The amount it takes back depends on the level of the fund performance of the assets supporting the contract, and the volatility

of that fund performance. The investment risk also depends on the type of the benefit. A roll-up benefit, a benefit that increases at a given rate each year, may cause a loss to the company if the underlying fund performance is less than the guaranteed roll-up. With a ratchet and a reset benefit the death benefit is linked to the account value at the end of a certain period. The ratchet benefit pays the maximum account value of all previous ratchet periods and a reset benefit equals the account value at the end of the reset period. Therefore the investment risk is higher when a ratchet benefit is offered because this type does not allow the benefit to decrease at any time. Another important factor is of course the mix of funds the company holds, more volatile investments involve higher risks whereas low volatile funds may not produce enough earnings to make up for the offered roll-up benefit.

The second risk the actuary has to consider is mortality. How conservative shall the mortality assumptions be in order to be still able to offer competitive prices? Another point that has to be considered by the actuary is mentioned by Campbell (Society of Actuaries, 1997a): „I've heard the argument that people who are uninsurable from a life insurance standpoint are going to purchase annuities with rich GMDBs." Also of importance are age limits built in GMDBs. One has to decide until what age does the company provide a death benefit exceeding the

account value. Some variable annuity contracts cover both, if different, the contract owner and the annuitant. In this case a company obviously takes more mortality risk.

The GMDB design is also affected by offering partial withdrawals with the contract. Partial withdrawals reduce both, the account value and the GMDB. Two different methods are used to accomplish the reduction in the GMDB:

- dollar for dollar; and
- pro-rata

The following example by Campbell (Society of Actuaries, 1997a) illustrates the two methods:

> Example: Assume a variable annuity with an account value of $1,000 and an GMDB of $1,100, the death benefit is $100 "in the money." Now assume there is a withdrawal of $500. Under the dollar-for-dollar offset, both the account value and the death benefit are reduced by equal amounts. The account value is reduced to $500 and the death benefit is reduced to $600, but the amount that the death benefit is "in the money" remains at $100. With a pro-rata offset, the death benefit is reduced in the same proportion as the account value. So in this example, the death benefit is reduced to $550 and is only $50 "in the money."

Therefore the actuary can reduce the company´s risk by using the pro-rata method.

Another pricing consideration is age. Other than in a life insurance policy, a variable annuity charges the same mortality and expense charges regardless of the age of the policyholder. The revenue the company receives from these charges is to offset GMDB, incorrect assumptions may lead to an insufficient return (Society of Actuaries, 1997a).

Besides mortality there are also lapse rates that have to be assumed. As mentioned above, GMDB may increase persistency of a contract and should therefore be considered in pricing the annuity.

One of the key assumptions in pricing a variable annuity is the mix of funds and the transfers made between them. These assumptions should consider the factor age. Young people tend to invest in riskier investments, older customers may prefer to invest more in the fixed account. There is no GMDB risk for money that is invested in the fixed account, whereas being able to invest in volatile funds and still being protected by a GMDB is one of the reasons people buy a contract with a GMDB. According to transfers the actuary has to consider that customers usually do not act like professional investment managers, there will be always unreasonable movements between investments, a

fact described by Campbell (Society of Actuaries, 1997a): „People tend to buy high and sell low." In addition, the actuary has to make assumptions regarding the fund performance.

The Unit Value Concept

One of the main basic principles behind a variable annuity is the unit value concept. In order to describe this concept for a variable annuity, one may look at the fixed annuity case first:

During the accumulation phase, one can construct a table of cash values using a series of net premiums, N_t, and the guaranteed interest rate, *i*. Based on Macarchuk (1969), the cash value table can be represented mathematically by the following expression:

$$\langle\{[N_1(1+i)+N_2](1+i)\}+N_3\rangle(1+i)...$$

This expression can be rearranged to get a formula for the *n*-th cash value, $(CV)_t$:

$$(CV)_t = N_1(1+i)^t + N_2(1+i)^{t-1} + ... + N_t(1+i)$$

Now define a series of accumulation unit values $v_1, v_2, ..., v_t$ such that $v_{k+1} = v_k(1+i)$. This successive relationship leads to:

$$v_{k+1} = v_1(1+i)^k.$$

Each net premium can be expressed in terms of accumulation units, the number of accumulation units which can be used to represent N_t is u_k, where (Macarchuk, 1969)

$$u_k = \frac{N_k}{v_k}.$$

Plugging this expression into the cash value formula yields

$$(CV)_t = u_1 v_1 (1+i)^t + u_2 v_2 (1+i)^{t-1} + \ldots + u_t v_t (1+i).$$

And since $v_{k+1} = v_k (1+i)$, we have

$$(CV)_t = (u_1 + u_2 + \ldots + u_t) v_{t+1}.$$

Hence, we can express the cash value of a traditional fixed annuity in terms of a number of accumulation units and a chain of unit values which reflect the interest rate guarantee implicit in the cash value table. Additionally, „it also demonstrates that the essence of the accumulation unit concept is a chain of unit values which are interrelated by an investment rate of return" (Macarchuck, 1969), which in this case is the guaranteed fixed interest rate.

After the end of the accumulation phase, the benefits under the traditional fixed amount annuity are measured in terms of a dollar amount of an annuity payment for a specific time period, $500 per month for example. This amount can be viewed as the amount that will amortize the funds which constitute the actuarial value of the annuity

and following investment earnings. Define the interest rate on which this amortization is based as *j*, and the annuity unit value, v_t^a, such that

$$v_t^a = v_{t-1}^a \left(\frac{1+j'}{1+j} \right).$$

According to Macarchuck (1969) let now P_i be the amount of the initial payment and u^a be the number of annuity units which is used to represent P_i, then

$$u^a = \frac{P_i}{v_i^a} \text{ or } P_i = u^a v_i^a$$

It also follows that

$$P_{i+1} = u^a v_i^a \left[\frac{(1+j')}{(1+j)} \right]$$

One can observe that by setting $j = j'$, a fixed amount annuity with level payments can be obtained. Here, j' can be interpreted as the credited rate of interest (Macarchuck, 1969).

Applied to variable annuities, *j* becomes the rate of investment earnings assumed by the actuary during the annuity payout phase. In this case, j' becomes a variable from period to period and is the actual net investment earnings rate for the block of assets that fund the contract benefits. In addition, Macarchuck (1969) states that „for simplicity's sake, the accumulation unit is commonly used for the period

prior to the commencement of annuity payments, and the unit values are interrelated by the series of rates j'. For convenience sake, the investment earnings rate assumed during the accumulation period is zero."

CHAPTER VII

ASSET INVESTMENTS FOR VARIABLE AND FIXED ANNUITIES

Assets held by life insurers back the companies´ life, health, and annuity liabilities. Based on the American Council of Life Insurers (2001), in 2000, US life insurers held $3.1 trillion in U.S. capital markets, 2.3% more than in 1999. These assets can generally be classified into the following categories:

- Bonds

Bonds are publicly traded debt securities. Often referred to as fixed-income securities, bonds generally offer low risk and a greater certainty of rates of return. Not only does the borrower (seller of the bond) agree to pay a fixed amount of interest periodically and repay a fixed amount of principal at maturity, but the obligation to make payments on the bond takes precedence over other claims of lenders and stockholders.

50% of life insurer assets were held in bonds at year-end 2000, totaling $1.6 trillion. Bonds are issued by various organizations such as domestic and foreign corporations, the U.S. Treasury, U.S. government

agencies, and state, local, and foreign governments (American Council of Life Insurers, 2001).

- Stocks

Since the early 1990´s, the share of assets held in stocks has been increasing. The average annual growth rate in equity holdings was 23% between 1990 and 2000.

Life insurers holdings of corporate stocks totaled $992 billion in 2000, or 31% of total assets. 74% of the common stock held was invested in industrial and miscellaneous sectors, 19% in parent subsidiaries and affiliates, 7% in bank, trust, and insurance companies, and 0.5% in public utilities (American Council of Life Insurers, 2001) .

- Mortgages

The American Council of Life Insurers (2001) states that 7%, or $237 billion, of the assets in 2000 were invested in mortgages. Those can be categorized in mortgages for residential properties, commercial properties, and farm mortgages. Mortgages for commercial properties such as office buildings, shopping centers, manufacturing plants represented 92% of mortgages held by life insurers. Farm mortgages accounted for 6% of total mortgages in 2000.

- Real Estate

Based on American Council of Life Insurers (2001) data, U.S. life insurers held 1% of their assets in 2000 in real estate, amounting $36 billion. 77% of all real estate owned by U.S. life insurers was invested in investment properties, 17% in land and property for company use, and the remaining 6% in real estate acquired through foreclosure.

- Policy Loans

Life insurance companies can loan money to policyholders up to the cash value of their life policies. Interest is charged on these loans, the amount of a policy´s protection is reduced by the amount of the loan.

At year-end 2000, $102 billion, or 3%, of life insurance company assets were held in policy loans.

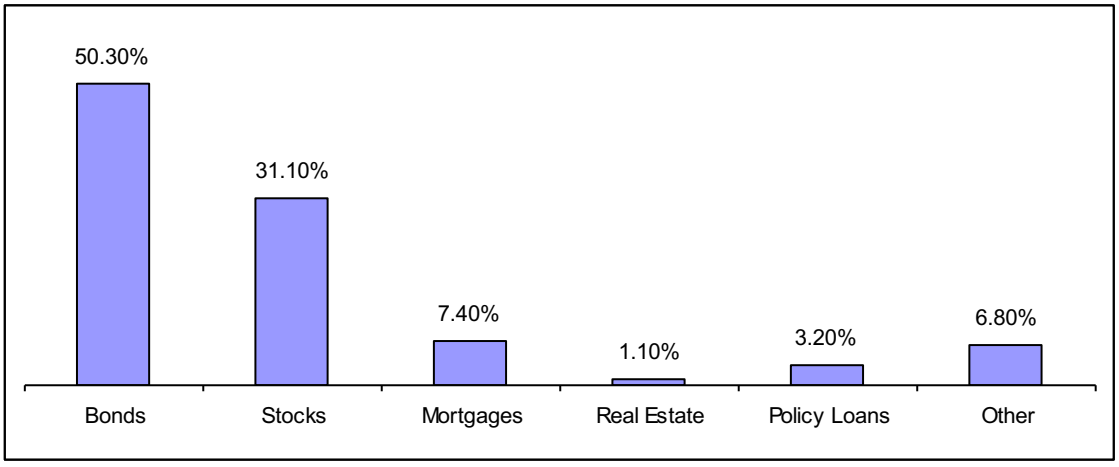

Figure 18: Investment Distribution of Life Insurers 2000

(Source: American Council of Life Insurers, 2001)

The classification of the different asset classes that is used for the CARVM stated in the *Actuarial Guideline XXXIII* by the American Academy of Actuaries (1998a), is the following:

- Equity

Although equity funds have a broad range of investment objectives, all invest primarily in publicly traded securities, such as common stocks, preferred stocks and convertible securities. The choice of securities purchased by the portfolio manager will be guided by the fund objective (such as growth of capital or income, or approximating an index), the capitalization of the companies issuing the stock (e.g. small, medium or large) or the target region (domestic U.S., Pacific Rim, etc.). Although some equity funds maintain a general strategy, allowing a portfolio manager great latitude in purchase, other equity funds have become quite specific in their investment objectives. All equity funds, however, are somewhere on the high end of the risk/return scale.

- Bond

Investment objective is usually to provide a high level of income consistent with moderate fluctuations in principal value. The objective is accomplished through investments in fixed income securities, such as U.S. government securities, foreign government securitites, or publicly traded debt securities issued by U.S. of foreign corporations. Since most

bonds are assigned ratings by private Rating Agencies, the specific objectives of the funds are often described by the funds´ tolerance for instruments at the various rating levels. Funds that focus predominantly on safety will tend to use more U.S. government securities, while a fund that focuses predominantly on income may tend to use more lower investment grade instruments. All bond funds, however, are somewhere in the midrange of the risk/return scale.

- Balanced

Investment objective is to seek a maximum total return over time, consistent with an emphasis on both capital appreciation and income. Typically, these funds will contain 50%-75% stocks, with the remaining assets invested in bonds and cash equivalents. However, balanced funds grant the portfolio manager the latitude to shift the asset allocation depending on a current analysis of market trends. Beside the term „Balanced", common terms for this fund type include „Total Return", „Adviser´s" and „Asset Allocation".

- Money Market

Investment objective is to achieve maximum current income consistent with liquidity and preservation of capital. These funds typically aim to maintain a stable net asset value of $1 per share. The assets contained in this fund typically have a stated maturity of less than

thirteen months with an average maturity of less than 90 days. Common assets held include U.S. government obligations, certificates of deposit, time deposits and commercial paper.

- Specialty

Investment objective is to seek a maximum total return with an emphasis on long term capital appreciation, and sometimes current income. Typically, this fund type will invest most of its assets in common stocks or debt instruments of companies that operate within a specified industry. Commonly, specialty funds invest in utilities, natural resources and real estate, although there is a broad range of possible industries to choose from. The key difference between a specialty fund and an equity or bond fund is the targeted approach to investing. In a specialty fund, no effort is made to diversify outside the target industry.

The following table shows the performance of different types of funds as of 08/31/01:

Table 11: Performance of different Types of Funds

(Source: Info-One, 2001)

Fund Type	1 Month Return	3 Month Return	1 Year Return
Aggressive growth funds	-7.81%	-13.81%	-43.82%
All balanced funds	-2.98%	-5.06%	-11.18%
Corporate bond general funds	0.98%	2.70%	7.57%
Corporate bond high quality funds	0.96%	3.35%	10.40%
Corporate bond high yield funds	0.67%	-1.53%	-6.72%
All equity funds	-5.46%	-10.30%	-26.96%
Equity-income funds	-3.94%	-7.19%	-5.19%
All fixed income/bond funds	1.02%	1.61%	3.42%
Growth funds	-6.42%	-11.35%	-29.12%
Government Bond General Funds	0.82%	2.92%	9.36%
Government Bond treasury funds	1.12%	3.87%	11.06%
Growth and income funds	-5.14%	-8.31%	-13.73%
International bond funds	2.61%	4.02%	5.31%
International stock funds	-3.44%	-10.12%	-30.09
All money market funds	0.18%	0.58%	3.80%
Specialty Funds	-5.44%	-10.83%	-29.66%
NASDAQ QTC Composite	-10.94%	-14.45%	-57.08%
Dow Jones Industrial Average	-5.45%	-8.82%	-11.28%

Regulatory Environment

The allowable investments for life insurance companies are guided by applicable legislation and regulation. These limitations generally seek a balance among the following objectives:

- Safety of principal
- Stability of value
- Sufficient liquidity
- Appropriate diversification
- Reasonable relationship between assets and liabilities

The principal way in which the above goals have been achieved is through a list of permitted investments. In the United States regulations for life insurance companies are generally produced by state insurance commissioners. A general summary of the types of regulation given by Stapleford and Stewart (1991) is the following:

- Permission to invest in bonds or other evidence of indebtedness of US governments, including states, provinces and municipalities, and US corporations.
- Some states require an earnings test for investment in corporate bonds or stocks, for example a company must have earned a 4% return on capital in four of the preceeding five years.
- Mortgages are limited to a maximum amount of 75% of the appraised value of the property.
- Limits are placed on single investments.
- A maximum percentage of ownership of a corporation may be specified.

- Limits on overall exposure to certain asset classes, such as real estate, stocks or foreign investments may be expressed, often as a percentage of assets.
- There may be a prohibition on investment in assets in default, or a limit on the percentage of funds that may be invested in below-investment-grade (high yield or junk) bonds.

Asset Distribution

The investment assets of a life insurance company are held in two accounts, either the insurer´s general account or its separate account. These accounts differ largely in the nature of the liabilities of obligations for which the assets are being held and invested. Assets in the general account support contractual obligations for guaranteed, fixed-dollar benefit payments, for example life insurance policies or fixed annuities. Assets in the separate account support the liabilities associated with products or lines of business that pass the investment risk to the customer, for example variable life insurance and variable annuities.

State laws allow assets in separate accounts to be invested without regard to the restrictions placed on the general account. Therefore the separate account contains more risky investments, whereas the general account invests in products that have a relatively small investment risk

(American Council of Life Insurers, 2001).

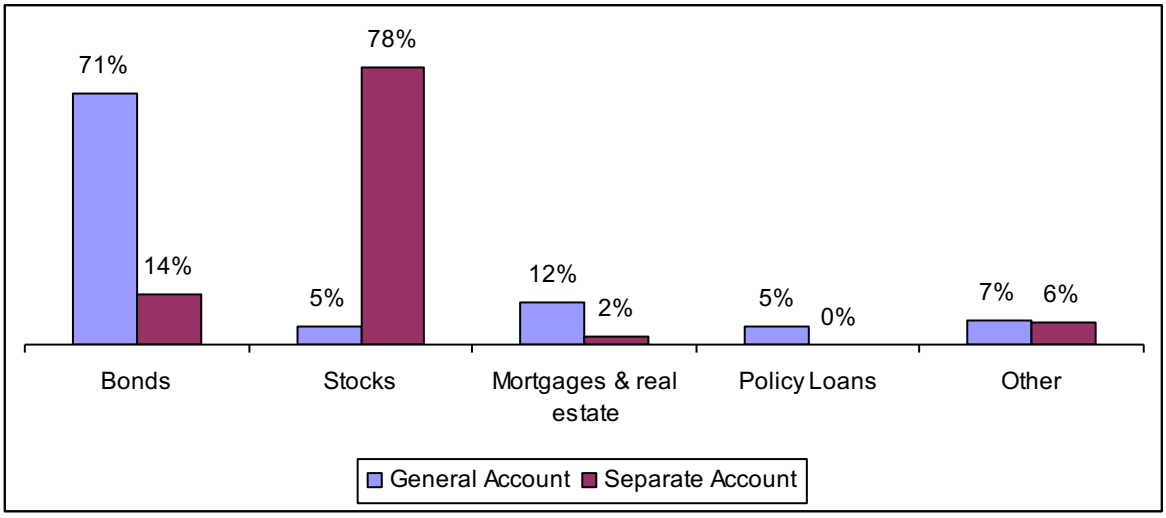

Figure 19: Asset Distribution of Life Insurers 2000

(Source: American Council of Life Insurers, 2001)

Fixed Annuities

Considerations of fixed annuities are generally invested in the general account of the insurance company. Since the annuity payments are guaranteed, the company has to follow the regulations according its investments.

Variable Annuities

Assets of variable annuities are held in separate accounts. The only exception is the fixed account option described in chapter II. The

insurance company offers various funds which the customer can choose from. These funds differ in their risk class, investment strategy and investment objective. The main difference to investments made for fixed annuities is the tendence towards investments that provide higher expected rates of return, given a higher risk. Transfers between these investment vehicles under a variable annuity are possible, but may be subject to additional charges. The insurance company also passes the different fees of the investment vehicles to the policyholder. For example management fees, operating expenses, or distribution and service fees that may apply.

The mix by investment objective showed that at the end of the first quarter 2002, $521.5 billion, or 58.5% of assets, was held in equity accounts. This is an increase of 0.5% as compared with year-end 2001 when equity accounts represented $518.8 billion, but a decrease of 19% as compared with year-end 2000 when equity accounts totaled $621.7 billion. The mix also shows that $200.6 billion, or 22.5% of assets, was held in fixed accounts, which is an increase of 2.1% as compared to the end of 2001. Balanced accounts made up for 7.8%, Bonds 7.1%, and Money Market accounts totaled 4.1%. Compared to year-end 2000, one can observe an increase from 4.6% to 7.1% of total net assets held in

bonds, and a decrease from 8.4% to 7.8% held in balanced accounts (National Association for Variable Annuities, 2002).

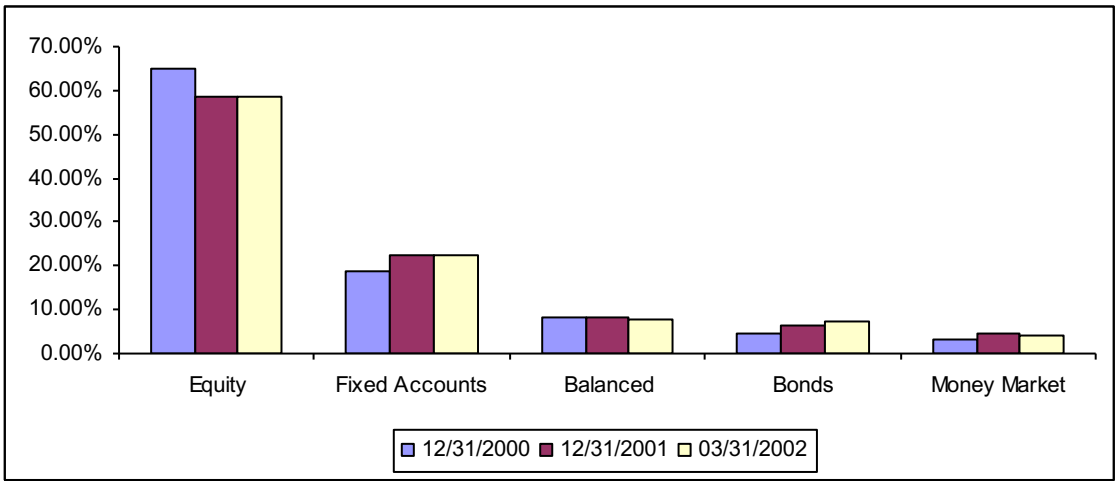

Figure 20: Variable Annuity Net Assets by Investment Objectives (Source: National Association for Variable Annuities, 2002)

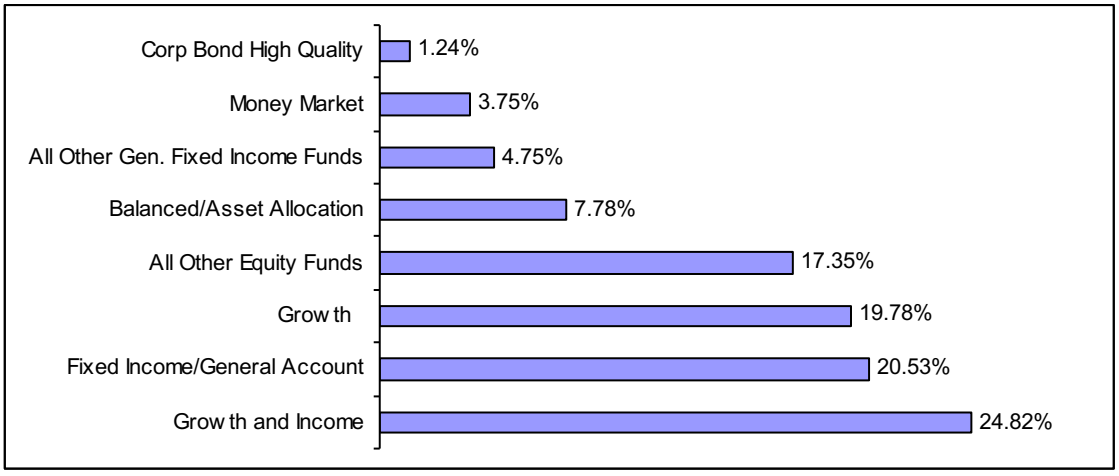

Figure 21: Variable Annuity Assets by Investment Objectives 06/30/01

(Source: Info-One, 2001)

A more detailed look results in the following: At the end of the second quarter 2001, 24.82% of total variable annuity assets was held in growth and income funds, 19.78% in growth funds, and 17.35% in all other equity funds. 1.24% were held in corporate high quality bonds and 4.75% in all other general fixed income funds (Info-One, 2001).

Dollar Cost Averaging

Some variable annuity contracts provide the customer with the opportunity of *dollar cost averaging*. This means the policyholder can decide to invest a fixed amount of money periodically in a certain investment vehicle, no matter how the actual value of this vehicle is. Therefore the number of units the customer actually buys varies, he will get more units if the price is lower than if it is high. The goal is to lower the prices of the units in the long run.

CHAPTER VIII

ASSET-LIABILITY MANAGEMENT FOR VARIABLE AND FIXED ANNUITIES

In the past years, asset-liability management has become an essential part of an insurance company. Due to a turbulent interest rate climate and uncertain stock markets it has become more difficult for an insurance company to produce a perfect match between its assets and liabilities. In order to match an insurer´s liability portfolio, various asset-liability management strategies and techniques have been evolved.

Strategies and Techniques

Robert van der Meer and Meije Smink (1993) classify the existing asset-liability management strategies and techniques as follows:

- Static
- Value driven
- Return driven

Static Techniques

Static techniques are commonly applied in banking and insurance business. They are relatively simple and easy to use. They focus on a complete match between assets and liabilities. But all these strategies lack the possibility of a consistent trade-off between risk and return because they are both static and provide only a one-dimensional perspective on the asstes and liabilities. They do not measure risk or return explicitly. Van der Meer and Smink (1993) mention the following static techniques:

- Cashflow payment calendar

The *cashflow payment calendar* presents a maturity overview of all cash inflows and outflows. It is a tool for detecting major imbalances between cashflows resulting from assets and liabilities.

- Gap analysis

Clifford (1981) defines the *Gap* as the balance sheet value difference between fixed and variable rate asset and liabilities. A non-zero Gap implies interest rate exposure. For instance, when there are more variable rate assets than liabilities, then a decline in rates will result in a loss in net operating income. Additionally, Gap analysis may be refined in order to account for maturity differences between assets and liabilities.

- Segmentation

With *segmentation*, liabilities are partitioned according to differences resulting from product characteristics. In addition, each segment obtains an identifiable asset portfolio, tailored to meet the particular characteristics of the liabilities.

- Cashflow matching

Cashflow matching aims to minimize the imbalances between all asset and liability cashflows, usually by means of linear programming. From an asset universe, a portfolio is selected which meets all liability payments with certainty, within a minimal acceptable time span, and with minimal cost. It may be noticed that in contrast to the other three techniques, which are descriptive, this is predominantly a prescriptive technique.

Multiscenario Analysis

According to Van der Meer and Smink (1993), Multiscenario analysis is intended to provide a link between the previously mentioned static techniques and completely dynamic strategies. The multiscenario technique is still static in nature, but it is possible also to formulate scenario contingent actions. Multiscenario analysis projects the development of the cashflows of the liability and the asset portfolios.

These projections are made under different assumptions regarding the future development of a number of key variables, e.g. interest rates, inflation, etc. The analysis shows under which scenarios cashflows are not matched and what the consequences are for the overall organization. In addition, it still focusses on flows instead of values.

Multiscenario analysis facilitates the modelling of complex relationships and allows for a multi-dimensional risk concept. However, the multiscenarios and different dimensions of risk also create the core of potential problems associated with this technique. The user is likely to be biased towards particular scenarios which are considered to be more likely, where other scenarios may lead to the most serious distress. This may still be true when so called randomly generated scenarios are created. Furthermore, even though multiscenario analysis may lead to problem detection in a more general way than single scenario or static analysis, multiscenario analysis by itself does not provide an easy tool for management unless objectives, restrictions and their relative importances are clearly specified.

Value Driven Dynamic Strategies

The basic idea behind these strategies is to maintain the net value, or surplus, of a portfolio consisting of assets and liabilities with fixed

cash flows. This process is called *immunization*. The various immunization strategies, based on Van der Meer and Smink (1993), are:

- Standard Immunization

Standard immunization implies matching of the interest sensitivities of assets and liabilities. In mathematical terms this requires equation of the first order partial derivatives of their valuation functions with respect to the yielding interest rate. Moreover the corresponding second order partial derivative of the assets is restricted to be at least as large as that of the liabilities. For fixed coupon assets, the first order partial derivative divided by the initial value, is known as *modified Macauly Duration*, while the relative second order derivative is known as *Convexity*. Where duration measures the point interest rate sensitivity of the asset or liability value, convexity measures the change in this duration as a result of changing interest rates. A more detailed description of various duration and convexity measures is given below.

Matching asset and liability durations implies that the initial change in value of the asset and liability are of the same magnitude and direction. However, this will only be true for infinitely small changes in the flat term structure interest rate and for a small instant of time. Therefore immunization requires continuous rebalancing of the portfolios and is explicitly a dynamic strategy. Creating and maintaining an asset

portfolio with a larger convexity than that of the liability portfolio, implies that the change in value of the asset will be such that it will never be outperformed by the value change of the liability. The result being that the net value of assets minus liabilities will not decrease.

- Model Conditioned Immunization

In order to improve the standard immunization strategy, some modifications of this strategy have been developed. Using the same operational respects, these strategies differ only in the duration and convexity measures used, they are conditional on assumptions regarding the stochastic process governing the development of the term structure.

- Single Factor Immunization

This simple model conditioned immunization strategy uses only the short term interest rate as a single stochastic factor determining bond prices. Van der Meer and Smink (1993) describe it as follows: „Given their assumptions on the term structure, the sensitivity of bond prices, for term structure shifts caused by the short term interest rate, can be represented by a model specific duration. However, once the appropriate duration measure is derived, an immunization strategy similar to standard immunization results."

- Multi-factor Immunization

The main idea in this technique is that a limited number of independent variables generate the bond price returns and thereby imply the shape of the term structure. The factors in the models are usually linked to theoretical parameters, e.g. the long term average of the short term rate or interest rate volatility. Other factors are based on observed forward rates and rely on statistical identification. Given the determined factors, strategies that immunize the portfolio for changes in these factors can be formulated.

- Key Rate Immunization

Key rate immunization is quite similar to standard immunization, the only difference is that it explicitly recognizes the possibility of non-parallel term structure shifts. It separates the cashflows and assumes that the shape of the term structure is caused by a limited number of key interest rates. All other values are obtained through interpolation (Van der Meer and Smink, 1993).

- Contingent Immunization

Contingent immunization techniques combine the possibility of active portfolio management with the requirements of portfolio matching. Based on the assumption that an asset portfolio can be immunized at any moment in time, one can manage it actively to achieve outperformance as long as it has sufficient value to meet the liabilities. If

the portfolio value declines to a previously defined minimum value, „the immunization mode is triggered and the portfolio is managed through an immunization strategy" (Van der Meer and Smink, 1993).

- Portfolio Insurance

This technique uses stocks and bonds, the idea is to create a put option on a stock portfolio, i.e. to replicate the value of the put option. Therefore the strategy can benefit of an increase in the stock investments but the value will not fall above a prespecified level.

- Constant Proportion Portfolio Insurance

This strategy combines the contingent immunization and the portfolio insurance. Similar to these two techniques, a minimum account value is specified. Van der Meer and Smink (1993) state that a „part of the total portfolio value, called the reserve account, is invested in a risk free asset or strategy and guarantees the value of the floor at the end of the investment period." The remaining part of the portfolio is then called the active account., which may be completely or partly invested in more risky investments. If so, however, „the proportion of the active account invested risky, is stable over time" (Van der Meer and Smink, 1993).

Return Driven Dynamic Strategies

These types of strategies focus mainly on returns or spreads. The two most common techniques are:

- Spread Management

The goal in this strategy is to maintain a yield spread between the asset and liability portfolio. It is similar to segmentation and a „buy and hold investment strategy, usually both asset and liability portfolio yields are related to term structure derived treasury bond yields" (Van der Meer and Smink, 1993).

- Required Rate of Return Analysis

Required rate of return analysis adjusts the asset investments in order to achieve a rate of return that meets the future cashflows of the liabilities. The asset selection process may depend on different scenarios and an underlying risk criterion.

Each of these strategies and techniques has advantages and disadvantages. There is no dominating type, the decision which one to use is to be made under the specific situation.

Risk Based Capital

Risk Based Capital (RBC) is a concept that intends to establish a minimum capital level on an insurance company-specific basis. The regulatory model became effective in 1995. A Morgan Stanley Study Note (1993) describes its primary purpose as „to allow regulators to monitor an insurer´s *RBC ratio* (*adjusted capital* divided by total RBC) over time and react to a deteriorating situation as soon as possible."

Depending on a company´s RBC ratio, a specific regulatory action is taken. Table 12 summarizes the regulatory actions based on *Risk Based Capital for Life Insurers*, 1993 by Morgan Stanley & Co, Inc.

Table 12: Regulatory Actions

(Source: Morgan Stanley, Inc., 1993)

RBC Ratio between	Action
1.25 and more	No action
1.00 and 1.25	Trend Test The company has to perform an extra test to check the recent trend in the RBC ratio. If the trend goes down fast, the company is required to implement a plan to increase the ratio.
0.75 and 1.00	Plan Level The company must draw up a plan in order to increase the RBC ratio.
0.50 and 0.75	Action Level The insurer has to submit an RBC plan covering whatever aspects of its business the insuranc commissioner deems necessary and then must take corrective actions determined by the commissioner.
0.35 and 0.50	Authorized Control Level In this case the commissioner can either take control of the company or may proceed as in the Action Level.
0 and 0.35	Mandatory Control Level The insurance commissioner takes control over the company.

To calculate the RBC, one needs four categories of risk:

- C-1: Asset default or depreciation risk
- C-2: Adverse insurance experience risk
- C-3: Loss from asset/liability mismatching
- C-4: General business hazards

The C-1 risk includes the risk of loss due to default for debt and debt-like investment instruments. For other assets, it is the risk of a depreciating value. C-2 risk covers risks of wrong assumptions concerning actuarial pricing factors like mortality rates, morbidity rates, persistency rates and expenses. C-3 is the risk in changes of interest rates and a mismatch between assets and liabilities caused by these changes. The value of the assets can change differently than the value of the liabilities, an unexpected loss might occur in this scenario. The C-4 risk covers all other risks that may occur and that are not included in the three categories mentioned above, for example loss caused by management incompetence.

The total RBC can be obtained by using the following formula:

The company´s adjusted capital equals the sum of its statutory capital and surplus, the asset valuation reserve, voluntary reserves (if any) and 50% of the policyholder dividend liability.

Interest Rate Risk and Immunization

The risk of losses due to changes in interest rates, C-3, can occur in various scenarios. Consider for example a situation where interest rates fall and an insurance company has to reinvest cash flows at a lower interest rate. This is called the *reinvestment risk*. Another possible situation is the following: If the company has to liquidate a number of bonds or other fixed-income securities whose values have fallen because of an increase in interest rates, a capital loss can occur. This is called the *disinvestment* or *price risk* (Panjer, 1998). As mentioned earlier, the concept of immunization tries to immunize an insurance company´s surplus from the results of changing interest rates.

In 1952, F.M. Redington defined immunization as „the investment of the assets in such a way that the existing business is immune to a general change in the rate of interest." A description of the mathematical approach to this theory is the following:

Let A_t denote the asset cash flow expected to occur at time *t* and L_t denote the liability cash flow expected at time *t* of a block of long-term insurance or annuity policies and its associated assets, $t > 0$. The present values of the assets and liabilities, for a given rate of interest *i*, are given by (Panjer, 1998)

and .

Now denote the surplus of this block of business with

.

Using the definition of a derivative, one can approximate a formula for small changes in the interest rate, i:

To immunize the surplus with respect to small changes in the interest rates, one has to structure the assets and liabilities in a way that

and therefore

.

If the cash flows are not functions of the interest rate, the assets and liabilities have to be structured in a way such that

,

which means that the discounted asset and liability cash flow streams have the same first moment (Panjer, 1998).

To quantify the interest-rate sensitivity of a fixed-income security, the concept of *duration* has been developed. According to Noris and

Epstein (1988), „duration is a measure of price sensitivity and is computed by finding out how much the price will change as interest rates change a small amount." The mathematical formulation of duration is the following:

$$duration \quad \frac{\frac{d}{dy}A}{A},$$

where *A* is the current price or market value of the cash-flow stream of a fixed-income security and *y* is the *yield to maturity*, defined as the solution of the equation

.

Assume that the cash flows are fixed, and consider the price *A* as a function of *y*. For the sake of convention, a negative sign is placed in front of the value such that securities whose prices decrease when interest rates increase will have positive durations.

Panjer (1998) defines the following three types of durations:
The derivative of the price with respect to the yield *y*,

—— ,

is called the *modified dollar duration*.
The *modified duration* is defined as

$$\frac{1}{A}\frac{d}{dy}A \qquad \frac{d}{dy}\log A,$$

and the *Macauly duration* as

— .

The Macauly duration can also be expressed as

— —— — ,

where *r* denotes the *force of interest*, , and thus,

.

Another measure based on the considerations about duration is called the *Macauly convexity*, denoted by

——— — .

Note the use of a second derivative term based on the three-term taylor approximation formula for the surplus *S(i)* (Panjer, 1998):

.

An important assumption in Redington´s model is that the asset and liability cash flows are independent of interest rate fluctuations. This condition certainly does not hold for assets such as callable bonds or liabilities such as single-premium deferred annuities (Panjer, 1998). One

way to value interest-sensitive cash flows is the option-pricing theory of Black and Scholes (1973). Another assumption is that the theory only holds for small changes in the interest rates.

To allow for not necessarily small interest rate changes one has to look at the generalization of Redington´s theory (Shiu, 1990 and Panjer, 1998):

Assume that the asset and liability cash flows A_t and L_t are independent of interest fluctuations. Let N_t be the net cash flow at time time t, $N_t = A_t - L_t$, and let S denote the current surplus,

$$S = \sum_{t>0} N_t P(0,t),$$

where $P(0,t)$ is the price at time 0 of a noncallable and default-free zero-coupon bond maturing for 1 at time t, $t > 0$ (Panjer, 1998). Now assume a change in the interest rates that changes the zero-coupon bond prices to $P^*(0,t)$, $t > 0$. This also changes the surplus value to

$$S^* = \sum_{t>0} N_t P^*(0,t).$$

The only condition that ensures $S^* \geq S$ is $S^* = S$ for all shocks and changes. In other words, the cash flow remains unchanged under all interest change scenarios. Equivalenty, the net cash flows are zero:

$$N_t = 0, \text{ for all } t > 0.$$

Now consider the change in the surplus, S^* - S. Define n_t as the discounted value of N_t with respect to the original term structure of interest rates (Panjer, 1998),

$$n_t = N_t P(0,t),$$

and the function

$$g(t) = \frac{P^*(0,t)}{P(0,t)} - 1.$$

The change in the surplus can now be expressed as

$$S^* - S = \sum_{t>0} N_t P(0,t) g(t) = \sum_{t>0} n_t g(t).$$

Assuming that the function g is twice differentiable, one can write it using Taylor´s formula with integral reminder as (Panjer, 1998)

$$g(t) = g(0) + g'(0) + \int_0^t (t-w) g''(w) dw .$$

The change in the surplus now is

$$S^* - S = g'(0) \sum_{t>0} t n_t + \sum_{t>0} n_t \int_0^t (t-w) g''(w) dw.$$

To be able to switch summation and integration in the last term, consider the notation $x^+ = \max(x,0)$, then the last term can be modified as follows (Panjer, 1998):

$$\sum_{t>0} n_t \int_0^t (t-w)^+ g''(w) dw = \sum_{t>0} n_t \int_0^\infty (t-w)^+ g''(w) dw = \int_0^\infty \left[\sum_{t>0} n_t (t-w)^+ g''(w) \right] dw$$

Suppose that the net cash flows $\{N_t\}$ satisfy either

$$\sum_{t>0} n_t (t-w)^+ \geq 0 \text{ or } \sum_{t>0} n_t (t-w)^+ \leq 0, \text{ for all positive } w.$$

According to Panjer (1998), by applying the weighted mean value theorem for integrals, one can now show that a positive number η exists such that

$$\int_0^\infty \left[\sum_{t>0} n_t (t-w)^+ g''(w) \right] dw = g''(\eta) \int_0^\infty \left[\sum_{t>0} n_t (t-w)^+ \right] dw.$$

Reversing the order of integration and summation yields (Panjer, 1998)

$$\int_0^\infty \left[\sum_{t>0} n_t (t-w)^+ \right] dw = \sum_{t>0} n_t \int_0^\infty (t-w)^+ dw = \sum_{t>0} n_t \int_0^t (t-w),$$

which can be written as

$$\sum_{t>0} n_t \frac{t^2}{2}.$$

Thus, the change in the surplus can be expressed as

$$S^* - S = g'(0) \sum_{t>0} t n_t + \frac{1}{2} g''(\eta) \sum_{t>0} t^2 n_t.$$

Additionally, assuming the asset and liability cash flows can be structured so that the first moment of the present values of the net cash flows is zero (Panjer, 1998),

$$\sum_{t>0} t n_t = 0,$$

or equivalently,

$$\sum_{t>0} tA_t P(0,t) = \sum_{t>0} tL_t P(0,t),$$

the change in the surplus simplifies to

$$S^* - S = \frac{1}{2} g''(\eta) \sum_{t>0} t^2 n_t \, .$$

Panjer (1998) states that Redington´s model can be viewed as the special case of parallel shifts in the yield curve, in this case

$$P^*(0,t) = e^{ct} P(0,t) \text{ or } g(t) = e^{ct} - 1$$

where the constant *c*, which can be positive or negative, denotes the amount of yield curve shift. The change in the surplus becomes

$$S^* - S = \frac{1}{2} \eta^2 e^{c\eta} \sum_{t>0} t^2 n_t \, .$$

Hence, if the conditions

$$\sum_{t>0} t n_t = 0 \text{, and}$$

$$\sum_{t>0} n_t (t-w)^+ \geq 0 \text{ or } \sum_{t>0} n_t (t-w)^+ \leq 0 \text{, for all positive } w,$$

hold, we have

$$S^* \geq S$$

for any value of *c*, which means for any instantaneous parallel shift in the yield curve, but not for all interest rate shocks (or for all shifts in the yield curve) (Panjer, 1998).

Risk Management

The actuary has to deal with various risks connected to variable annuities. Especially new prodcut options like guaranteed minimum death benefits (GMDB), guaranteed minimum accumulation benefits (GMAB), guaranteed minimum annuity floor (GMAF), guaranteed minimum income benefit (GMIB), etc. present familiar risks such as persistency, mortality, and investment, and also unfamiliar risks such as capital markets, behavorial, regulatory. Each risk has three components: the amount at risk, the exercise rate for the option, and the claim cost, which equals the exercise rate multiplied by the amount at risk.

The following table summarizes the most common product options and the amounts at risk respectively:

Table 13: Common Product Options and the Amounts at Risk

(Source: Byers, 2002)

Option	Amount at Risk	Main Risk Drivers
GMDB	Death benefit at time t – account value at time t	Mortality, Persistency
GMIB	Present value of the income benefit at time t – account value at time t	Election, persistency, survival
GMAB	Guaranteed value at time n – account value at time n (n is the time when the annuity payments start)	Persistency, survival
GMAF	Guaranteed income at time t – calculated income at time t	Survival

Capital market risks include return, volatility, interest rate and fund manager risks. For example interest rates or stock values may drop, or fund managers may manage funds differently if the insurance company´s guarantees stand behind them.

Behavioral risks include

- Mortality
- Persistency
- Benefit election

There is difference for the insurance company in what kind of annuity payment option the policyholder chooses, for example a lump sum or periodically payments.

- Transfer activity

If a lot of customers suddenly decide to transfer parts of their investments from the separate account into the fixed acount option, the question arises, what can the company do with this sudden increase in its general account?

- Premium

What do the customers decide to invest as premium after the initial payment?

- Investment allocation
- Partial withdrawals/surrenders
- Dollar cost averaging (see chapter VII)
- Commencement date

Does the customer choose to postpone his retirement and therefore the beginning of the annuity payments?

- Spousal continuance for benefit

Distribution risks include

- Age
- Sex
- Contract size
- Asset allocation
- Time

Account values and contract sizes are usually higher at higher ages that have higher mortality.

Regulatory risks include

- Reserves

  Are the calculated reserves sufficient?

- Risk-based capital

In order to mitigate these risks, the actuary has to know their origins, consequences, results, and he has to establish a company´s risk tolerance, which means how much of each risk is acceptable. It is also important for the risk management strategy to include an active monitoring of the risks as well as a plan of response for adverse conditions. For example, response plans could altering the new business versus inforce business, varying charges by fund, limiting investment choices, changing product design, etc. (Byers, 2002).

The risk management must address various issues including capital market volatility, limited reinsurance coverage for variable annuities, increasing competition and decreasing profit margins.

Risk management options include:

- Retain the risk and hold capital
- Reinsurance

Reinsurance reduces risk and has the advantages of no basis risk, it requires less risk management efforts. It can be used on individual product and portfolio bases. But reinsurance can be expensive, it can have credit risk, and may have limited coverage.

- Capital market solutions

One can use long-dated put options. However, there is still basis risk, the company may be less liquid, a loss may occure due to deviance of the actual experience from the expected experience. There is also a counterparty risk since long-dated puts are offered on the counter. These derivatives have the advantage of reduced credit risk, coverage will probably available at some price, and one can buy a put option immediately if necessary. However, derivatives require extensive risk management procedures, and they have basis risk. They also require a large payment up-front.

- Product design

The company can use age restrictions that reduce residual and reinsurance costs. Other options are benefit cutbacks and caps, waiting periods, investment choice limitations, etc. It is also possible to vary the premium for different ages.

- Combination strategies

One can reinsure for attractive prices, hedge the risks that are unacceptable but too costly to reinsure, and retain the remaining risk.

Asset Adequacy Analysis

According to *Special Issues for Variable Annuities* (American Academy of Actuaries, 1998b), many actuaries believe variable annuities are covered by the Actuarial Opinion, based on the *NAIC Model Actuarial Opinion and Memorandum Regulation* (AOMR). Companies subject to section 8 of the AOMR are required to base their Actuarial Opinion on *asset adequacy analysis.* Under section 8, the actuary's work must conform to the appropriate *Actuarial Standards of Practice* promulgated by the *Actuarial Standards Board*. According to the ASOP No. 22, asset adequacy analysis should reflect all material risks, including those created by guarantees made by the general account in support of additional benefits. Extracts of ASOP No. 22 and the AOMR can be seen in Appendix C and D.

One approach currently being used by some actuaries is to demonstrate that the risk associated with the book of variable annuity business is highly risk controlled or that the degree of conservatism in the reserves is so great that it provides protection for reasonably anticipated deviations from current assumptions. This type of

methodology is used most often for variable annuities with a smooth surrender charge pattern, without a fixed account option or without significant additional benefits.

Cash flow testing methodologies are often used for products where future cash flows may differ under different economic or interest rate scenarios. For example, cash flow testing may be used for a variable annuity without a smooth surrender charge pattern, for one with a fixed account option, or with an GMDB design that varies materially by economic scenario (American Academy Of Actuaries, 1998b).

For non-variable products, cash flow testing scenarios are generally based on assumed future fixed interest rate movements. For variable products, one key consideration is usually the projection of variable fund performance. Thus, to perform cash flow testing on variable products, many actuaries try to specify how future fund performance correlates to fixed interest rate movements.

Cash flow testing models used by many actuaries also reflect the presence of any existing fixed and market value adjusted account options and the movement of assets between funds, including the movement of assets between variable funds and any fixed and market value adjusted account options. Such models frequently take into account the impact of all benefits, including surrender and additional benefits, on model

assumptions (e.g., lapse rates may be impacted by the existence of a generous GMDB) and any material restrictions or other provisions put into place to protect the company (e.g., surrender charges and market value adjustment), as well as any significant constraints on policyholder actions (e.g., tax penalties) (American Academy Of Actuaries, 1998b).

ASOP No. 22 requires the valuation actuary to examine combinations of risk and to apply sensitivity testing to the results to reflect the interaction of assumptions. It lists several alternative assumption bases, one of which is the use of a deterministic scenario or set of scenarios and another of which is the use of a statistical distribution or stochastic method. In choosing the assumption basis, „the actuary should be satisfied that the assumption bases chosen are suitable for the business and risks involved. In particular, the actuary should be satisfied that the number and types of scenarios tested are adequate". Therefore, either a stochastic or a deterministic approach is permitted by the ASOP as long as the scenarios tested are properly determined and applied.

In practice, actuaries use both stochastic and deterministic scenarios to perform cash flow testing on variable annuity business. Stochastic methods typically use *Monte Carlo simulations*. Some actuaries model all funds stochastically, while some may only model

equity funds stochastically, modeling the performance of bond funds through the use of a set of fixed interest rate scenarios based on the interest rate scenarios used to model general account products. Other actuaries model aggregated performance for all funds (fixed and variable) on a stochastic basis (American Academy Of Actuaries, 1998b).

Deterministic methods used by valuation actuaries typically project the total fund performance for the entire book of variable annuity business based on a reasonable (and often conservative) total return consistent with the expected mix of funds for that book of business. Deterministic scenarios are often chosen to produce conservative fund performance projections. One example of such a scenario is a large one-time drop in asset values, followed or preceded by a period of lower than expected returns. Another example is an extended period of fund under-performance.

With either assumption basis, ASOP No. 22 requires the valuation actuary to be satisfied that the scenarios tested reflect the expected return and volatility of the underlying funds and reasonably cover the distribution of possible outcomes (American Academy Of Actuaries, 1998b).

One source of specific variable annuity fund data used by some actuaries, which includes fund performance data for the entire industry

by fund type, is *Morningstar Principia for Variable Annuities*, a CD-Rom published by Morningstar, Inc. Unfortunately, this source has a limited number of years of historical data. In order to reflect an appropriate measure of fund volatility for a longer time period, some actuaries supplement this data with historical return data from indices, such as the S&P 500, that reflect the underlying assets contained in each variable fund (e.g., cash, foreign and domestic equities, and foreign and domestic bonds). Some actuaries are reluctant to use only historical data, since future experience could vary from historical. Also, some actuaries carry out tests to determine whether using Morningstar data appropriately reflects the characteristic of the specific company funds, since company funds can vary significantly within Morningstar fund type. When supplementing Morningstar data with historical indices, many actuaries choose a time period that reflects both favorable and adverse results in both the equity markets and the fixed interest rate environment. In addition, actuaries may compare fund expenses to those reflected in the data source. Also, actuaries may model the correlation between the performance of the funds under various economic scenarios (American Academy Of Actuaries, 1998b).

When modeling fixed account options of variable annuities, actuaries usually consider the interaction of the options with variable

fund options. For example, during a period of low interest rates it is common to expect an increase in lapse rates with a standalone fixed annuity. However, when modeling a fixed account option of a variable annuity contract, some actuaries assume an increase in the movement of funds from the fixed account option to the variable funds rather than an increase in lapse. Conversely, during a period of high interest rates, these actuaries assume an increase in movement of funds from the variable funds into the fixed account option. When considering the selection of assets to use in the modeling of the fixed account option, many valuation actuaries consider the requirements of section 10B of the AOMR (American Academy Of Actuaries, 1998b).

Many actuaries use the CARVM allowance to support specific general account liabilities. One such general account liability is the reserve held for fixed account options of the variable annuity, which, due to its cash flow and duration characteristics, may be particularly suited to this treatment. Since investment gains and losses of the separate account assets belong to the variable funds, the cash flow available to the general account usually consists of contractual fees (e.g., mortality and expense charges), surrender charges and fund transfers. Some actuaries perform sensitivity tests to check that the underlying assets

provide the necessary liquidity to support the liabilities under reasonable adverse scenarios.

Guaranteed Minimum Death Benefits

As noted earlier, most of the investment risk associated with a variable annuitiy is taken by the policyholder. However, by offering GMDBs, a company is taking back a portion of that investment risk. The amount of risk the company takes back depends on the design of the GMDB.

Actuarial Guideline XXXIV, as interpreted by the American Academy Of Actuaries (1998b) requires that the death benefit be projected using a combination of a specified immediate drops and net assumed returns which vary by fund class (see chapters IV and V). The Guideline states that the „determination of the appropriate fund classifications, for purposes of this Guideline, is the responsibility of the appointed actuary." Under the AOMR and ASOP No. 22, the valuation actuary is also responsible for making sure that the interest rate and variable fund projection scenarios used in asset adequacy testing properly reflect the risks inherent in the GMDB design (American Academy Of Actuaries, 1998b).

For example, scenarios used in the analysis of a product with a ratchet benefit design may include a large drop in fund value shortly after the valuation date while scenarios used in the analysis of a product with a roll-up benefit design may include a prolonged period of fund underperformance (American Academy Of Actuaries, 1998b).

CHAPTER IX

PRODUCT SAMPLES

This chapter describes two representative variable annuity products in detail. Both contracts contain the typical features that are offered within a variable annuity contract in the United States.

The Director

This variable annuity contract is offered by Hartford Life and Annuity Company and ranked third in variable annuity contract sales between year-end 2000 and 06/30/2001 (Info-One, 2001). It held a market share of 3.75% in this period. On June 30th 2001, assets held under the Director totaled $39,489.6 million, a market share of 4.34%.

The following informations are taken from the prospectus *The Director Variable Annuity* (May 1, 2002) by Hartford Life and Annuity Company.

The Contract

The Director is an individual or group tax-deferred variable annuity contract. It can be purchased with a premium payment of at least $1000.

Additional premium payments have to be at least $500. Prior approval is required for premium payments of $1,000,000 or more. The customer and his/her annuitant, if different, must not be older than 85 on the date when the contract is issued.

The initial premium payment will be invested within two valuation days after the application is completed properly. Every subsequent payment will be invested on the same valuation day if it is received before the close of the New York Stock Exchange.

Investment Options

The customer can choose to invest his contributions in the following funds, which are all sponsored and administered by Hartford and may not be available in all states:

- Hartford Advisers HLS Fund
- Hartford Bond HLS Fund
- Hartford Capital Appreciation HLS Fund
- Hartford Dividend and Growth HLS Fund
- Hartford Focus HLS Fund
- Hartford Global Advisers HLS Fund
- Hartford Global Communications HLS Fund
- Hartford Global Financial Services HLS Fund

- Hartford Global Health HLS Fund
- Hartford Global Leaders HLS Fund
- Hartford Global Technology HLS Fund
- Hartford Growth HLS Fund
- Hartford Growth and Income HLS Fund
- Hartford Growth Opportunities HLS Fund
- Hartford High Yield HLS Fund
- Hartford Index HLS Fund
- Hartford International Capital Appreciation HLS Fund
- Hartford International Opportunities HLS Fund
- Hartford International Small Company HLS Fund
- Hartford MidCap HLS Fund
- Hartford MidCap Value HLS Fund
- Hartford Money Market HLS Fund
- Hartford Mortgage Securities HLS Fund
- Hartford SmallCap Growth HLS Fund
- Hartford Small Company HLS Fund
- Hartford Stock HLS Fund
- Hartford U.S. Government Securities HLS Fund
- Hartford Value HLS Fund
- Hartford Value Opportunities HLS Fund

These funds differ in their investment objectives, strategies and goals. They range from aggressive, growth orientated funds to conservative, low risk funds that invest mostly in bonds. Three of these options are described more detailed in the following:

Hartford Global Technology HLS Fund

This fund seeks long-term capital appreciation by investing in stocks of technology companies worldwide. The top ten holdings as of March 31st 2002 were

- Microsoft (9.2%)
- IBM (7.8%)
- Cisco Systems (7.2%)
- First Data (5.6%)
- Sabre Holdings (4.5%)
- Lexmark International (4.1%)
- Maxtor Corporation (4.0%)
- Oracle Corporation (3.7%)
- Bisys Group (3.5%)
- Palm (3.4%)

22% of the fund are invested in software and service, 55% in technology, hardware and equipment, and 23% in other companies. The

fund charges a 0.85% management fee and 0.04% other expenses of the net assets at the fund´s year-end.

From inception May 1st 2000 through March 31st 2002 the fund lost about 55% if its value. The annual return in 2000 was –37.89%, in 2001 –23.77%.

Hartford Index HLS Fund

The investment goal of the Hartford Index HLS Fund is to provide investment results which approximate the price and yield performance of publicly traded common stocks in the aggregate. The fund has 499 different holdings, 99% is invested in stocks. The industry weightings as of March 31st 2002 were

- Financial (21%)
- Consumer General (21%)
- Health (14%)
- Telecommunication/Communication Services (14%)
- Technology (12%)
- Industrial/Transportation (7%)
- Basic Industry (4%)

The annual return in 2000 totaled –10.63%, in 2001 –13.41%. A hypothetical investment of $100,000 on May 1st, 1987, the date of

inception, would be worth $433,327 on March 31st, 2002, including the deductions for management fees and the risk charge. The average annual total return since inception amounts 10.33%. The management fee is 0.40% and other expenes total 0.03%.

Hartford Bond HLS Fund

The objective of this fund is to provide a high level of current income, consistent with a competitive total return by investing primarily in investment grade bonds. The asset distribution is the following:

- Corporate and Foreign Denominated (49%)
- Mortgage related Securities (32%)
- U.S. Treasury and Agencies (16%)
- Maturities under 1 Year (3%)

The top five issuers as of March 31st, 2002 were:

- Government National Mortgage Association (GNMA)
- U.S. Treasury Securities
- Federal National Mortgage Association (FNMA)
- Canadian Pacific Corporation
- German Government

In 2000, the total return was 10.60%, in 2001 7.33%. Since inception on August 1st, 1977, the average annual total return is 7.21%.

A 0.48% management fee and 0.03% other expenses are deducted annualy.

Other Investment Features

The company also allows *Mixed and Shared Funding*, described in the prospectus as follows: „Shares of the Funds may be sold to our other separate accounts and our insurance company affiliates or other unaffiliated insurance companies to serve as the underlying investment for both variable annuity contratcs and variable life insurance policies."

It is also possible to allocate premium payments and contract values to the *Fixed Accumulation Feature*, a fixed account that currently guarantees an interest rate of 3% per year. A rate in excess of 3% may be credited by Hartford, depending on the performance of the investments in the general account of the company.

Other investment related features offered are:

- Dollar Cost Averaging Program
- Dollar Cost Averaging Plus Program

This option is available on either a 6-month or a 12-month basis, allowing the customer to automatically transfer all program assets into any other investment option.

- Earnings/Interest Averaging Program

With interest averaging one can automatically sweep interest earned from either rhe Hartford Money Market HLS Fund or the Fixed Accumulation Feature into any other investment option. Earnings averaging allows to sweep earnings from one investment option into another.

Transfers

Transfers between sub-accounts are generally allowed and not subject to additional charges. The transfer request will be processed on the day it is received as long as it is received on a valuation day before the close of the New York Stock Exchange. To avoid abusive or disruptive transfers, however, Hartford introduced the following policy: The customer may submit 20 sub-account transfers each contract year for each contract by U.S. Mail, Voice Response Unit, internet, telephone, or facsimile. Additional transfer requests have to be submitted by U.S. Mail or overnight delivery service, and the company claims the right to restrict or terminate the policyholder´s transfer privileges until the next contract anniversary.

Transfers out of the fixed account to sub-accounts are also restricted. The customer may transfer either 30% of the total amount in the fixed accumulation feature or an amount equal to the largest

previous transfer. And Hartford reserves the right to defer those tranfers for up to 6 months from the date of the request. The policyholder has to wait 6 months before he can move sub-account values back to the fixed accumulation feature.

Tranfers may be made by an authorized person by the customer according to the same restrictions mentioned above.

Charges and Fees

The following charges and fees are associated with the contract:

- Contingent Deferred Sales Charge

This charge is assessed when the customer requests a full or partial surrender. It is based on the amount surrendered and how long the premium payments have been in the contract. Each premium payment has its own contingent deferred sales charge schedule, premium payments are surrendered in the order in which they were received. The charge is calculated using the following table:

Table 14: Contingent Deferred Sales Charge

(Source: Hartford, 2002)

Number of years from premium payment	Contingent deferred sales charge
1	7%
2	6%
3	6%
4	5%
5	4%
6	3%
7	2%
8 or more	0%

Exceptions are made when the withdrawals do not exceed 15% of the total premium payments each contract year during the first seven years. The charge will also be waived if the customer gets in serious health condition, dies or chooses to annuitize the contract.

- Mortality and Expense Risk Charge

This charge is deducted daily at an annual rate of 1.25% of sub-account value. It is broken into charges for mortality risks and expense risk.

- Annual Maintenance Fee

This is a flat fee of $30 that is deducted proportionately from each account the customer is invested in. It is due each contract anniversary

or when the contract is fully surrendered if the contract value at either of those times is less than $50,000.

- Premium Taxes

If required by a state or other government agency, premium taxes are deducted. The rate varies from state to state, some states collect the premium tax when the premium is made, others at annuitization.

- Funds charges

The shares of the funds are purchased by the separate account at net asset value. All fund related fees and expenses are already deducted.

- Additional Charges

If the customer chooses one of the offered additional features, he will be charged for each feature respectively.

Death Benefit

This contract pays a guaranteed death benefit upon the death of the annuitant, the contract owner or joint contract owner, whoever dies first. If the death occurs during the accumulation period, the death benefit equals the greatest of

- 100% of premium payments minus surrenders from the contract
- the maximum anniversary value established prior to age 81

- the contract value.

The anniversary value is calculated each year prior to the 81st birthday of the policyholder. It is the value of the contract on the contract anniversary minus adjustments for any surrenders and plus any premium payments made after that date. The maximum anniversary value is the highest anniversary value that occurs prior to the 81st birthday.

In order to improve this protection, the customer may choose one of the following additional features:

- Optional Death Benefit

If chosen, the optional death benefit provides the beneficiary with the greater of the guaranteed death benefit or 5% guaranteed annual growth of premium up to 200% of premiums minus proportinal surrenders. The benefit stops compounding at age 81. Hartford subtracts an additional charge on a daily basis during the accumulation period that is equal to an annual charge of 0.15% of the contract value invested in the funds.

- Earnings Protection Benefit

  This feature provides the beneficiary with the greatest of

  - 100% of premium payments minus surrenders from the contract

- the maximum anniversary value established prior to age 81
- the contract value plus a percentage of contract gain up to 200% of premium payments with adjustments for surrenders and premium payments made one year prior to death

The contract gain is determined by comparing the contract value on the date the earnings protection benefit was added to the contract with the contract value on the date the death benefit is calculated. Premium payments are deducted and adjustments are made for any partial surrenders made during that time.

The death benefit may be taken in one lump sum or under any of the annuity payout options being offered by Hartford. If the beneficiary is the contract owner´s spouse, the spouse can choose to continue the contract with a contract value equal to the death benefit that would have been paid.

Annuity Payouts

The policyholder can select or change the date when the annuity payments start at any time during the accumulation period. The wish to change this date has to be submitted within thirty days prior to the date. The annuity payout options the customer can choose from are the following:

- Life Annuity

This option provides annuity payments as long as the annuitant is living. If he/she dies, no more payouts are made.

- Life Annuity with a Cash Refund

This option also provides annuity payments as long as the annuitant is living. But if the annuitant dies before having received the full contract value minus any premium tax, the remaining value will be paid to the beneficiary.

- Life Annuity with Payments for a Period Certain

Under this feature the annuitant receives annuity payouts as long as he/she is living. In addition, the company at least guarantees to make the annuity payments for a time period selected by the customer. This period can be between 5 years and 100 years minus the annuitant´s age. If the annuitant dies before the guaranteed number of years have passed, the beneficiary may elect to continue receiving annuity payments for the remaining years or to receive the commuted value in one sum.

- Joint and Last Survivor Life Annuity

With this option the annuitant and the joint annuitant receive annuity payout as long as they are living. When one annuitant dies, the other annuitant continues to receive payments until he/she dies. The

policyholder has to decide what will happen to the annuity payments after the first annuitant dies. He can select the annuity payouts to

- remain the same at 100% or
- decrease to 66.67% or
- decrease to 50%.

These percentages impact the annuity payout amount paid while both annuitants are living. The payments while both annuitants are alive are higher if a lower percentage is selected.

- Joint and Last Survivor Life Annuity with payments for a period certain

In addition to the option above, the payments under this option are made for a guaranteed time period selected by the customer. This period can be between 5 years and 100 years minus the younger annuitant´s age. If both annuitants die before the guaranteed number of years have passed, the beneficiary may continue to receive payments for the remaining years or receive the commuted value in one sum. As in the other joint and last survivor option, the policyholder has to decide what will happen to the payouts after the first annuitant dies.

- Payments for a period certain

The customer can select a specified time for which the company guarantees to make payments. The minimum period that can be selected

is 10 years during the first two contract years and 5 years after the second contract anniversary. The maximum period that can be selected is 100 years minus the annuitant´s age. If the annuitant dies before the end of this period certain, the beneficiary may elect to continue the remaining annuity payouts or receive the commuted value in one sum.

The contract also allows to select the frequency of the annuity payouts. One can choose to receive the annuity payouts monthly, quarterly, semi-annually, or annually. Once a frequency is selected, it cannot be changed. The frequency has to be selected in a way such that the payments are at least $50.

The policyholder can choose either a payout option with a fixed dollar amount or variable dollar amounts.

Once the fixed dollar amount annuity payouts have been selected, the customer cannot change the selection to receive variable dollar amount payouts. The annuitant receives equal fixed dollar amount annuity payments throughout the annuity payout period. The amount is determined by multiplying the contract value minus any applicable premium taxes, by an annuity rate set by the company.

The variable dollar amount annuity payouts are based on the investment performance of the sub-accounts. This amount may fluctuate with the performance of the underlying funds. Hartford describes the

calculation of these payouts as follows: „To begin making variable dollar amount annuity payouts, we convert the first annuity payout amount to a set number of annuity units and then price those units to determine the annuity payout amount. The number of annuity units that determines the annuity payout remains fixed unless you transfer units between sub-accounts."

The dollar amount of the first variable annuity payout depends on:

- the annuity payout option chosen,
- the annuitant´s attained age and gender (if applicable),
- the applicable annuity purchase rates based on the 1983a Individual Annuity Mortality table, and
- the assumed investment return.

The assumed investment return is selected by the customer before the annuity payouts start. One can depending on the state currently choose between 3%, 5% or 6%. The greater the assumed investment return (AIR), the greater the initial annuity payout. A higher AIR may result in smaller potential growth in the payouts and vice versa.

„The total amount of the first variable dollar amount annuity payout is determined by dividing the contract value minus any applicable premium taxes, by $1,000 and multiplying the result by the payment factor defined in the contract for the selected annuity payout option. The

dollar amount of each subsequent payout is equal to the total of annuity units for each sub-account multiplied by annuity unit value of each sub-account. The annuity unit value of each sub-account for any valuation period is equal to the accumulation unit value net investment factor for the current valuation period multiplied by the annuity factor, multiplied by the annuity unit value for the preceding valuation period." (Hartford, 2002)

AnnuiChoice

This single premium variable annuity is offered by National Integrity Life Insurance Company. All information about the product was obtained by the prospectus, May 1st, 2001, and the National Integrity Website.

The Contract

The contract allows contributions of at least $100 at any time during the first contract year. The first contribution, however, cannot be less than $1,000. The company may limit the total amount of premium payments under a contract to $1,000,000 if the customer is under age 76 or to $250,000 if the customer is 76 or older. The company may also

refuse to accept any contributions once the policyholder reached eight years before his retirement date.

Investment Options

The customer can choose to invest his premium payments in a wide range of different funds, which are advised by different investment companies.

Table 15: Investment Options

(Source: National Integrity, 2002)

Fidelity VIP Funds	Equity-Income
	Growth
	Overseas
	High Income
	Investment Grade Bond
	Asset Manager
	Index 500
	Contrafund
	Asset Manager: Growth
	Growth Opportunities
	Balanced
	Growth & Income
	Mid-Cap
	Dynamic Capital Appreciation
	Money Market
Janus Aspen Series Funds	Aggressive Growth
	Growth
	Capital Appreciation
	Balanced
	Worldwide Growth

Table 15 continued:

	Equity Income
	International Growth
	Strategic Value
The Legends Fund	Baron Small Cap
	Gabelli Large Cap Value
	Harris Bretall Sullivan & Smith Equity Growth
	Third Avenue Value
MFS Funds	Capital Opportunities
	Emerging Growth
	Investors Trust
	Mid Cap Growth
	New Discovery
	Investors Growth Stock Series
	Total Return
	Research
Putnam VT Funds	Voyager II
	International Growth
	Growth and Income
	Small Cap Value
Touchstone Variable Series Trust Funds	International Equity
	Emerging Growth
	Small Cap Value
	Growth/Value
	Equity
	Enhanced 30
	Value Plus
	Growth & Income
	Balanced
	High Yield
	Bond
	Money Market
Van Kampen Life Portfolios	Bandwith & Telecommunications Portfolio
	Biotechnology & Pharmaceutical Portfolio
	Internet Portfolio
	High-Technology 35 Index Portfolio

Table 15 continued:

	Morgan Stanley U.S. Multinational 50 Index Portfolio
	U.S. Real Estate
	Emerging Markets Debt
Scudder VIT Funds	EAFE Equity Index
	Equity 500 Index
	Small Cap Index

Other Investment Features

The company also offers *Systematic Transfer Options*, that guarantee an interest rate declared in advance for each calendar quarter. This rate applies to all contributions made to this fixed account during the quarter for which the rate has been declared. The customer must transfer all contributions he/she makes to the six-month systematic transfer option into other investment options within six months and transfer all contributions to the twelve-month systematic transfer option within one year of contribution. Transfers are automatically made in installments of at least $1,000 each. One cannot transfer from other investment options into the fixed account, the guaranteed interest rate is 3%.

Transfers

Transfers of the account value among the variable account options must be at least $250 or, if less, the entire amount in the investment option. The customer has twelve free transfers per contract year, for additional transfers a charge will apply. Exceptions are made for the following features:

- Dollar Cost Averaging
- Systematic Transfer Options
- Customized Asset Rebalancing

This program allows to determine how often rebalancing occurs. The customer can choose to rebalance monthly, quarterly, semi-annually or annually. The value in the variable account options will automatically be rebalanced by transfers among the policyholder´s investment options, except the fixed account.

The company reserves the right to restrict the number of transfers in any contract year to avoid excessive trading by the customer.

Charges and Fees

- Separate Account Charges

The company deducts a daily expense amount equal to an effective annual rate of 1.00% of the account value in the variable account options. This charge includes the mortality and expense risk charge.

- Annual Administrative Charge

This charge of $30 is deducted proportionally from the account value in each investment option, including the fixed account.

- Portfolio Charges

Shares in the variable account options are bought at net asset value, management fees and other expenses have already been deducted.

- Premium Tax

If required by state law, state premium taxes are deducted from the contributions before they are invested.

- Contingent Withdrawal Charge

The customer may withdraw up to 10% of the account value each year without any contingent withdrawal charge. The charge for additional withdrawals varies with the age of the contribution.

Table 16: Contingent Withdrawal Charge

(Source: National Integrity, 2002)

Number of Years from the date of Contribution	Charge as a % of the Contribution withdrawn
1	8%
2	7.5%
3	7%
4	6%
5	5%
6	4%
7	3%
8 or more	0%

- Transfer Charge

Tranfers exceeding the twelve free transfers are subject to a transfer charge of $20.

Death Benefit

In case of death of the policyholder during the accumulation phase, the company pays a death benefit. The benefit is the greater of

- the total contributions minus withdrawals, or
- the current account value, or

- the account value on the 7th contract anniversary plus subsequent contributions and minus subsequent partial withdrawals.

For additional protection, the customer may choose one of the following options:

- Enhanced A (Highest Anniversary)

  The death benefit is the greater of

  - The highest account value on any contract anniversary prior to the annuitant´s 81st birthday, plus subsequent contributions and minus subsequent partial withdrawals, or
  - the standard death benefit as described above.

- Enhanced B (Annual Ratchet)

  The death benefit is the greater of

  - the total contributions minus withdrawals accumulated at an annual effective rate of 5% from the date each contribution is received until the annuitant´s 81st birthday, plus subsequent contributions received after that birthday and minus subsequent partial withdrawals, or
  - the standard death benefit as described above.

- Enhanced C (Highest Anniversary or Annual Ratchet)

  The death benefit is the greatest of

- the standard death benefit, or
- the highest anniversary, or
- the annual ratchet.

These options are subject to additional charges, that are assessed quarterly as an additional dollar amount deducted from the variable accounts only.

Table 17: Additional Death Benefit Charges

(Source: National Integrity, 2002)

Option	Cost per Year for Life of contract
Enhanced A	0.15%
Enhanced B	0.30%
Enhanced C	0.35%

Annuity Payouts

The customer can select and change the date when the annuity payments start. Integrity offers the following payout options:

- Lump Sum

  The customer receives the cash value under the contract.

- Life and ten years certain annuity

This is a fixed life income annuity with 10 years of payments guaranteed, funded through the company´s general account.

- Period certain annuity

This option provides for fixed payments for a fixed period. The amount depends on the period selected. If the annuitant dies before the end of the period selected, the beneficiary can choose to receive the total present value of the remaining future payments or to continue the annuity payouts.

- Period certain life annuity

This annuity guarantees fixed payments for at least the period selected and after that for the life of the annuitant, or for the lives of the annuitant and another annuitant under a joint and survivor annuity. If the annuitant, or both annuitant´s under the joint and survivor annuity, dies, the beneficiary can either continue to receive the annuity payments for the remaining time of the selected period or receive the total present value of these remaining payments.

- Life income annuity

The annuitant receives fixed annuity payments as long as he/she is living, or until the last annuitant dies under a joint and survivor annuity.

All annuity payments are fixed, they depend on the payout option chosen, the age and sex of the annuitant.

The Added Value Option

An additional feature of the AnnuiChoice contract is the *added value option*. This option allows to choose between a 1% and 3% credit on the first-year contributions. For example, if $20,000 is deposited into the annuity in the first 12 months, and the 3% added value option is selected, Integrity will credit $600 to the account. There is a base charge of 0.15% annually for 1% credit, which is based on the account value and is deducted quarterly. This charge is subject to a maximum of 0.182% per 1% credit, which is assessed against the first-year contributions plus the added value option credit. On the other hand, the charge is also subject to a minimum of 0.145%, assessed against the first-year contributions plus the added value option credit.

A percentage of the added value option credit is recaptured on partial and full withdrawals above the 10% free withdrawal amount, based on the contract year the withdrawal is taken. These percentages are applied to a portion of the added value option credit, this portion is calculated as the non-free withdrawal amount divided by the contract account value.

Table 18: Recapture Percentages

(Source: National Integrity, 2002)

Contract Year when withdrawal requested	Recapture percentage
1	100%
2	85%
3	65%
4	55%
5	40%
6	25%
7	10%
8 or more	0%

More Additional Product Features

This section covers additional product features for variable annuities offered by various companies.

The Guaranteed Return Option

This option is offered by American Skandia Life Assurance Corporation. It guarantees the customer to receive at the end of the 7th year after starting the option no less than the account value on the date the option was selected. American Skandia monitors the account value daily and transfers systematically amounts between the fixed account and the variable investment options. At the end of the 7 year program,

the customer may elect another 7 years. Additional premium payments made during the program will only increase the amount guaranteed. However, all or a portion of any additional payments may be allocated to the fixed account. American Skandia charges a 0.25% fee of the account value per year for participating in the guaranteed return option.

The Beneficiary Protector Option

Nationwide Life Insurance Company offers an option providing that upon the death of the annuitant and in addition to any death benefit payable, an additional amount will be credited to the contract. After this benefit is credited to the contract, the beneficiary may terminate the contract or continue the contract in accordance to a minimum required distribution. Nationwide assesses a fee of 0.40% on any allocations made to the fixed account, and therefore any guaranteed interest rate in the fixed investment options will be lowered by 0.40%. The option is only available for contracts with annuitants who are age 70 or younger.

The amount credited is calculated as follows: If the Beneficiary Protector Option was elected at the time of application and the annuitant dies prior to the first contract anniversary after the annuitant´s 85th birthday, then the amount credited will be equal to:

40% x Adjusted Earnings

Adjusted Earnings = (a) – (b) – (c); where

a = the contract value on the date the death benefit is calculated and prior to any death benefit calculation

b = purchase payments, proportionally adjusted for withdrawals;

c = any adjustment for a death benefit previously credited, proportionally adjusted for withdrawals

If the Beneficiary Protector Option was elected at any time after the contract issue date and the annuitant dies prior to the first contract anniversary after the annuitant´s 85th birthday, then the amount credited will be equal to:

40% x Adjusted Earnings from the date the option is elected

Adjusted Earnings from the date the option is elected = (a) – (b) – (c) – (d); where

a = the contract value on the date the death benefit is calculated and prior to any death benefit calculation;

b = the contract value on the date the option is elected, proportionally adjusted for withdrawals;

c = purchase payments made after the option is elected, proportionally adjusted for withdrawals;

d = any adjustment for a death benefit previously credited to the contract after the rider is elected, proportionally adjusted for withdrawals.

If no benefits have been paid under this option by the first contract anniversary following the annuitant´s 85th birthday, then:

(a) Nationwide will credit an amount equal to 4% of the contract value on the contract anniversary to the contract;

(b) The benefit will terminate and will no longer be in effect; and

(c) The charge for the benefit will be eliminated, reducing charges by 0.40%.

(Nationwide Insurance Company, 2001)

CHAPTER X

SUMMARY

Over the last decade in the United States, investments in variable annuity products have grown at a rapid rate. The trend shows that variable annuities are going to be the most popular annuity product. Traditional fixed annuities cannot compete with them anymore. Even the biggest advantage of a fixed annuity, the guaranteed investment rate, has no impact anymore. Variable annuities today offer the same guaranteed income combined with the advantages of traditional annuities and the bigger growth potential in their investments.

Various other product features make it possible for the customer to fit his variable annuity exactly to his needs. One can for example include spousal protection in the contract and thereby achieve protection for the whole family if a death benefit is also elected. The variety of provided investment options with a variable annuity contract enable the policyholder to adjust his investment portfolio on different market situations such as high interest rate periods.

Another reason for the popularity of variable annuities in the United States is that they can be used within retirement plans. In

addition, the possibility to invest in a tax-deferred investment option that is easy to manage are some of the reasons. Variable annuities enable customers without a lot of knowledge about investments to participate in the growth of the stock markets.

Designing, reserving and managing variable annuities has become an important task for the actuary in an insurance company. The competition on the market makes it necessary to develop new attractive product features as well as to offer high guarantees for the growth in the account value and the death benefit. These factors, however, force the actuary to create ways how to set up reserves in the company. This area still has no clear regulatory guidance and therefore leaves the decisions to the actuary.

Why are variable annuities not present on foreign markets, for example Germany, or other European Nations? One reason may be the fear of having a flexible retirement income that varies with the performance of its investments, and thus carries greater risk. The different federal social security system may also have limited the demand for additional annuity products in Germany. In our opinion, variable annuities do offer a viable alternative to traditional annuities, when one takes into full consideration all the guarantees and features embedded in them.

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APPENDIX A

1971 U.S. INDIVIDUAL ANNUITY MORTALITY, MALE

age	q_x
0	0.003255
1	0.001274
2	0.000715
3	0.000576
4	0.000505
5	0.000456
6	0.000424
7	0.000403
8	0.000392
9	0.000389
10	0.000390
11	0.000397
12	0.000405
13	0.000413
14	0.000422
15	0.000433
16	0.000444
17	0.000457
18	0.000471
19	0.000486
20	0.000503
21	0.000522
22	0.000544
23	0.000566
24	0.000591
25	0.000619
26	0.000650
27	0.000684
28	0.000722
29	0.000763
30	0.000809
31	0.000860
32	0.000916
33	0.000978
34	0.001046
35	0.001122
36	0.001204
37	0.001295
38	0.001397
39	0.001509
40	0.001633
41	0.001789
42	0.002000
43	0.002260
44	0.002569
45	0.002922
46	0.003318
47	0.003754
48	0.004228
49	0.004740
50	0.005285
51	0.005860
52	0.006461
53	0.007088
54	0.007740
55	0.008417
56	0.009119
57	0.009850
58	0.010613
59	0.011411
60	0.012249
61	0.013133
62	0.014073
63	0.015083
64	0.016185

65	0.017405	91	0.187147
66	0.018767	92	0.208457
67	0.020290	93	0.231885
68	0.021992	94	0.257146
69	0.023890	95	0.283841
70	0.026000	96	0.311565
71	0.028341	97	0.340214
72	0.030933	98	0.369769
73	0.033801	99	0.400194
74	0.036976	100	0.431413
75	0.040494	101	0.463312
76	0.044393	102	0.495756
77	0.048715	103	0.528599
78	0.053500	104	0.561692
79	0.058787	105	0.594884
80	0.064599	106	0.628022
81	0.070902	107	0.660949
82	0.077668	108	0.693503
83	0.084941	109	0.725521
84	0.092874	110	0.756852
85	0.101689	111	0.787390
86	0.111652	112	0.817125
87	0.123048	113	0.846198
88	0.136123	114	0.874915
89	0.151070	115	1.000000
90	0.168040		

q_x is defined as the probability of death during the given year

(Source: Society of Actuaries, 2002)

APPENDIX B

1996 U.S. ANNUITY 2000 BASIC, MALE

age	q_x
0	0.002311
1	0.000906
2	0.000504
3	0.000408
4	0.000357
5	0.000324
6	0.000301
7	0.000286
8	0.000328
9	0.000362
10	0.000390
11	0.000413
12	0.000431
13	0.000446
14	0.000458
15	0.000470
16	0.000481
17	0.000495
18	0.000510
19	0.000528
20	0.000549
21	0.000573
22	0.000599
23	0.000627
24	0.000657
25	0.000686
26	0.000714
27	0.000738
28	0.000758
29	0.000774
30	0.000784
31	0.000789
32	0.000789
33	0.000790
34	0.000791
35	0.000792
36	0.000794
37	0.000823
38	0.000872
39	0.000945
40	0.001043
41	0.001168
42	0.001322
43	0.001505
44	0.001715
45	0.001948
46	0.002198
47	0.002463
48	0.002740
49	0.003028
50	0.003330
51	0.003647
52	0.003980
53	0.004331
54	0.004698
55	0.005077
56	0.005465
57	0.005861
58	0.006265
59	0.006694
60	0.007170
61	0.007714
62	0.008348
63	0.009093
64	0.009968
65	0.010993
66	0.012188
67	0.013572

68	0.015160	92	0.145575
69	0.016946	93	0.156727
70	0.018920	94	0.168290
71	0.021071	95	0.180245
72	0.023388	96	0.192565
73	0.025871	97	0.205229
74	0.028552	98	0.218683
75	0.031477	99	0.233371
76	0.034686	100	0.249741
77	0.038225	101	0.268237
78	0.042132	102	0.289305
79	0.046427	103	0.313391
80	0.051128	104	0.340940
81	0.056250	105	0.372398
82	0.061809	106	0.408210
83	0.067826	107	0.448823
84	0.074322	108	0.494681
85	0.081326	109	0.546231
86	0.088863	110	0.603917
87	0.096958	111	0.668186
88	0.105631	112	0.739483
89	0.114858	113	0.818254
90	0.124612	114	0.904945
91	0.134861	115	1.000000

q_x is defined as the probability of death during the given year

(Source: Society of Actuaries, 2002)

APPENDIX C

EXTRACTS OF ACTUARIAL STANDARDS OF PRACTICE NO. 22

Section 5. Analysis of Issues and Recommended Practices

5.3 Statement of Opinion

The form, content, and recommended language of the statement of opinion are specified in Section 8 of the *Model Regulation*. The opinion must include a statement on reserve adequacy based on an asset adequacy analysis, the details of which are contained in the supporting memorandum to the company.

5.3.1 Asset Adequacy Analysis

Both the type and depth of asset adequacy analysis will vary with the nature and significance of the asset, obligation, and/or investment-rate-of-return risks. The appointed actuary may use a single analysis for reserves in aggregate or a number of analyses for each of several blocks of business. In either case, a number of considerations may bear on the actuary's work. The actuary should use professional judgment in determining which of the following, or other, considerations apply:

a. Analysis Methods

A number of asset adequacy analysis methods are available to, and used by, actuaries. The most widely used method is cash flow testing (see ASOP No. 7, *Performing Cash Flow Testing for Insurers*; and ASOP No. 14, *When to Do Cash Flow Testing for Life and Health Insurance Companies*). This method is generally appropriate for products and/or investment strategies where future cash flows may differ under different economic or interest-rate scenarios. Such differences are associated with, for example, call options and prepayment risk for assets, and with policyholder withdrawal rights in the case of products. Among other acceptable methods described in actuarial literature are the following:

i. Demonstration that a block of business being tested is highly risk-controlled or that the degree of conservatism in the reserve basis is so great that reasonably anticipated deviations from current assumptions are provided for. For example, such methods might be appropriate for a block of accidental death and dismemberment insurance.

ii. Gross premium reserve tests, which may be appropriate when the business is not highly sensitive to economic or interest-rate risks, but is sensitive to obligation risk. If the reserve held is not materially greater than the gross premium reserve, sensitivity testing of variables such as expenses, mortality, morbidity, or lapse should be done to determine whether additional reserves are needed.

b. Assumption Bases

In addition to selecting an appropriate analysis method, the appointed actuary should select acceptable assumption bases. Acceptable alternatives described in actuarial literature include the following:

i. Adaptation of company experience or industry studies.
ii. Use of a deterministic scenario or set of scenarios.
iii. Statistical distributions or stochastic methods.

The appointed actuary should be satisfied that the assumption bases chosen are suitable for the business and risks involved. In particular, the actuary should be satisfied that the number and types of scenarios tested are adequate. Limiting such scenarios to those contained in the *Model Regulation* is not necessarily adequate.

c. Additional Considerations

These include the following:

i. Modeling

Asset adequacy analyses are generally based on modeling of in-force mix, asset mix, current yields, investment policy, etc. Such modeling may be based on data taken from a time that predates the valuation date; for example, September 30 data may be used to support a December 31 valuation. However, in such cases the actuarial memorandum should contain an

explicit statement that the appointed actuary has confirmed the reasonableness of such prior period data and is satisfied that no material events have occurred prior to the valuation date that would invalidate the analysis on which the reserve adequacy opinion was based.

ii. Use of Prior Studies
As with the use of modeling data from a date that precedes the valuation date, the appointed actuary may also use asset adequacy analyses performed prior to the valuation date (e.g., prior year's analysis of a closed block of business). Again in such cases, the actuarial memorandum should contain an explicit statement that the appointed actuary has confirmed the reasonableness of such prior period studies and is satisfied that no material events have occurred prior to the valuation date that would invalidate the analysis on which the reserve adequacy opinion was based.

iii. Testing Horizon
Asset adequacy should be tested over a period that extends to a point at which reserves on a closed block are immaterial in relation to the analysis. Use of a shorter testing horizon is acceptable if, in the appointed actuary's judgment, use of a longer period would not materially affect the analysis.

iv. Completeness and Consistency
The asset adequacy analysis should take into account all anticipated cash flows such as renewal premiums, guaranteed and nonguaranteed benefits, expenses, and taxes. In determining the assets supporting the tested reserve, any asset segmentation system used by the company should be considered. For reserves to be reported as “not analyzed,” the appointed actuary should judge them to be immaterial.

(Actuarial Standards Board, 1993)

APPENDIX D

EXTRACTS OF THE ACTUARIAL OPINION AND MEMORANDUM

REGULATION

Section 8. Statement of Actuarial Opinion based on an Asset Adequacy Analysis

A. General Description

The statement of actuarial opinion submitted in accordance with this section shall consist of:

(1) A paragraph identifying the appointed actuary and his or her qualifications (see Section 8B(1));

(2) A scope paragraph identifying the subjects on which an opinion is to be expressed and describing the scope of the appointed actuary´s work, including a tabulation delineating the reserves and related actuarial items which have been analyzed for asset adequacy and the method of analysis, (see Section8B(2)) and ifentifying the reserves and related actuarial items covered by the opinion which have not been so analyzed;

(4) An opinion paragraph expressing the appointed actuary´s opinion with respect to the adequacy of the supporting assets to mature the liabilities (see Section 8B(6));

(5) One or more additional paragraphs will be needed in individual company cases as follows:

(a) If the appointed actuary considers it necessary to state a qualification of his or her opinion:

(b) If the appointed actuary must disclose the method of aggregation for reserves of different products or lines of business for asset adequacy analysis;

(c) If the appointed actuary must disclose reliance upon any portion of the assets supporting the Asset Valuation Reserve (AVR), Interest Maintenance Reserve (IMR) or other mandatory or voluntary statement of reserves for asset adequacy analysis.

(d) If the appointed actuary must disclose an inconsistency in the method of analysis or basis of asset allocation used at the prior opinion date with that used for this opinion.

(e) If the appointed actuary must disclose whether additional reserves of the prior opinion date are released as of this opinion date, and the extent of the release.

(f) If the appointed actuary chooses to add a paragraph briefly describing the assumptions which form the basis for the actuarial opinion.

B. Recommended Language

(6) The opinion paragraph should include the following:

„In my opinion the reserves and related actuarial values concerning the statement items identified above:

(a) Are computed in accordance with presently accepted actuarial standards consistently applied and are fairly stated, in accordance with sound actuarial principles;

(b) Are based on actuarial assumptions which produce reserves at least as great as those called for in any contract provision as to reserve basis and method, and are in accordance with all other contracts provisions;

(c) Meet the requirements of the Insurance Law and regulation of the state of [state of domicile] and are at least as great as the minimum aggregate amounts required by the state in which this statement is filed.

(d) Are computed on the basis of assumptions consistent with those used in computing the corresponding items in the annual statement of the preceding year-end (with any exceptions noted below);

(e) Include provision for all actuarial reserves and related statement items which ought to be established.

The reserves and related items, when considered in light of the assets held by the company with respect to such reserves and related actuarial items including, but not limited to, the investment earnings on such assets, and the considerations anticipated to be received and retained under such policies and contracts, make adequate provision, according to presently accepted actuarial standards of practice, for the anticipated cash flows required by the contractual obligations and related expenses of the company.

The actuarial methods, considerations and analyses used in forming any opinion conform to the appropriate Standards of Practice as promulgated by the Actuarial Standards Board, which standards form the basis of this statement of opinion.(…)"

Section 10. Additional Considerations for Analysis

B. Selection of Assets for Analysis

The appointed actuary shall analyze only those assets held in support of the reserves which are the subject for specific analysis, hereafter called "specified reserves." A particular asset orportion thereof supporting a group of specified reserves cannot support any other group of specified reserves. An asset may be allocated over several groups of specified reserves. The annual statement value of the assets held in support of the reserves shall not exceed the annual statement value of the specified reserves, except as provided in Subsection C below. If the method of asset allocation is not consistent from year to year, the extent of its inconsistency should be described in the supporting memorandum.

(American Academy of Actuaries, 1998a)