CHAPTER III

C-3 RISK

Building a liability model to help evaluate the C-3 risk is not much different from the traditional modeling that actuaries have been doing for years. Several of the assumptions will be tied to interest rate movements, but the majority of the assumptions will be independent of interest rates and will be no different from the assumptions used in any pricing model. However, it is important that the model be flexible enough to accommodate those assumptions that will vary with interest. The model should also be flexible enough to accept reserves and cash values that vary from one interest scenario to the next. Because the reserves and cash values will generally vary from one scenario to the next, it is typically easiest to generate them right in the projection system so that it is not necessary to rerun a separate values system each time a new scenario is desired.

Commissions, expenses, death benefits, mortality, and initial premiums are all assumptions that need to be made both for traditional models and for modeling the C-3 risk. Occasionally, expense inflation will be tied to the interest scenario, but since inflation is a minor factor in this type of analysis, this is typically an unnecessary refinement. Death benefits may change as account values grow, but they are essentially independent of the interest scenario. Theoretically, antiselection should cause mortality experience to deteriorate under scenarios in which lapses are substantially higher than normal, but this is a fairly complex refinement that many companies choose to ignore. At some point in the future, it will probably be common practice to reflect deteriorating mortality under high lapse scenarios, but for now, most companies are giving this refinement a far lower priority than developing the basic analytical structure.

Product characteristics, such as mortality charges, expense loads, and surrender charges, will be needed to develop cash values, reserves, and possibly death benefits under the different scenarios. The most obvious liability assumption that will vary with the interest scenario is the credited rate. The first step in projecting credited rates is to determine what the crediting strategy will be—that is, how management will change the credited rate in response to changes in the interest rate environment. Since many managements have not developed a clearly defined crediting philosophy, developing this assumption may require substantial discussion with, and education of, management. There is an infinite variety of possible crediting strategies, but most can be placed into several broad classes of strategies (many strategies are hybrids of two or more classes of strategies). Some of the broad classes of crediting strategies follow:

1. Credit a fixed rate that does not vary with market conditions.
2. Credit a competitive market rate at all times.
3. Lag the market.
4. Lag the market in one direction only.
5. Credit the earned rate less some predefined spread.
6. Credit the market rate plus (or minus) a predefined number of basis points.
7. Follow one of the above strategies, but do not pierce the bailout until the surrender charge disappears.
8. Credit a fixed rate during the period that the surrender charge is in effect, and then credit the market rate.

One of the questions that is immediately apparent upon looking at this list of strategies is, "What is the market rate?" Ideally, the market rate will be the rate a policyholder can get by lapsing the policy and buying a comparable new policy from a competitor. Since market rates are largely a factor of what insurance companies can earn, the market rate typically would be equal to the rate on new bonds less some spread. For example, the market rate might be equal to the 7-year corporate bond rate less 150 basis points or just the 7-year Treasury rate, or it might be set equal to the greatest rate from among 1- to 15-year bonds less 175 basis points. Since many companies credit interest based on their portfolio rates, the market credited rates might lag the market rates on investments. Perhaps the most realistic assumption would be to assume that portfolio rate companies drive the market as rates fall and that new money rate companies drive the market as rates rise; thus, the market rate would be based on the greater of current and recent rates. For example, the market rate might be set at 200 basis points less than the greater of the current 10-year corporate rate and the 3-year average of 10-year corporate rates.

Once formulas for determining the market rate and market credited rates have been determined, it is necessary to develop lapse rate assumptions. The lapse assumption will be largely based on intuition and the actuary's judgment, for two reasons. First, there is little experience about how lapses respond to interest rate movements. Second, it is uncertain how valuable experience will be as a predictor of future lapse rates, given the recent rapid changes in the insurance market. Any experience prior to 1980 is probably invalid, because it reflects ______ a different environment.

Both intuition and the limited amount of experience that we do have indicated that lapses are dependent on the difference between a policyholder's actual credited rate and what the policyholder can get in the market on a similar policy. As the differential between market and actual credited rates widens, the policyholder's incentive to lapse increases dramatically. Many companies experienced annual lapse rates in excess of 30 percent or even 40 percent during the interest rate spike of the early 1980s. Several companies experienced annual lapse rates in excess of 60 percent.

The other major factor in determining lapse rates is the policy's surrender charge. The surrender charge provides a disincentive to lapse, particularly if it will disappear within the next several policy years. There are a number of intangible factors, such as the sophistication of policyholders and agents, the affiliation and loyalty of the agents, and policy characteristics, that also affect lapses. These factors are probably best dealt with by considering them when choosing the parameters for the lapse formula.

Although there is no right or wrong formula, the lapse formula should conform generally to the limited experience that we have, as well as appeal to the intuitive sense of how lapses will behave. That is to say that if the credited rate remains constant and the market rate rises, lapses should increase. Similarly, if the surrender charge is decreased, lapses should increase. There may also be one-time jumps in the lapse rates when certain events occur. For example, the lapse rate might be increased to reflect "shock" lapses the first time that the credited rate is lowered or when the bailout is pierced. It should be noted that triggering the bailout will cause the surrender charge to be zero,

so that if the surrender charge is a component of the lapse formula, lapses will automatically increase. A decreasing surrender charge will probably provide more of an incentive not to lapse than a flat or increasing surrender charge.
As an example of the type of formula that could be used to generate lapse rates, consider

> 15% + 2 x Z x $(MR - CR)^2$ - 3 x SC with a minimum of 3 percent. SC equals the surrender charge as a percentage of the account value. MR equals the market rate as a percentage and CR equals the credited rate as a percentage. Z equals -1 if MR - CR is negative and 1 if MR - CR is positive.

This formula should not be viewed as <u>the</u> lapse formula; rather, it is important because of the principles it embodies.

The impact of the formula is illustrated in Figure 3-1. In this formula, lapses increase rapidly if the market rate increases relative to the credited rate and lapses are substantially reduced by the surrender charge. When the formula has a large surrender charge component, lapses will tend to be low until the surrender charge disappears, unless the market rate moves substantially. After the surrender charge disappears, the lapses will be much higher, even if MR - CR equals 0. The lapse formula does not have to involve $(MR - CR)^2$; the formula could just as easily be linear or have some other relationship with respect to MR - CR.

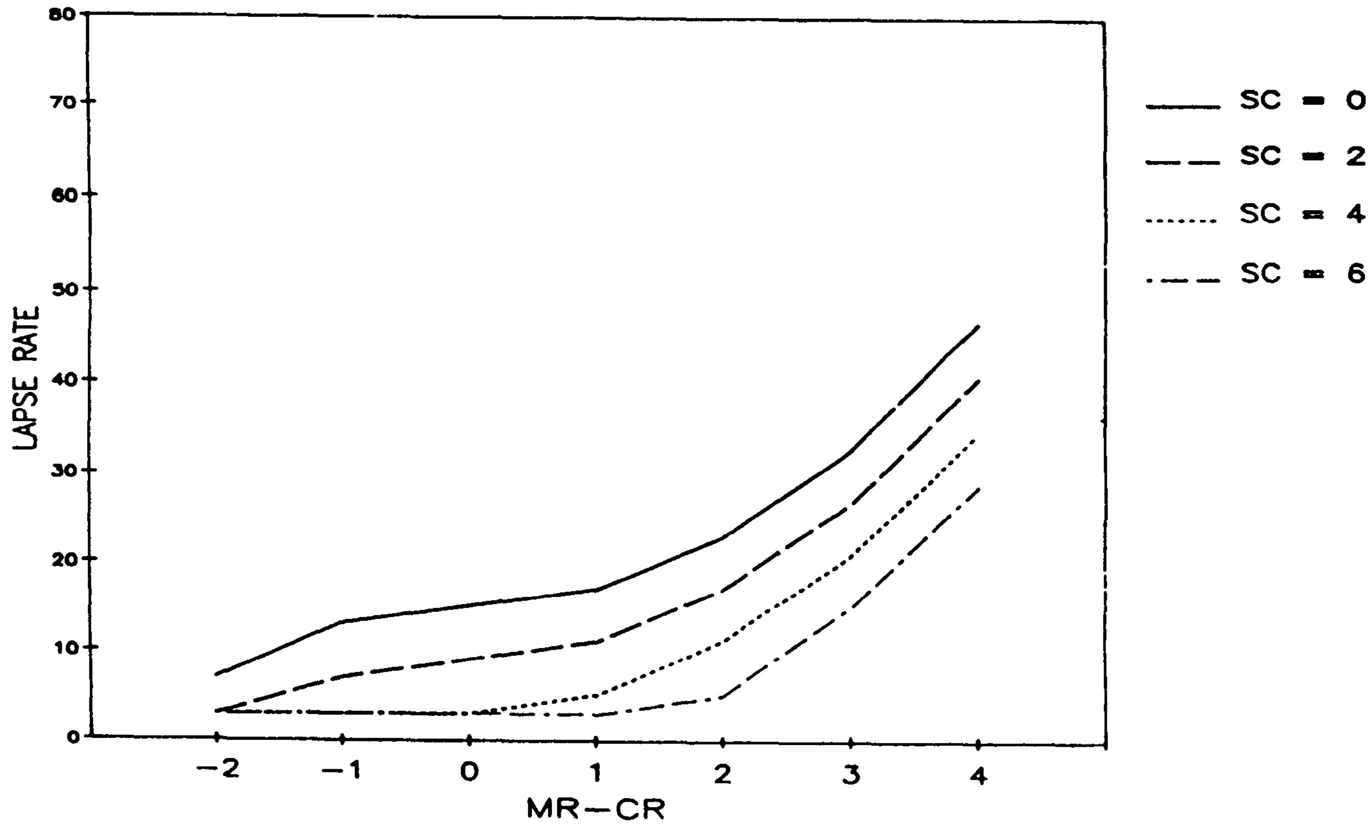


FIGURE 3-1

Figure 3-2 illustrates the formula

> 10% + 7 x (MR - CR) - 2 x SC, with a minimum of 3 percent. Even the form of the lapse rate function could be different from the formulas shown so far. For example, the surrender charge could be incorporated into the MR - CR term:
>
> 5% + 2 x Y x $(MR - CR - 0.5 \times SC)^2$, where Y equals 1 if MR - CR is positive, and equals 0 otherwise. Figure 3-3 illustrates this formula.

For nontraditional products, the policyholder's premium-paying pattern is not fixed in advance. The rate at which policyholders stop paying premiums on policies that remain in force is called the premium suspension rate. The premium suspension rate should vary in much the same manner as the lapse rate, although the parameters will be different. The surrender charge will probably increase premium suspension rather than decrease it, because unhappy policyholders may be more likely to stop paying premiums than to lapse outright if they incur a surrender charge by lapsing.

Policy loan utilization should also be an interest-sensitive variable, much like premium suspension. Policy loan utilization will also reflect how the policy is designed and marketed. An alternative to having separate lapse, premium suspension, and loan utilization formulas would be to have a generalized withdrawal function with no surrender charge component; withdrawals would then be allocated among lapses, premium suspension, and policy loan utilization using a formula that incorporates the surrender charge.

FIGURE 3-2

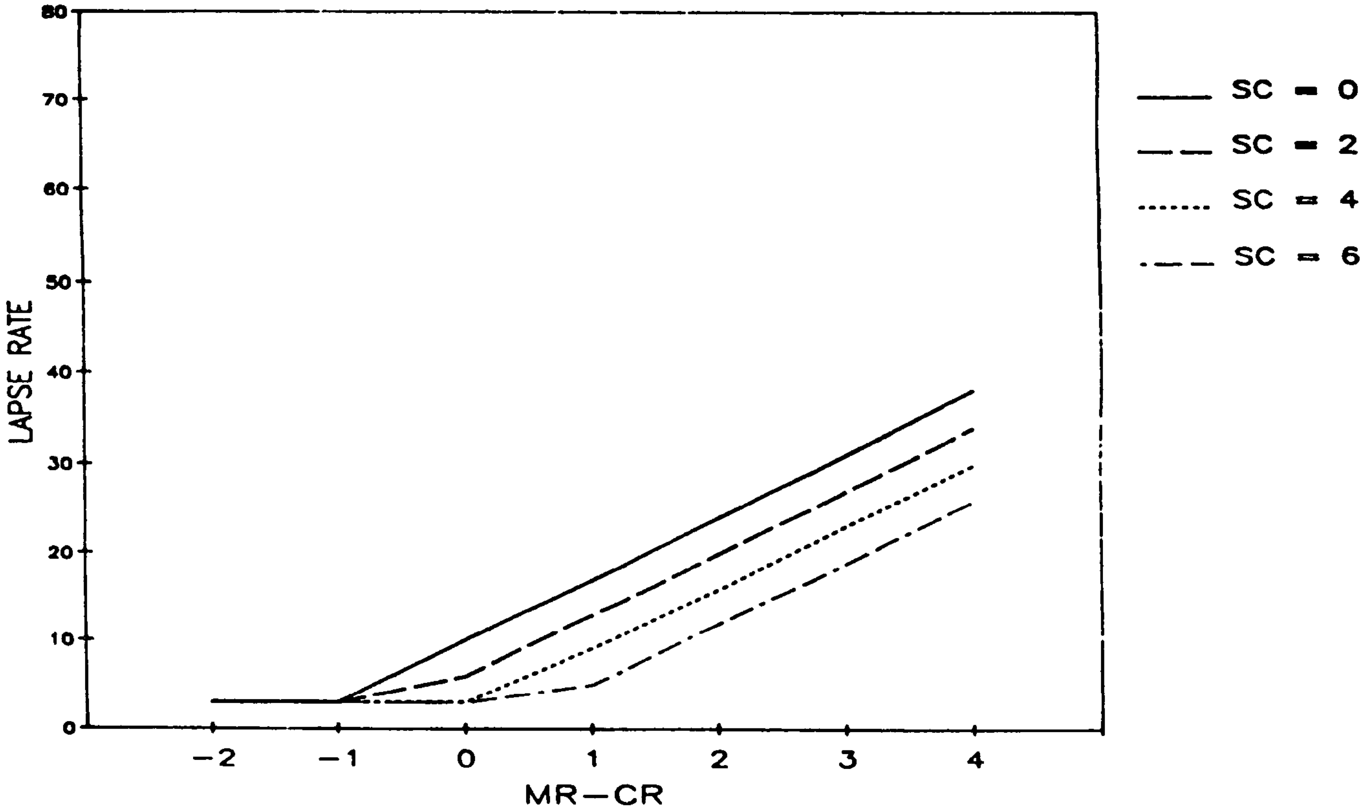


FIGURE 3-2

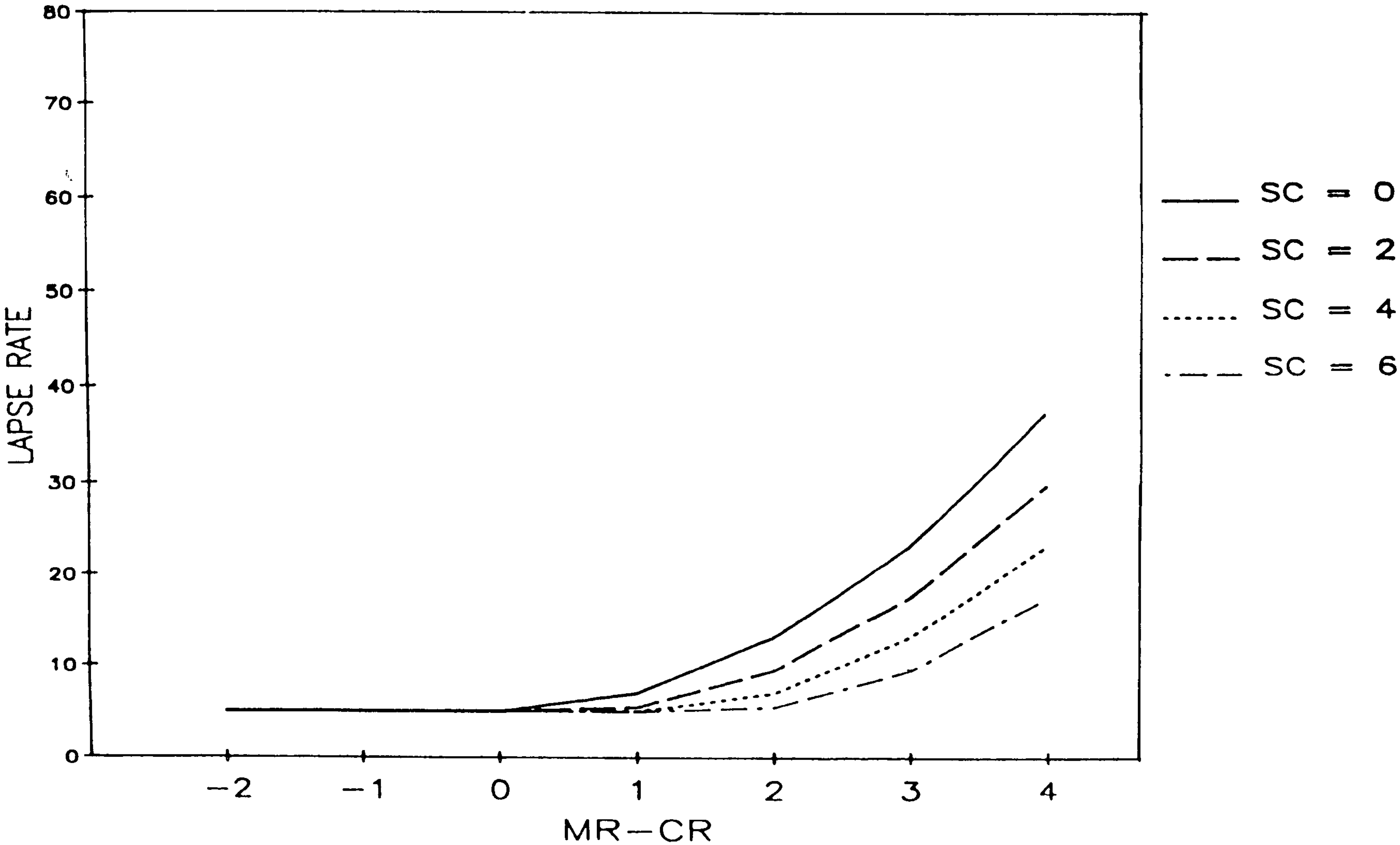


FIGURE 3-3

In order to project asset cash flows, it is necessary to project investment income, maturities, payment of mortgage principal, calls, prepayment of mortgage principal, and the market value of any liquidations. These items will need to be projected both for existing assets and for assets that are assumed to be purchased during the projection period. Projecting investment income simply involves keeping track of each security's outstanding par value and coupon and multiplying the two. Similarly, projecting maturities requires that each security's maturity date and outstanding par value be known. Projecting mortgage principal payments requires that the amortization schedule be calculated.

Projecting calls and mortgage prepayments is somewhat more difficult, because they will vary with interest. It will be necessary to develop assumptions as to when bonds will be called and how much of a given block of mortgages will prepay under different interest environments. Bond calls are somewhat simpler than mortgage prepayments, because the decision to call a bond is typically all or nothing, whereas mortgage blocks tend to have prepayments of part of the block.

There will be no calls prior to the bond's call date. Thereafter, calls will be a factor of call price, years to maturity, and prevailing interest rates. (In projecting the value of calls, it is important to remember that call prices generally start above par and decline linearly to par at maturity.) A simple approach would be to say that a bond will be called when rates on comparable new bonds are X percent. More complex approaches might have only a portion of bonds being called when the difference in rates is less than, say, 4 percent, but 100 percent being called when the difference exceeds 4 percent. It is also possible to adjust X to reflect the bond's current call price and current years to maturity. The extra sophistication of these more complex approaches is probably not worth the effort for companies that are just getting started in valuation actuary analyses.

Mortgage prepayment rates behave much like lapse rates, except that the relationship to market rates is reversed. For mortgages, what we mean by market rates is the rate at which a mortgagor could borrow today. The lower the mortgage market rate falls, the higher the prepayment rate will be. However, because mortgagors typically are affected by noneconomic factors more than bond issuers are, the prepayment rate will be less of an all-or-nothing affair.

As an example of a prepayment formula, consider

> $P = 5\% + 7 \times (C - M)$, with a minimum of 2 percent and a maximum of 50 percent. P equals the annual prepayment rate. M equals the mortgage market rate, and C equals the coupon rate for the mortgage.

This type of formula reflects the incentive to prepay the mortgage as rates fall and also reflects the noneconomic factors that keep mortgagors from being completely responsive to economic conditions. The sample formula is designed to demonstrate a concept, so the focus should not be on the numbers, but on the approach. It is quite reasonable to use other formulas, perhaps including a $(C - M)^2$ term. Most investment managers will be willing to make a guess at what the prepayment formula and call formula should be if you show them the type of framework you want the formula to fit.

Many people avoid the question of the market value of liquidations by assuming that negative cash flows will be met by borrowing. However, even if this assumption is made, it is still necessary to calculate the market value of assets at the end of the projection period. Whether the market value of the portfolio is being calculated to determine the residual value of assets and liabilities or to calculate the market value of liquidations, the same considerations apply. There are formulas in any interest textbook that tell how to calculate the market value of a bond or mortgage given the market interest rate. However, those formulas assume that the security's cash flows are fixed, and they do not assign any value to the issuer's option to call the security. Ideally, the market value of the bond or mortgage should be reduced by the value of the issuer's option. In practice, the value of the option is often approximated by assuming that the market value of bonds is the lesser of the market value calculated, assuming that the bond will be held to maturity, and the market value calculated assuming that the bond will be called. This, in effect, places a cap on the value of the bond and tends to moderately overstate the market value of the bond. Similarly, for mortgages, it is common to value the mortgage assuming that the prepayment rate will always reflect the then current market rate. However the market value is calculated, you may want to reduce it by a small amount (for example, 0.25 percent) to reflect transaction costs.

If the analysis is performed strictly for valuation actuary purposes, then the book value and book yield are irrelevant. However, if profitability is being measured or if it is desired to compare the book value of assets to reserves in the future, then the model must be able to amortize the difference between book and par. Frequently, par and book are close together, in which case the actuary may choose to set the two equal to each other and avoid this issue.

Although defaults are accorded a separate classification (C-1 risk), the valuation actuary may wish to incorporate defaults into the C-3 risk model. Defaults could be incorporated into the model as a random variable, or a fixed deduction from yields could be made to reflect expected defaults with a reserve determined externally to cover the value of possible random fluctuations in defaults. The major disadvantage of the first approach is that it would require many more projections of the entire model to gain the same degree of C-3 information. The second approach would allow a sophisticated analysis of the default risk to be made without requiring redundant C-3 analyses. However, under the second approach, it would be difficult to reflect any potential interaction of the C-1 and C-3 risks.

Most asset portfolios contain a much smaller number of holdings than the typical liability portfolio. Therefore, it may not be necessary to group the assets into model cells. If the actuary decides to group the assets, the first criterion will be maturity date. The second criterion will be coupon. The third criterion will be call characteristics. As an example of an asset model, bonds could be grouped by maturity year in 2 percent coupon intervals. Noncallable bonds would be kept separate from callable bonds, and callable bonds would be grouped by call date in one-year intervals, with bonds with more than 5-1/2 years of call protection maintained as a single cell.

After an asset model has been built, it will be necessary to make assumptions about what the new investments will look like. Each year's new investments can be appended onto the model, but determining what the new investments will look like requires that the investment department make assumptions as to what the characteristics of the universe of potential investments will be and as to what the investment strategy will be. It is necessary to specify the maturity dates of new securities, the call dates (unless the securities are noncallable), the call prices, and the yields. Typically, the interest scenarios to be tested do not specify the interest rate for every security, but rather specify some smaller group of rates, such as the Treasury yield curve. Thus, rules must be developed to relate yields on other assets to yields on the base yield curve. The most common way to link the yields is through additive or multiplicative spreads. That is, the yield on each bond equals the yield for a comparable maturity on the base curve plus or times X, where X will be different for each security. The investment strategy can be either dynamic or fixed. In dynamic strategies, investment and liquidation percentages change in response to changes in the environment. In fixed strategies, the investment and disinvestment percentages for a given year are not affected by the interest environment. Duration-matching strategies for fixed liabilities or pseudoduration-matching strategies for interest-sensitive products are examples of dynamic strategies.

As with any model, once the interest-sensitive model is in place, it is necessary to develop in-force data. For the liabilities, you will need the beginning reserve, account value, cash value, and face amount for each cell. You will also want some data on the recent premium-paying history of each cell, as well as the current average crediting rate and the period for which that credited rate is guaranteed. The criteria for selecting model cells may be somewhat different from the criteria for more traditional models. The surrender charge and credited rate will be the most important criteria for selecting model cells, followed by age or mortality characteristics. Depending on the modeling method used, it is quite likely that separate cells will be necessary for the last several issue years. Depending on the actuary's judgment and the distribution of expected mortality gains across ages, it is possible that no distinction will be made between different issue ages, because the model will already be extremely complex just from the consideration of groupings by plan, current surrender charge level, and credited rate (often groupings in accordance with the last two can be accomplished by grouping by issue year).

Most companies already have systems in place that will provide the necessary liability in-force data. If the systems to gather the data are not in place, it would be advisable to design the necessary systems, even if there were no valuation actuary requirements. The liability data that are needed to perform the valuation actuary analyses are also needed to make realistic corporate planning projections and to perform the types of analyses that can be used to compare different asset and liability strategies.

The following items are needed as of the valuation date for each security or group of securities to model existing assets: (1) book value, (2) market value, (3) par value, (4) book yield, (5) coupon, (6) call date, (7) call price, (8) maturity date, and (9) special features of the security (for example, sinking fund). Most of these items are readily available from the data used to generate Schedule D for the annual statement. However, many companies do not have accurate call data, because all that is required for Schedule D is the call date and price for those bonds that are being amortized to call. Getting the necessary call data may require a special project, because although the investment department usually has the data, the data are not always in an easily usable form.

Several other issues must be considered. Depending on the company's tax situation, it may be appropriate to perform the projections on an after-tax basis. Under the new tax law, taxes are fairly straightforward to calculate, although it may be necessary to provide for the separate calculation of tax reserves. If projections are done on a by-line basis for a mutual company, the surplus tax will need to be allocated.

Typically, in performing a valuation actuary analysis, future issues are ignored for several reasons. First, there is a great deal of uncertainty about both the amount and characteristics of future issues, so they may impair the validity of the analysis. Second, the concept of the valuation actuary is to test the adequacy of current reserves to cover benefits on the policies currently in force. Third, if aggressive growth assumptions are used, the value of future issues often dwarfs the value of existing business so that the valuation actuary's analysis will not reflect the current state of the company. Fourth, projecting 20 years of future issues when so many of the assumptions are scenario dependent may unduly complicate the analysis.

One of the thorniest issues facing the valuation actuary is what scenarios to test. If the scenarios are not dictated by the applicable valuation actuary regulation (or by senior management, if it is internal valuation actuary work), the actuary will have to use his judgment as to how volatile the scenarios to test should be. The interest scenario represents the single most important assumption the actuary will make, yet it is probably the assumption for which he has the least data on which to base his assumption.

Another issue is whether or not the analysis should incorporate any reinsurance treaties in place. The most realistic approach seems to be to look at everything net of reinsurance, particularly since that is the way reserves are measured. However, under some coinsurance treaties it may be feasible to ignore reinsurance if the reinsurer simply accepts a prorata share of the insurer's gain or loss.

The last issue is how long a projection period to use and how to end the study. The appropriate projection period will vary with the contract being studied. For GICs and some deferred annuities, 5 or 10 years is appropriate, whereas some structured settlement annuities may require a 50 or 60 year projection period. The key is to use a projection period that is long enough that the combination of lapses and mortality diminishes the remaining block to an insignificant size. At the end of the projection period, it is appropriate to compare the market value of assets to the present value of remaining liabilities at the then prevailing rates. If the liabilities are interest-sensitive, the present value of the future benefits is probably best approximated by the cash surrender value, unless rates have fallen low enough that contract guarantees exceed the interest rates prevailing in the market.

The easiest way to understand this sort of material is through examples. The following case studies are based on actual company situations, although the numbers have been changed to protect the identity of the companies.

The first example involves a GIC writer that had $1.4 billion of assets and liabilities as of June 30, 1985 (see Table 3-1). The company's portfolio was duration matched, and its intention was to rebalance the portfolio every quarter to maintain the duration match. The company was interested in determining how much risk it faced under different interest scenarios, so it selected the 12 scenarios shown in Table 3-2 for testing purposes. Figure 3-4 displays the results of the analysis. If interest rates do not change, as in scenario 1, the company would have a small surplus at the end of the projection period. Under the worst of the twelve scenarios (scenario 5, which was an extremely severe rising interest scenario), the company would have a shortfall of $37.2 million at the end of the projection period. Given the severity of scenario 5, $37.2 million is not a great deal to put at risk for a $1.4 billion portfolio, and this indicates how effective a duration matching strategy can be in minimizing risk for fixed liabilities. However, $37.2 million is substantial enough to indicate that duration matching does not by any means eliminate interest rate risk.

TABLE 3-1

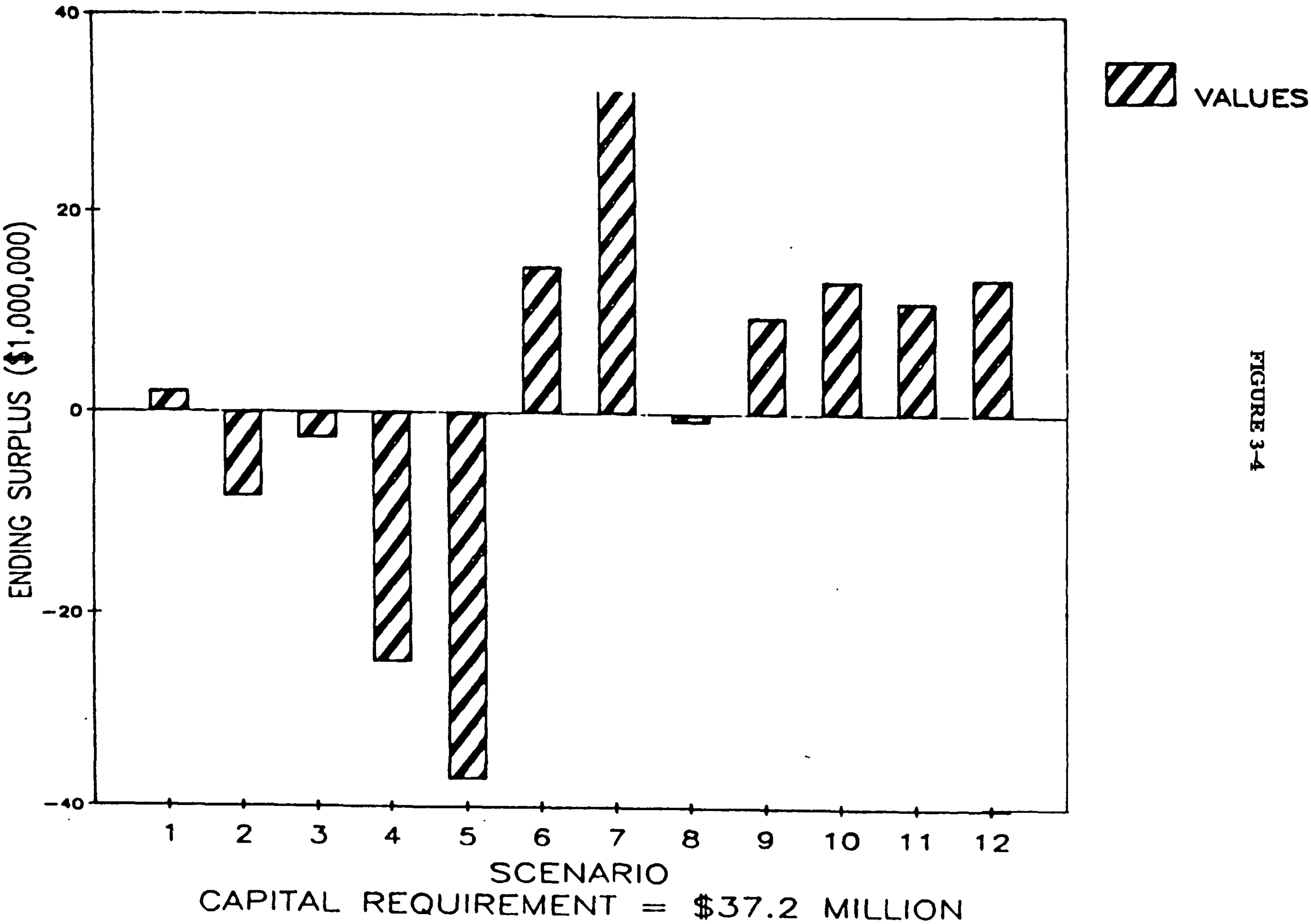
GIC ASSUMPTIONS

Deposit:	Initial deposit of $1.2 billion has grown to $1.4 billion by 6/30/85
Book value withdrawals:	Death benefits
Annuitization:	$100 million
Compound GIC:	$1.0 billion
Simple GIC:	$300 million

TABLE 3-2

SCENARIO DESCRIPTIONS FOR PROJECTIONS OF
"IMMUNIZED" GIC PORTFOLIO

1. Level.
2. Level. Yield curve steepens.
3. Valley—rates fall, then return to original level. Yield curve steepens.
4. Mountain—rates rise, then fall back to original level. Yield curve steepens.
5. Rising. Yield curve steepens.
6. Falling. Yield curve steepens.
7. Falling. Yield curve becomes less steep.
8. Rising. Yield curve inverts.
9. Mountain—rates rise, then fall back to original level. Yield curve becomes less steep.
10. Valley—rates fall, then return to original level. Yield curve becomes less steep.
11. Deep valley—rates fall further than in scenario 10. Yield curve becomes less steep.
12. Level. Yield curve becomes less steep.



40
20
0
-20
-40
ENDING SURPLUS ($1,000,000)
VALUES
1
2
3
4
5
6
7
8
9
10
11
12
SCENARIO
CAPITAL REQUIREMENT = $37.2 MILLION

FIGURE 3-4

It is interesting to note that scenarios 1, 2 and 12 are all described as being "level." In each of these scenarios, the 5-year bond rate never changes, but in scenario 2, long-term rates increase and short-term rates decrease, whereas in scenario 12, long-term rates decrease and short-term rates increase. The ending surplus for scenario 1 is about $1 million; for scenario 2, about $-8million; and for scenario 3, about $12 million. These results indicate that the slope of the yield curve is almost as important as the level of the yield curve, especially for duration matching strategies.

The second example involves a company that we have called Make Your Spread Life, which issues SPDAs. This company is interested in issuing SPDAs and wants to know how much risk capital it should allocate if it issues $100 million of SPDAs. Table 3-3 shows the investment assumptions that Make Your Spread Life used for its analysis. This table describes the characteristics of the securities that Make Your Spread Life will be assumed to be able to buy for the projection. Table 3-4 shows a sampling of the 21 yield curves that were assumed to be possible for this analysis. A probability distribution was used to randomly generate interest scenarios based on this yield curve universe. Examples 3 and 4, which will be given later, are also based on Tables 3-3 and 3-4.

Table 3-5 shows the other major assumptions for Make Your Spread Life. This company's intent was to buy 20-year callable bonds initially and thereafter to buy 7-year callable bonds. The credited rate would be equal to the earned rate less 150 basis points, because the product had been priced by assuming that the company would earn 150 basis points more than it credited. Figure 3-5 shows the results for this analysis. Based on 50 randomly generated trials, Make Your Spread Life has an expected present value of profits at 15 percent of about $2

TABLE 3-3

INVESTMENT ASSUMPTIONS

- Spreads to Treasuries:
  - 50 basis points for noncallable bonds.
  - 150 basis points for callable bonds.
- Bonds are called if rates fall 150 basis points.
- 7-year callable bonds are callable in 4 years at par.
- 10-year callable bonds are callable in 5 years at par.
- 20-year callable bonds are callable in 5 years at 106 percent of par.
- 30-year callable bonds are callable in 5 years at 106 percent of par.

TABLE 3-4

YIELD CURVE UNIVERSE

Curve Number	1-Year Treasury	5-Year Treasury	10-Year Treasury	20-Year Treasury
1	1.41	2.27	2.38	2.78
3	2.41	3.27	3.38	3.78
7	4.41	5.27	5.38	5.78
11[a]	6.41	7.27	7.38	7.78
15	10.41	11.27	11.38	11.78
19	15.34	15.27	15.15	15.10
21	18.27	17.27	16.92	16.42

[a]Current curve.

TABLE 3-5

MAKE YOUR SPREAD LIFE

SPDA NEW ISSUES

- Premium: $200 million.
- Average size: $25,000.
- Surrender charge: 7, 7, 7, 6, 5, 4, 3, 2, 1, 0 percent.
- Investment strategy: 20-year callable bonds initially; thereafter, 7-year callable bonds.
- Credited rate: Earned rate less 150 basis points.
- Market rate: 5-year Treasury.
- Lapse rate: $15\% + 2 \times (MR - CR)^2 - 3 \times SC$. Minimum = 3%.
- Issue expense: $50 per policy.
- Maintenance expense: $25 per policy, inflated at 3 percent.
- Commission: 5 percent.
- Investment expense: 0.2 percent of fund.
- Bailout: 0.
- Guaranteed interest: 4 percent.

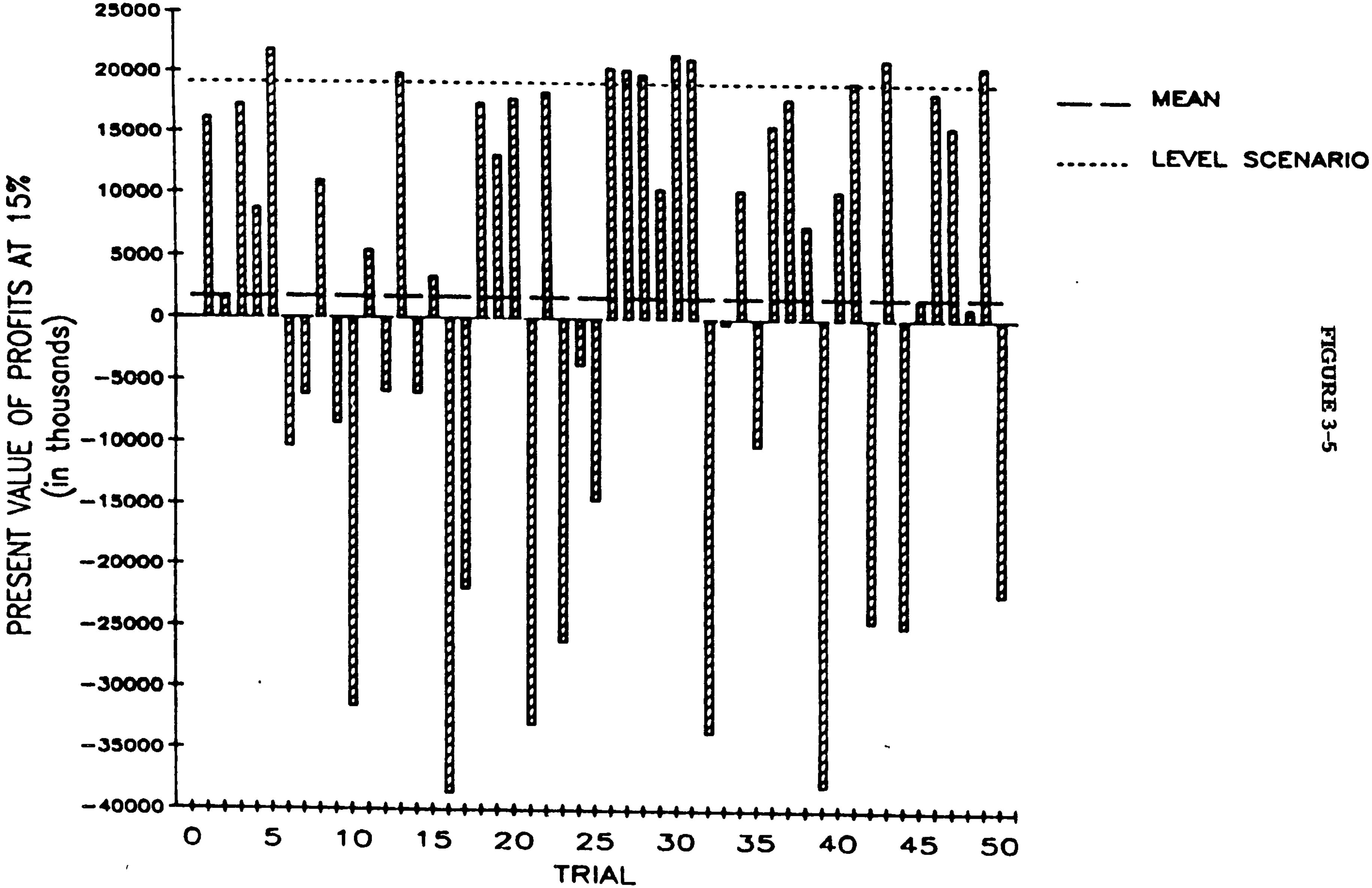

PRESENT VALUE OF PROFITS AT 15%
(in thousands)
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40000
0
5
10
15
20
25
30
35
40
45
50
TRIAL
MEAN
LEVEL SCENARIO

FIGURE 3-5

million (see the dashed line in Figure 5). Under the worst of the 50 scenarios, the present value of profits was $-39 million, and there were nine other scenarios where losses exceeded $20 million.

It should be noted that in Example 1, the results are displayed as ending surplus numbers, whereas in Examples 2 through 4, the results are displayed as the present value of profits. Thus, if all other things are equal, a loss of $1 million in Example 1 will require less initial surplus than a loss of $1 million in the other examples. It should also be noted that in Example 1, the scenarios were selected by management, and several were chosen to be severe, whereas in Examples 2 to 4, the scenarios were chosen through a random process to produce what management hoped was a reasonable cross-section of scenarios.

One interesting result of the analysis for Make Your Spread Life is that when interest rates never change (the level scenario result is indicated by a dotted line in Figure 3-5), the present value of profits is considerably higher than the mean present value of profits over the 50 scenarios and is almost as high as the best of the 50 trials. Since the company's actuaries had priced the product assuming a 150 basis points spread with no adverse lapse deviations, their pricing result was close to the result under the level scenario. It is quite common for analysis of the impact of swings in interest rates to indicate that results will be far worse than would be indicated by conventional pricing analyses. Interest rate movements have an adverse impact on profitability, because insurers typically grant options both to their policyholders and to bond issuers. In a level interest scenario, those options have no value, but when interest rates are volatile, insurers face heavy antiselection as those options are exercised, either through higher lapses in rising rate environments or through calls in falling rate environments.

Example 3 involves an SPDA writer that we have labeled Matched Life. Table 3-6 shows the major assumptions for this company. It is important to note that although Matched Life believes that it is duration matched, the duration of the typical interest liability changes as interest rates change, and there are not any assets that behave comparably. Since Matched Life intends to credit a market rate of interest, its liability will behave more like a series of 1-year bonds rolling over than anything else, but if it invests in short assets, its earnings will be insufficient to fund its credited rate. Nonetheless, Matched Life has concluded that its liability has a duration that is comparable to that of a 7-year bond, so it will buy 7-year bonds initially. Thereafter, Matched Life will buy shorter and shorter intermediate bonds in an attempt to maintain its so-called match. Figure 3-6 shows the results for Matched Life. Over 50 scenarios, its mean present value of profits is $2 million, and the low is $-22 million. In five of the 50 scenarios, Matched Life has losses in excess of $20 million. Although Matched Life has lower risk than Make Your Spread Life, it clearly has not come close to eliminating the interest rate risk. As in Example 2, the level scenario produces a result that is considerably better than the mean.

The final example, Example 4, involves a universal life writer, called Universal Life Company. Because universal life is a more complex product than an SPDA, the assumptions shown in Table 3-6 are more extensive than for the SPDAs. However, the basic approach and principals are unchanged. This company intends to buy 10-year callable bonds and credit the market rate, which

TABLE 3-6

MATCHED LIFE

SPDA NEW ISSUES

o	Premium:	$200 million.
o	Average size:	$25,000.
o	Surrender charge:	7, 7, 7, 6, 5, 4, 3, 2, 1, 0 percent.
o	Investment strategy:	Intermediate bonds; initially 7-year callable bonds.
o	Credited rate:	Market.
o	Market rate:	5-year treasury.
o	Lapse rate:	$15\% + 2 \times (MR - CR)^2 - 3 \times SC$. Minimum = 3%.
o	Issue expense:	$50 per policy.
o	Maintenance expense:	$25 per policy, inflated at 3 percent.
o	Commission:	5 percent.
o	Investment expense:	0.2 percent of fund.
o	Bailout:	0.
o	Guaranteed interest:	4 percent.

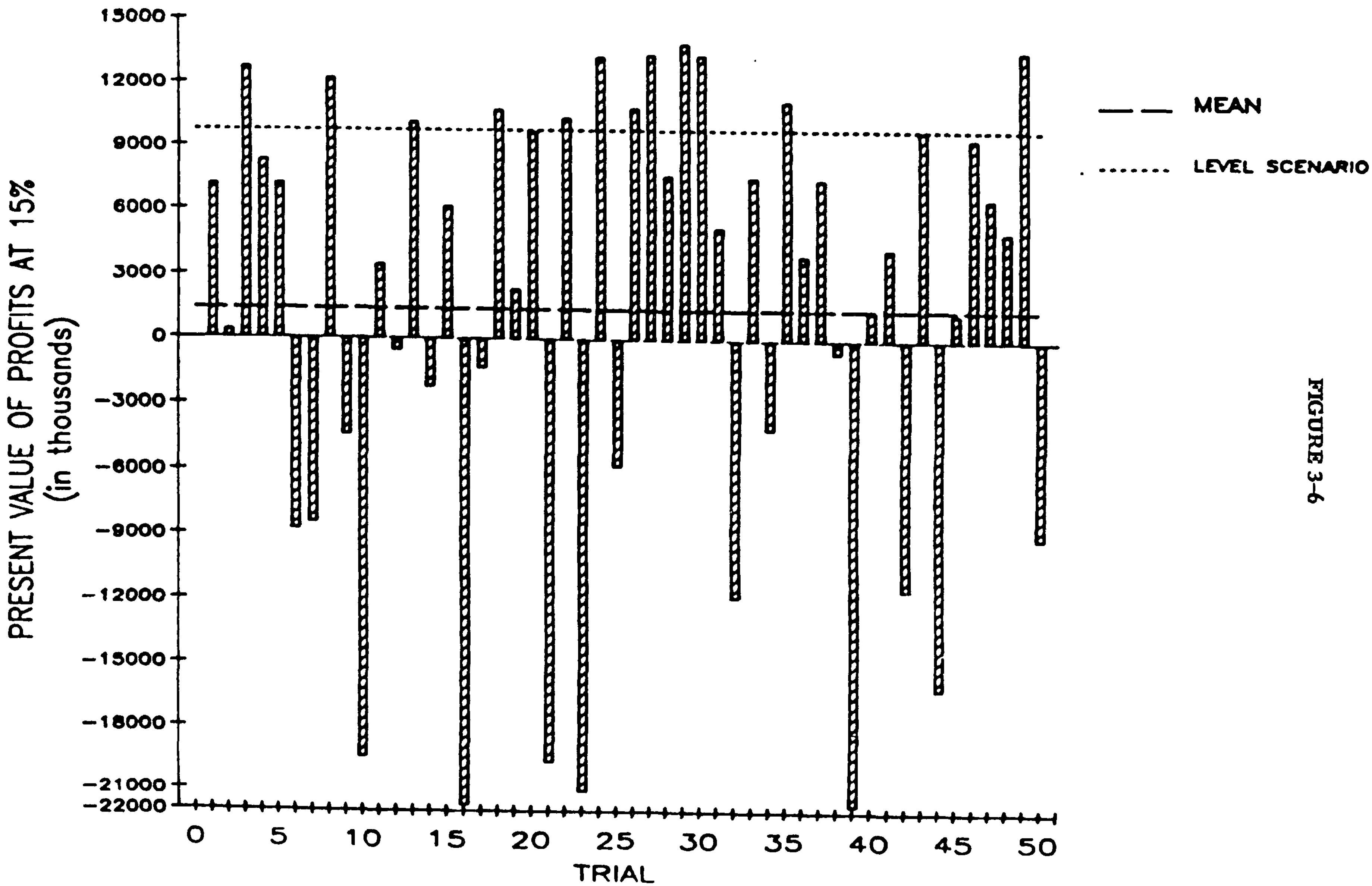

PRESENT VALUE OF PROFITS AT 15%
(in thousands)
15000
12000
9000
6000
3000
0
-3000
-6000
-9000
-12000
-15000
-18000
-21000
-22000
0
5
10
15
20
25
30
35
40
45
50
TRIAL
MEAN
LEVEL SCENARIO

FIGURE 3-6

TABLE 3-7

UNIVERSAL LIFE COMPANY

UNIVERSAL LIFE NEW ISSUES

Premium:	Initially $5 million per year.
Average size:	$100,000.
Investment strategy:	10-year callable bonds.
Surrender charge:	100 percent of first-year target premium grading to 0 in year 16.
Credited rate:	Market.
Market rate:	7-year Treasury.
Lapse rate:	$17\% + 1.5(MR - CR)^{2.5} - SC$. Minimum = 4%.
Suspension rate:	15 percent first year, 5 percent thereafter.
Issue expense:	$150 per policy plus $1.75 per $1,000.
Maintenance expense:	$50 per policy.
Investment expense:	0.15 percent.
Premium tax:	2.25 percent.
Commission and allowances:	115 percent of first-year target premium; 15 percent of second-year target premium; 5 percent of all other target premiums and excess premiums.
Loads:	4 percent of target premium.
Mortality charge:	85 percent of 65/70 ultimate.
Actual mortality:	75 percent of 65/70 select and ultimate.
Guarantee:	80 CSO and 5.5 percent.

it has defined as the 7-year Treasury rate. The results, which are shown in Figure 3-7 are fairly favorable. The mean present value of profits at 15 percent is $450,000, and the low of the 50 trials is only $-150,000. Again, the results under the level scenario are considerably better than the mean result.

In all of these analyses, it is important to remember that the results are extremely sensitive to the assumptions used. The actuary will often want to perform sensitivity testing to see what the results look like using alternative assumptions. If the results do not change much, there is no problem, but if they change dramatically, the actuary will want to be sure that the audience for his work understands the implications of changes in the crucial assumptions. Some of the leading candidates for sensitivity testing are the interest scenarios tested, the lapse assumption, and the relationship of the market credited rate to the investment market.

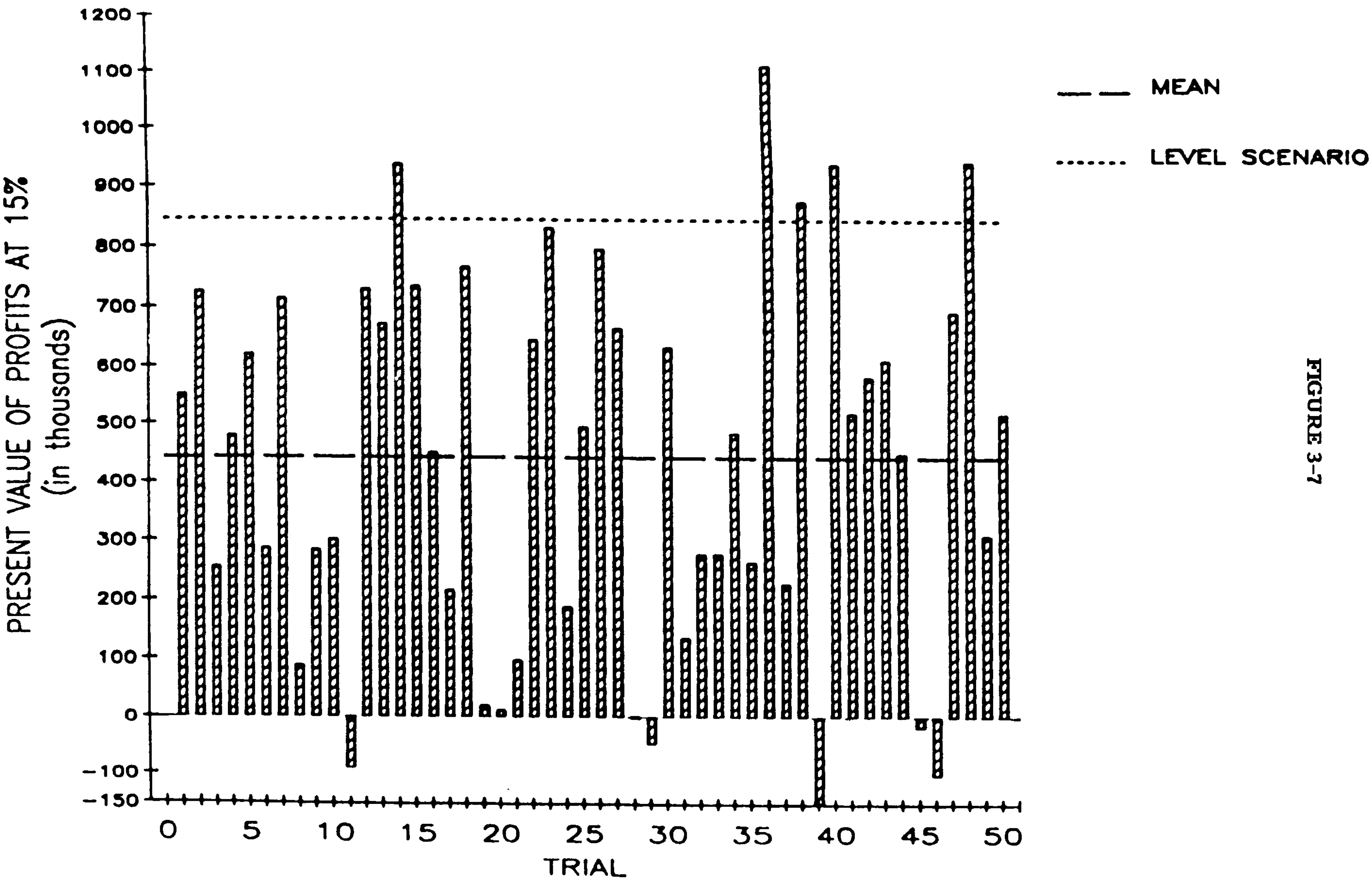

PRESENT VALUE OF PROFITS AT 15%
(in thousands)
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
−100
−150
0
5
10
15
20
25
30
35
40
45
50
TRIAL
MEAN
LEVEL SCENARIO

FIGURE 3-7