SESSION 10

MAKING VALUATIONS USING CASH FLOW ANALYSIS

MR. MICHAEL E. MATEJA: The goal for this concluding session of the 1986 valuation actuary symposium is to examine the "nuts and bolts" of cash flow analysis. Not surprisingly, this is the primary goal of my presentation. Some of the earlier presentations got pretty deep into the nuts and bolts, but there are still some loose ends left. After we get the cash flow issues together, I want to address the issue of good and sufficient reserves. This is the ultimate goal of the cash flow analysis process performed by the valuation actuary, and I have a few thoughts that may help you to better understand this elusive concept.

Let me state up front that for many of you who have already undertaken cash flow analysis, the first part of my presentation will be somewhat elementary. The organizers of this symposium, however, have strong convictions that we need to lay down some very basic ideas about cash flow analysis. That is my job. Mike Tuohy and Steve Radcliffe, standing in for Joe Buff, will get a bit more technical. You should understand that you do not need sophisticated models such as those described by Stan Tulin or Denny Carr to get useful results. You can get started on a small scale, and I want you to consider my remarks in this context.

What are the nuts and bolts of cash flow analysis? The connotation is clearly that this is where you take a look at the pieces and see how they fit together. And I propose to do just that.

I think we can best get at the nuts and bolts of cash flow analysis by looking at three interrelated areas as presented in the program: developing, processing, and interpreting cash flows. The first job is to develop the cash flows. Our business, as I finally realized several years ago, is fundamentally a cash flow business. Your initial goal must be to get a handle on the specific cash flows we are talking about and understand the logic that relates the various cash flows. The next task is processing, which basically involves building models to develop the expected cash flows for specific scenarios. I won't dwell long on this, because Denny Carr's presentation on assumptions adequately covered what you need to know. Finally, there is the job of interpreting what it all means. My presentation is based in part on an analysis we did to illustrate the relationship of "good and sufficient" reserves as developed by cash flow analysis to the statutory minimum reserves. The results provide a good example of how cash flow analysis can be interpreted and how it can be practically useful to you on the job.

Let's focus now on the problem of developing cash flows. As we all realize by now, we must be concerned with both assets and liabilities, so the simple prescription for developing cash flows is to understand your products and understand the investments backing those products. Actuaries traditionally have worked with the cash flows associated with products, but new skills are required to understand the options associated with our products. The completely new challenge is on the investment side, and if you have not done so already, you need to develop more familiarity with the practical side of investments. Investments are nothing more than combinations of future cash flows, and there

are many options here also to complicate the analysis. If you really understand both your product and your investment cash flows, I can assure you that you will understand the insurance business.

Table 10-1 shows all the major cash flows that you will have to consider in doing any cash flow analysis. I think everyone understands that the product cash flows are defined by our contracts. Investment cash flows, of course, are generated when the product cash flows are positive and an investment is purchased. This is perhaps clearest in the case of single premium products, but the concept applies equally to products with any premium frequency.

TABLE 10-1

Product Cash Flow	Investment Cash Flow
+ Premium	+ Investment income
- Benefit	+ Principal
- Expense	± Capital gain/loss
- Fit	+ Call premium
- Dividends	- Investment expense

If you can design a product and supporting investment program where the net of all of these cash flows at all durations is positive, then clearly you have a winner. This is the theoretical ideal, but the practical world produces a crazy quilt pattern of positive and negative cash flows that changes materially as the external environment changes. If, indeed, you can control the cash flows under

all future circumstances so that you always have positive cash flows, you really do have a winner.

Let's look more closely at the product cash flows. My experience as a valuation actuary has been that the line actuaries look at their product cash flows based on pricing expectations or assumptions, and they tend to think they are locked in. This is certainly an appropriate place to start, but the fundamental problem of valuation based on cash flow analysis is to understand the implications of deviations from expectations. Optimism has no place in valuation; the mandate is to really understand and have convictions about what the product cash flows will look like under a variety of future conditions that are characterized as "reasonable" deviations from expectations. Only when such an understanding has been achieved will it be possible to understand the relationship to investment cash flows, which, in the final analysis, is the real goal of cash flow analysis.

Even when premiums were fixed and level, they were not easy to understand. With today's products that give policyholders discretion over the amount and timing of premiums, the problem is much more difficult. Understanding how your policyholders will vary the amount and frequency of premium payments under various future assumptions thus represents your first challenge. I personally believe that there should be a measure of conservatism in this and all other assumptions. Conservatism in this context would be an understatement of cash inflows when you would like cash to invest and an overstatement of cash outflows when you would rather hang onto it. The approach conceptually is similar to the choice of a mortality table for valuation of life or annuity benefits based on current valuation practice.

Given an assumed stream of premium cash flows, the major challenge then becomes a matter of generating the corresponding benefit cash flows. The major determinant of the benefit cash flows is the guarantees provided by contract. These typically are some combination of death benefits, interest credits, surrender benefits, and maturity values. Surrender values are usually subject to surrender charges, and these sometimes are made contingent on "bailout" provisions. If you have read any of the reports of the C-3 Risk Task Force, you should understand the sensitivity of reserves to surrender benefits and changes in interest rates.

One point in particular with regard to benefit cash flows deserves special mention—the interest-crediting methodology as it applies to the new generation of fund accumulation products such as universal life and deferred annuities. You will recall that other speakers have mentioned this. When you analyze the benefit cash flows to understand what part is a return of premium and what part is credited interest, it becomes obvious that the latter (that is, the interest component) is a major determinant of future benefits. So, a precise and consistent definition of the interest-crediting methodology is very critical to getting a good handle on the benefit cash flows.

For most products sold today, there is a great sensitivity associated with the benefit cash flows. This has been clearly illustrated in the results presented by other speakers. Certainly there is more sensitivity than traditionally recognized in pricing. The charge to the valuation actuary is to understand this sensitivity and assess what it means.

I won't dwell on expense and FIT cash flows except to say that they are important. Every cash flow is important. In modeling, it is possible to make realistic assessments of how expenses shift based on volume indicators such as policies, premiums, or assets. For FIT, you basically need to develop the components of taxable income.

I want to focus now on the dividend cash flow. This is a very important cash flow, and one that actuaries have not paid much attention to in the past. By dividend cash flow, I mean the cash paid to shareholders of stock companies or the difference between actual and illustrated dividends paid to mutual policyholders. I prefer to think of illustrated dividends under par policies as a benefit.

When you sort out all the product and investment cash flows, it becomes plainly apparent that after the benefits have been paid to policyholders, any remaining cash flow is divided between the Treasury and the owners. We can be assured that the Treasury will get its due on a timely basis, so the dividend becomes what I call a "residual" cash flow. Very simply, it's what's left over, and it can be positive or negative. The negatives, of course, are what the valuation actuary is fundamentally concerned with, and additional reserves/assets must be established to eliminate them.

Rarely do you see a product with a string of negative cash flows up front; more likely, the "residual" cash flows are positive. Clearly, if they are accumulated, the future financial results will be better than if they are paid out as they materialize. In Denny Carr's examples, the dividends were accumulated, and it was established in the follow-up discussion that this was important and could

affect results. Remember, also, that these residual cash flows fund growth. Thus, there may not be an actual cash outflow from the company, but this cash would clearly not be available any longer specifically to support the product. In practice, the problem of dividend accumulation is solved by setting model assets equal to model liabilities at the end of each year. I personally think that a better understanding of dividends will someday be recognized as one of the greatest benefits associated with cash flow analysis.

Let's turn now to the investment side. Investment cash flows are every bit as subtle as those associated with products. I used to think about our investments as bonds and mortgages with a particular yield and maturity schedule. Cash flow was pretty remote from my vision of investments. With interest rates on the way down, we are all learning about call protection—or the absence thereof. Exercise of call or refund options will get you cash to invest just when you don't want it, which is when interest rates are low. Most investment departments have been getting intensive on-the-job training in this regard this year. Just a few years ago we saw the opposite happen. Repayment of principal under mortgage loan pools stretched out just when we would have liked to have more funds to invest.

Simple bonds and mortgages no longer are the sole debt instruments in our portfolios. There is a whole new generation of debt instruments on the market, many of which have unique provisions regarding future cash flows. Your investment staff can help you better understand investment cash flows, and the sooner you get them involved, the better off you will be. Some of the issues that will surely be debated in the years to come include the appropriateness of

various assets to back insurance liabilities and the impact on valuation reserves of assets with unusual cash flows.

Perhaps the most troublesome aspect of investment cash flows is related to default. Any investment professional will tell you that it is simply unrealistic to assume that all investment cash flows will be paid as promised, unless, of course, your portfolio consists of 100 percent government-backed securities. Some might even question that assumption. In our own cash flow analysis, we make a uniform deduction from the yield to cover "expected" asset defaults. The deduction is based on an assessment of actual default experience in our portfolio, which consists of investment-grade instruments (that is, instruments with an average rating of Baa). Recent experience is driving that deduction upward.

There has been much concern expressed recently about investments in junk bonds, and my only suggestion is that the same approach—that is, a deduction from the yield—is appropriate. The $64,000 question, of course, is what's the right deduction. Realistically, I think the deduction must be much higher than that considered appropriate for investment-grade bonds. The conventional assumption is that "expected" asset defaults on junk bonds will be less than the yield differential. But there is also a more substantial downside risk, which is why investors require the yield differential to begin with.

I was quite interested in the recent Wall Street Journal article (September 29, 1986) on this subject, which presented data that indicate that 3.4 percent of the junk bonds issued since January 1, 1980, are in default. For several underwriters, the percentage of bonds in default was 17 percent. The article also pointed out that it was likely that all defaults had not been properly

reported. The question of how to appropriately recognize asset quality in cash flow analysis will likely be debated for some time. My personal feeling is that I can't accept that the financial markets are stupid, and over time the premiums received in terms of higher yield on junk bonds will likely be offset by higher asset default costs. This is an area where current standards of practice will ultimately control the assumptions made by the valuation actuary.

Back in Table 10-1, I identified ten major product and investment cash flows. I've discussed most of them, and the others should be intuitively clear. With respect to virtually all of these cash flows, I have established that there is some unpredictability. The next step is cash flow processing, which attempts to understand the interrelationship of the various cash flows. Basically, this is scenario analysis, and you need a model to keep everything in order. Denny Carr's presentation on assumptions illustrated most of the nuts and bolts you will have to deal with in this area.

It is commonly assumed that the major product and investment cash flows are a function of the assumed interest rate level. With increasing interest rates, lapse rates will increase, and investment prepayments decrease. Just the opposite happens in decreasing interest scenarios. I mentioned previously, in discussing benefit cash flows, that the interest-crediting methodology was also very important. To model benefit cash flows accurately, you need to understand how interest-crediting rates will be managed.

The assumption that interest rates alone drive the cash flows is undoubtedly an oversimplification. Tax considerations, for example, are also very important, but who would be brave enough to predict tax law changes? It is important to

understand that models are only approximations to reality. This is why I believe it is necessary basically to take a conservative approach in developing each cash flow.

Other cash flows, which are dependent on the major product and investment cash flows, such as expenses, FIT, and future surrender benefits, will also be dependent on the interest scenarios. Once you have developed the logic of your cash flow model, you should quickly begin to appreciate just how much the overall cash flows will move.

Developing formulas that predict lapses or calls as interest rates shift really gets you right into the nuts and bolts of cash flow analysis. In the example that I will present momentarily, the lapses are assumed to change as indicated in Table 10-2. The underlying formula is presented in the Kolkman-Feldman report on C-3 risk for the SPDA product; we have modified it to produce a reduced lapse rate when interest rates decline.

TABLE 10-2

LAPSE

New Money Rate	Lapse Rate
9%	2.5%
14	5.0
19	13.0

Table 10-3 shows an assumed call frequency and a typical call premium formula, which is used in the upcoming example. Once call protection has expired, you can assume that the more economically advantageous it is to refinance, the more likely that borrowers will do so. Discussions with your investment staff will help you to understand how to provide realistically for calls and refunds for your particular portfolio.

TABLE 10-3

CALL

Reduction in i_n	Probability of Call
0%	0%
1	15
2	40
3+	95

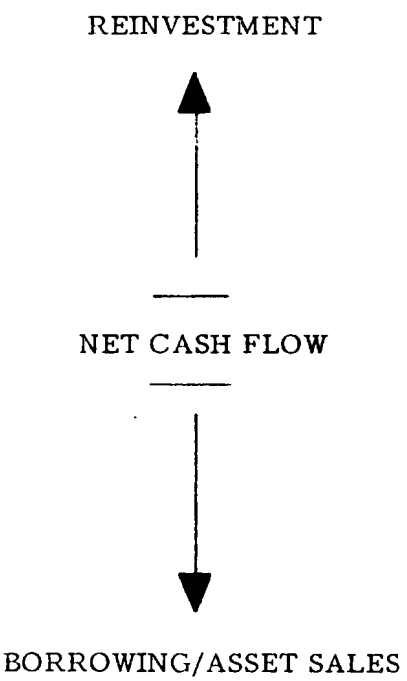
$$\text{Call Premium} = C \times \left(1 - \frac{(a - 1)}{T}\right).$$

C = Coupon.
a = Years since issue.
T = Original term of bond.

There is one other point to consider before I leave the general subject of processing cash flows (Figure 10-1). Net cash flow is simply the net of all the individual cash flows we have been considering. If net cash flow is positive, it must be reinvested; if it is negative, it is necessary to borrow or sell assets. Assumptions in this regard can materially influence results. I personally favor neutral assumptions, which apply no matter which way interest rates are going,

on the theory that few companies will be smart enough to invest short if interest rates are going up or to invest long if interest rates are going down. A 5-year bond is neither short nor long, and this is the assumption we typically use.

FIGURE 10-1



Borrowing is usually easier to handle than asset sales, largely because of FIT considerations, and it is usual to assume borrowing on the same terms as reinvestments. Refinements are possible here, but I would stress the point that assumptions in this regard should be neutral—that is, they should not take advantage of foreknowledge of the assumed trend in interest rates.

One last thought about investment cash flows concerns the difference between models, where the assets have neatly defined cash flows, and real-world portfolios, where developing the cash flows can be a challenge in its own right. The typical asset accounting system in an insurance company doesn't understand cash flows, so you will undoubtedly have to scramble a bit. Another real-world problem is control—making sure that you're looking at the same assets and liabilities. New business, trading, and commitments are some areas that should be of particular concern as you address the problem of control.

I'm going to save the final phase of cash flow modeling, interpreting cash flows, for the example. Dealing with even a single cash flow stream is messy at best. With several cash flow streams, you have the makings of a disaster. There is an obvious need to reduce the cash flow streams to manageable proportions. This can be done through an accumulation or discounting approach. I prefer the latter, as I will explain in a moment.

Let's get into an example where many of these thoughts about cash flows will come to life (Table 10-4). In order to illustrate clearly how some of the cash flows behave, I had to keep the example fairly simple. The assumptions are presented in Table 10-4. We have a 6-year compound bullet SPDA. This is perhaps an unrealistic product, but it serves to illustrate many points well. Surrenders are subject to a disappearing surrender charge, as indicated. We are dealing with a closed block of business. Investments are assumed to be in 10-year bonds with 2-year call protection. FIT and expenses have been ignored for the sake of simplicity, but this will not materially affect the usefulness of our example. We will consider three interest scenarios, imaginatively labeled low, level, and high. These are so-called pop-down and pop-up scenarios, and the

resultant impact on lapses and calls is indicated. A 50 percent probability of call was used simply to prevent all assets from rolling over at the end of 2 years, when call protection expires. The interest-crediting methodology assumes that 13 percent is credited in all cases. This is admittedly oversimplified, but it provides a meaningful basis for comparison. In practice, you would want to analyze several interest-crediting methods, recognizing the resultant impact on lapse.

TABLE 10-4

E X A M P L E

- 6-year compound bullet.
  - 13 percent guarantee.
  - S.C. - 5, 4, 3, 2, 1, 0.
- Closed block.
- 10-year bond/2-year call protection.
- Ignore FIT and expense.
- Interest scenarios:

	i_n	L	Call Probability
Low	9%	2.5%	50%
Level	14	5.0	—
High	19	13.0	—

The net cash flows for these three scenarios are shown in Table 10-5. In each case there is a $1,000 deposit at time 0. This cash flow is invested in the 10-year bond and produces the bulk of subsequent asset cash flows. The similarity ends abruptly after the deposit, as the future cash flow streams are quite dissimilar. If the "Level" column may be regarded as the "expected," the results of the low and high scenarios typify the results you may expect to see. In the "low" scenario, there is plenty of cash to invest, and in the high scenario, there is virtually none.

TABLE 10-5

NET CASH FLOW

Year	Low	Level	High
0	$ 1,000	$ 1,000	$ 1,000
1	113	86	1
2	120	94	1
3	684	102	3
4	390	111	4
5	247	120	6
6	(657)	(399)	(27)

Before addressing the significance of these different net cash flow streams, I want to look briefly at what is driving them. First, let's look at the liability cash flows, which consist simply of surrender benefits prior to year 6 and the maturity benefits at year 6 (Table 10-6). Note that the earlier cash flows reflect the assumed lapse rate relativity of 2.5, 5, and 13 percent. The interesting point is the greatly reduced maturity values in the high scenario relative to the other

scenarios. The high early surrenders have a snowballing effect that greatly depresses future maturity values.

TABLE 10-6

LIABILITY CASH FLOWS

Year	Low	Level	High
1	$ 27	$ 54	$ 139
2	30	58	139
3	33	63	138
4	37	68	137
5	41	74	136
6	1,834	1,611	1,038

The more interesting results show up on the asset side (Table 10-7). In the high scenario, the asset cash flows are restricted almost entirely to the coupon cash flows associated with the investment purchased with the original premium. With high surrenders, there is essentially no new cash to invest at the high prevailing rates. The increased asset cash flows in the level scenario reflect the effect of reinvestment of prior positive cash flows. Additionally, there is an overall greater book of business because of the reduced lapse rates. The asset cash flows in the low scenario reflect a huge influx of cash in the third through fifth years, reflecting the effect of calls. Of course, this extra cash must be invested at the lower yields assumed to be available then.

TABLE 10-7

ASSET CASH FLOW

Year	Low	Level	High
1	$ 140	$ 140	$ 140
2	150	152	140
3	714	165	141
4	427	179	141
5	288	194	142
6	1,177	1,212	1,011

One can almost sense that cash flow patterns so dissimilar have serious financial implications. The bottom line of cash flow analysis, of course, is interpreting the results. We must understand the financial implications, particularly the impact on reserve/asset levels of these disparate cash flow streams. At last year's symposium, I discussed cash flow-based surplus—CFS for short—as an appropriate methodology for discounting cash flows. CFS greatly simplifies interpretation of cash flow so I can't review the details of CFS with you now, but I would strongly urge you to study the paper that Jim Geyer and I prepared on this subject. Discounting cash flows, particularly in a nonlevel interest environment, is a very subtle problem.

Table 10-8 shows CFS results for the three scenarios. In the level scenario, the present value of the 1 percent interest margin is $52. This means that $52 of the initial $1,000 of assets could be taken as a dividend at time 0, and the remaining $948 of assets would prove just sufficient to mature all liabilities as they are

assumed to fall due. The lower CFS values for the low and high scenarios indicate a loss relative to the level scenario. In the high scenario, in fact, there is an economic loss.

TABLE 10-8

	CFS	
Low	13	(39)
Level	52	—
High	(4)	(56)

CFS does not necessarily equate directly to statutory reserves, but in this example, where the initial premium is assumed to equal the initial reserve, the equivalence holds. If good and sufficient reserves are defined to cover a ±500 basis point movement in interest rates, the valuation actuary should strengthen reserves by 0.4 percent to protect against the economic loss in the high interest scenario. If FIT and expenses were recognized, of course, the effect on reserves would be greater.

At this point, I would like to try to generalize some of the points I have made thus far and illustrate how cash flow analysis can be used to understand good and sufficient reserves. Table 10-9 was prepared by two members of my staff, Joel Thomison and Linda Dinius, and addresses this subject in some depth. In order to save time, I will not review the assumptions in detail, but they are generally consistent with those used in the example I have just reviewed. In particular, required reserves are set at a level to mature benefits, assuming a

±500 basis point movement in interest rates. I am not suggesting this as a standard for good and sufficient reserves. Rather, I want to develop a good and sufficient reserve level that is clearly on the conservative side, and I submit that ±500 basis points is conservative. The only material changes in assumptions are with the call protection, which has been reduced to 1 year, and the call probability, which has been increased to 95 percent. The kind of work involved in this example is well within the capability of any actuary who can use LOTUS.

TABLE 10-9

G + S ANALYSIS ASSUMPTIONS

- 6-year compound bullet.
  - 13 percent guarantee.
  - S.C. - 5, 4, 3, 2, 1, 0.
- Various bonds/1-year call protection.
- Ignore FIT and expense.
- Interest scenarios:

	i_n	L	Call Probability
Low	9%	2.5%	95%
High	19	13.0	—

We used a 10-year bond in our previous example, and we found somewhat greater risk in the high scenario relative to the low scenario based on the CFS results. What if we had assumed a 5-year bond or a 15-year bond? Asset cash flow surely

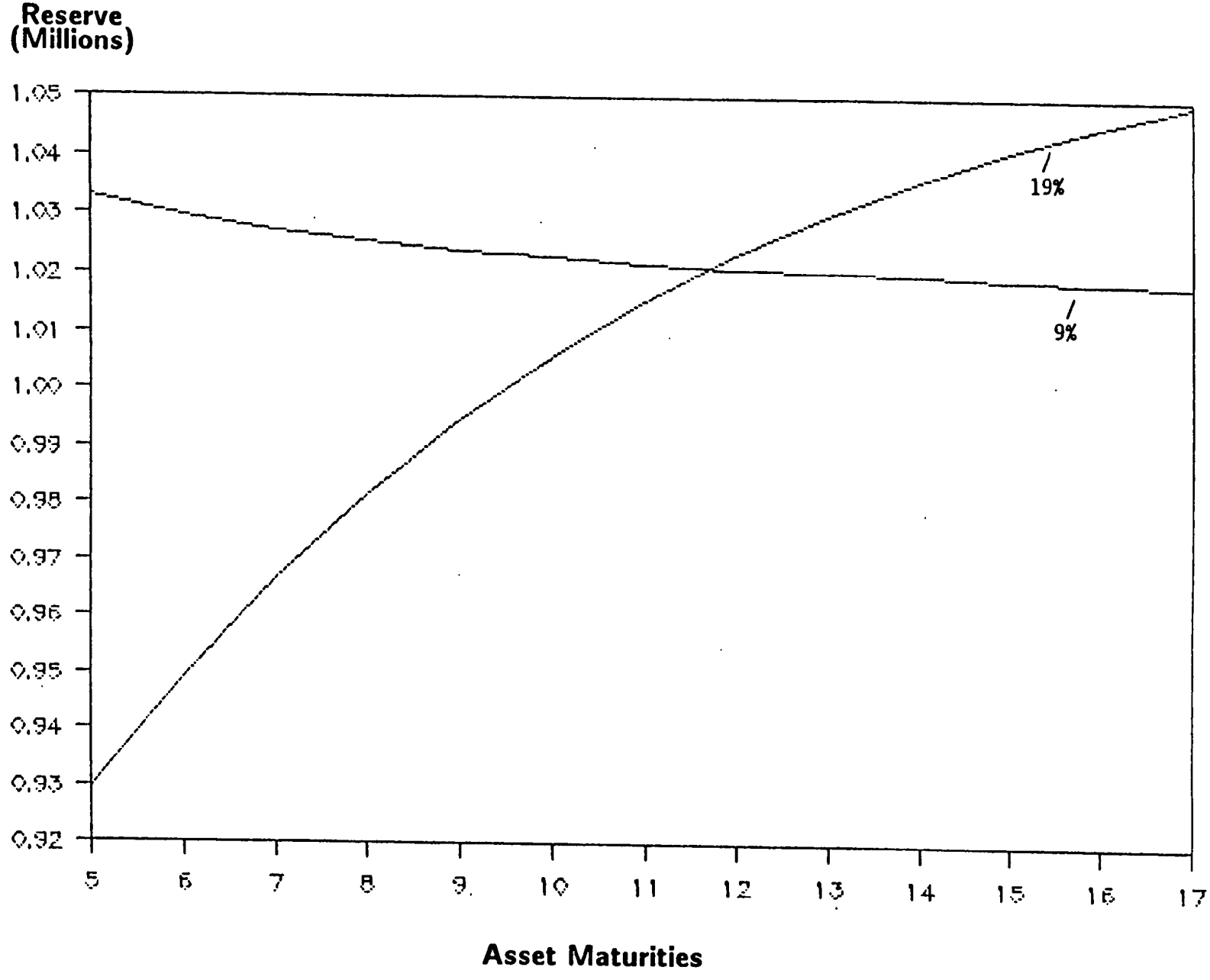
would have changed, and this suggests a corresponding change in risk and reserve levels. Once we have an operating model, it is not difficult to change the underlying asset, and we can develop some interesting graphs that show the effect on required reserves of using various assets.

Figure 10-2 shows reserve requirements for the low (9 percent) and high (19 percent) scenarios, and you can immediately begin to see how the choice of assets affects the good and sufficient reserves. In an increasing interest scenario, short assets are great, since you can capitalize on high reinvestment rates. As the assets lengthen, there is less and less gain from reinvestment, and required reserves/assets increase accordingly.

In a decreasing interest scenario, long assets, naturally enough, produce the more favorable result. The call assumption used in this example essentially eliminates asset length as a factor in determining the required reserves in the downside case; essentially all assets are called when the 1-year call protection expires.

The required reserve for any given asset maturity is simply the higher of the reserve required in the low or high interest scenario, as illustrated by the highlighted line in Figure 10-3. For any given product, you should be able to develop a comparable relationship between required reserves and asset maturities.

The intersection of the two lines suggests that there is an optimal asset that would produce a minimum required reserve. In this example, it is a bond with a maturity of between 11 and 12 years. I believe this simple example illustrates why the valuation actuary must eventually be more involved in the formulation


Reserve
(Millions)
1.05
1.04
1.03
1.02
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1.00
0.99
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0.97
0.96
0.95
0.94
0.93
0.92
19%
9%
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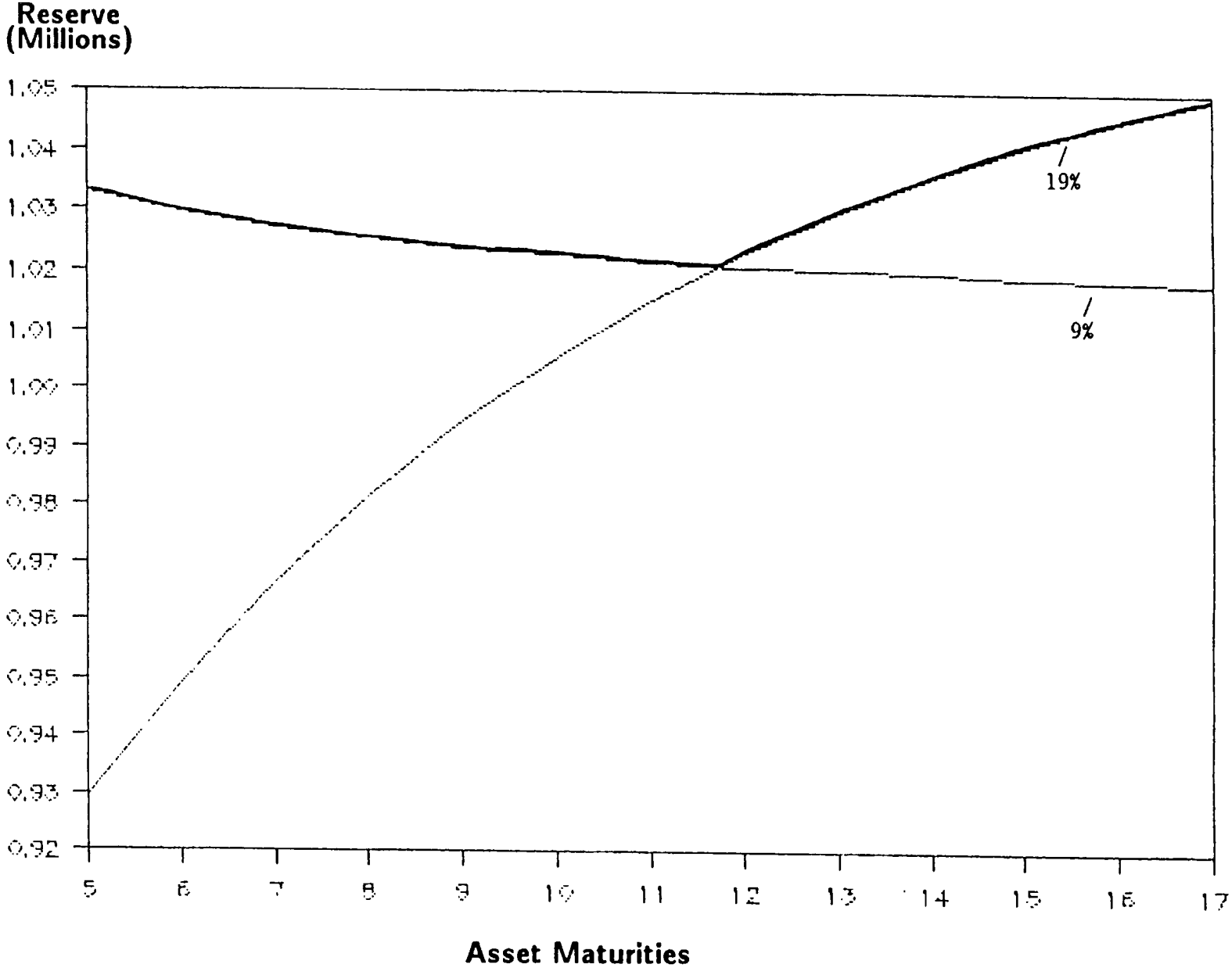
17
Asset Maturities

FIGURE 10-2


Reserve
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19%
9%
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15
16
17
Asset Maturities

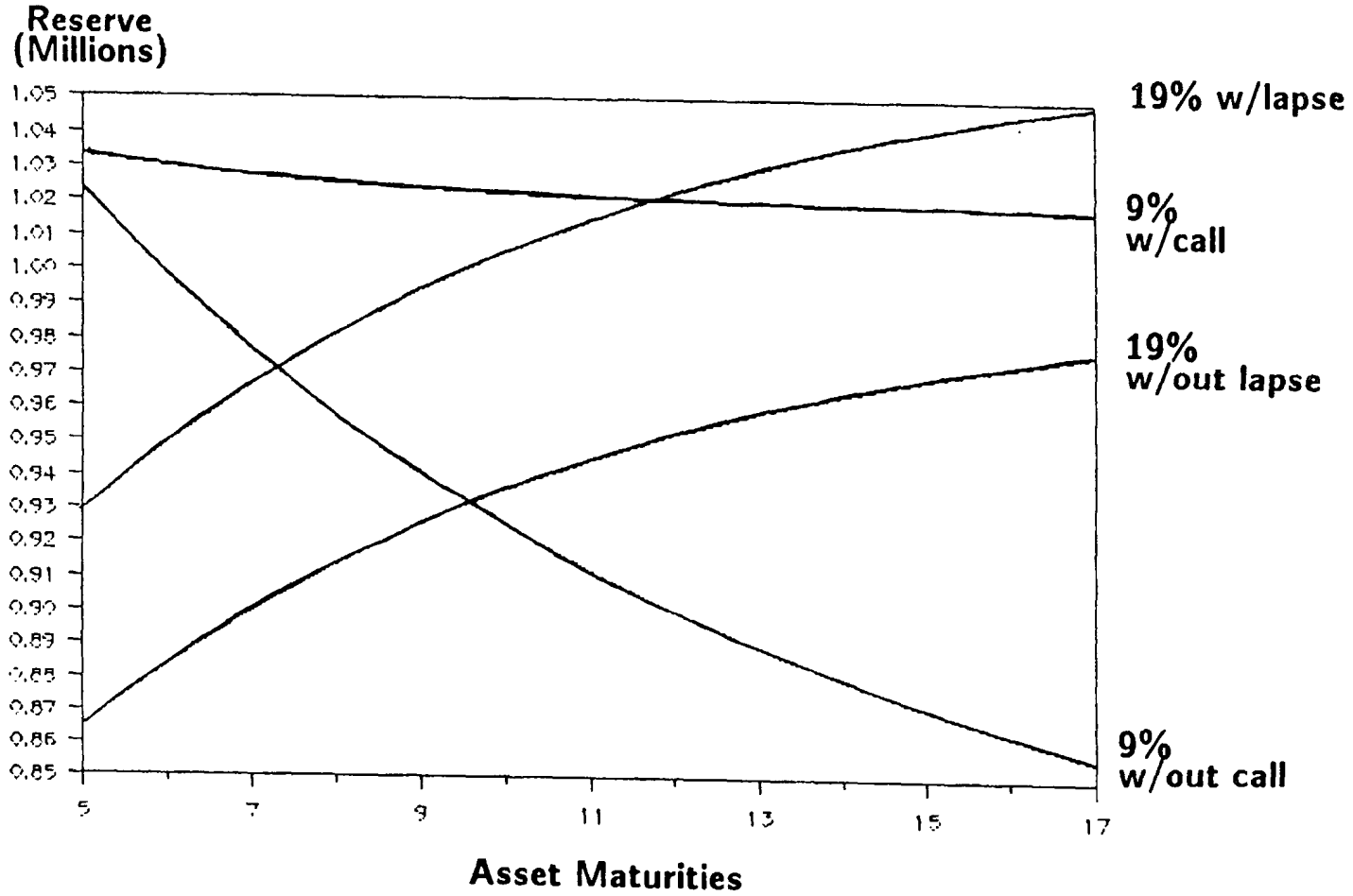
FIGURE 10-3

of investment policy. The choice of the investment to support a particular product is very important, and it simply cannot be assumed that short assets are better than long assets or vice versa.

In our example thus far we have assumed that both asset and liability cash flows can shift because of the effect of calls and lapses, respectively. What if the product were defined so that lapse was not permitted? Suppose also that assets could be purchased where there was no risk of call. What would happen to required reserves?

Figure 10-4 shows that, as would be expected, the overall level of required reserves declines in both the high and low interest scenarios. It is interesting to note that the shape of the high interest line remains virtually unchanged—there is simply a parallel downward shift. When the risk of call is eliminated, there is a dramatic change in the shape and slope of the curve in the low interest case. The advantage of long assets in a declining interest rate scenario is plainly apparent. The intersection of these lines again suggests an optimal asset that will minimize required reserves for this particular combination of product and investment cash flows. Given the greater range of the required reserve, the higher of the reserve required in the low or high interest scenario, it is obviously more important to have the valuation actuary involved in the formulation of investment policy before the fact.

The four curves in Figure 10-5 effectively define the boundaries of a good and sufficient reserve for any combination of asset call and product lapse assumptions less severe than that defined by the first set of curves. Note that the interaction of the upside and downside risks makes it impossible to pick up


Reserve
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0.88
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0.86
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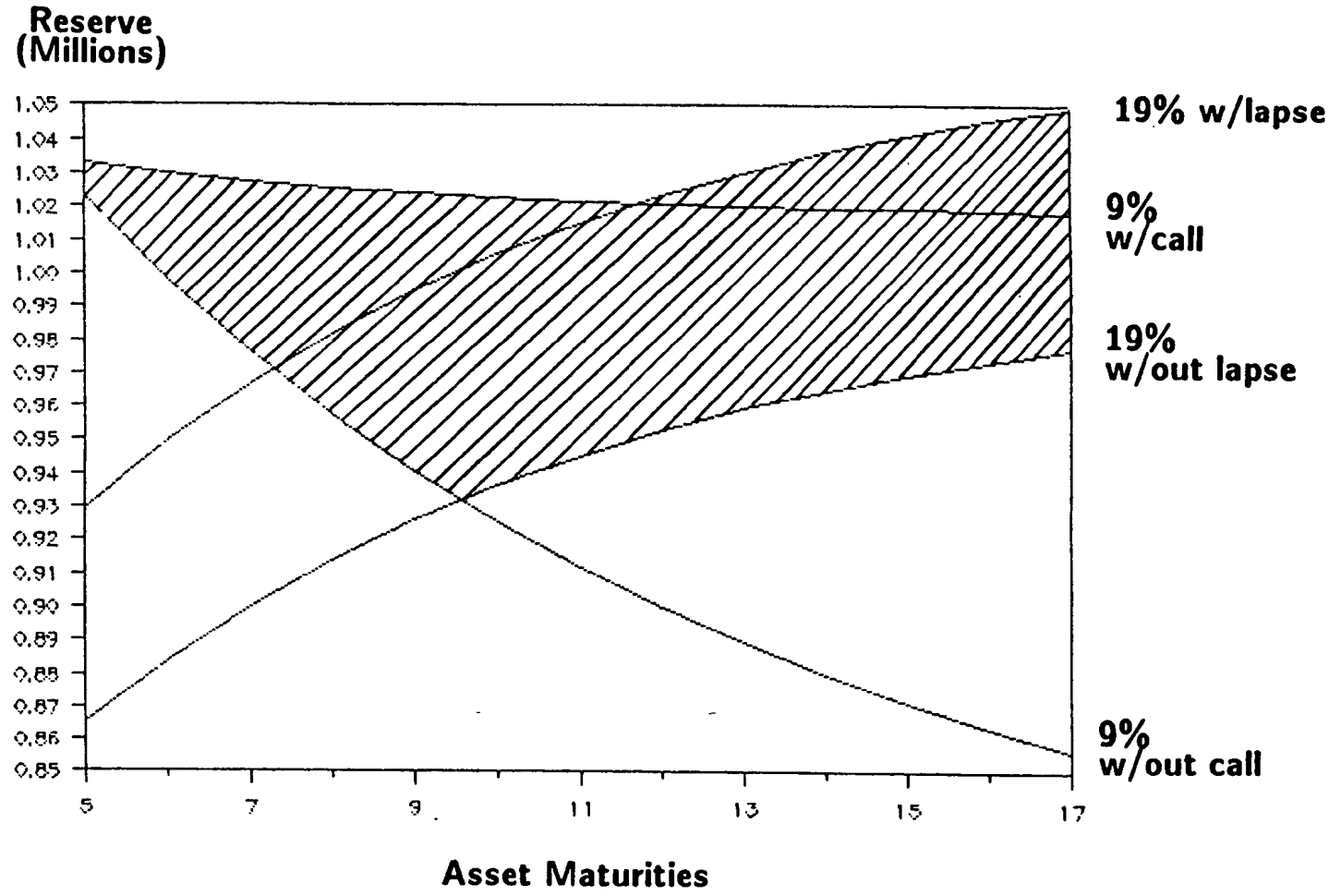
5
7
9
11
13
15
17
Asset Maturities
19% w/lapse
9%
w/call
19%
w/out lapse
9%
w/out call

FIGURE 10-4


Reserve
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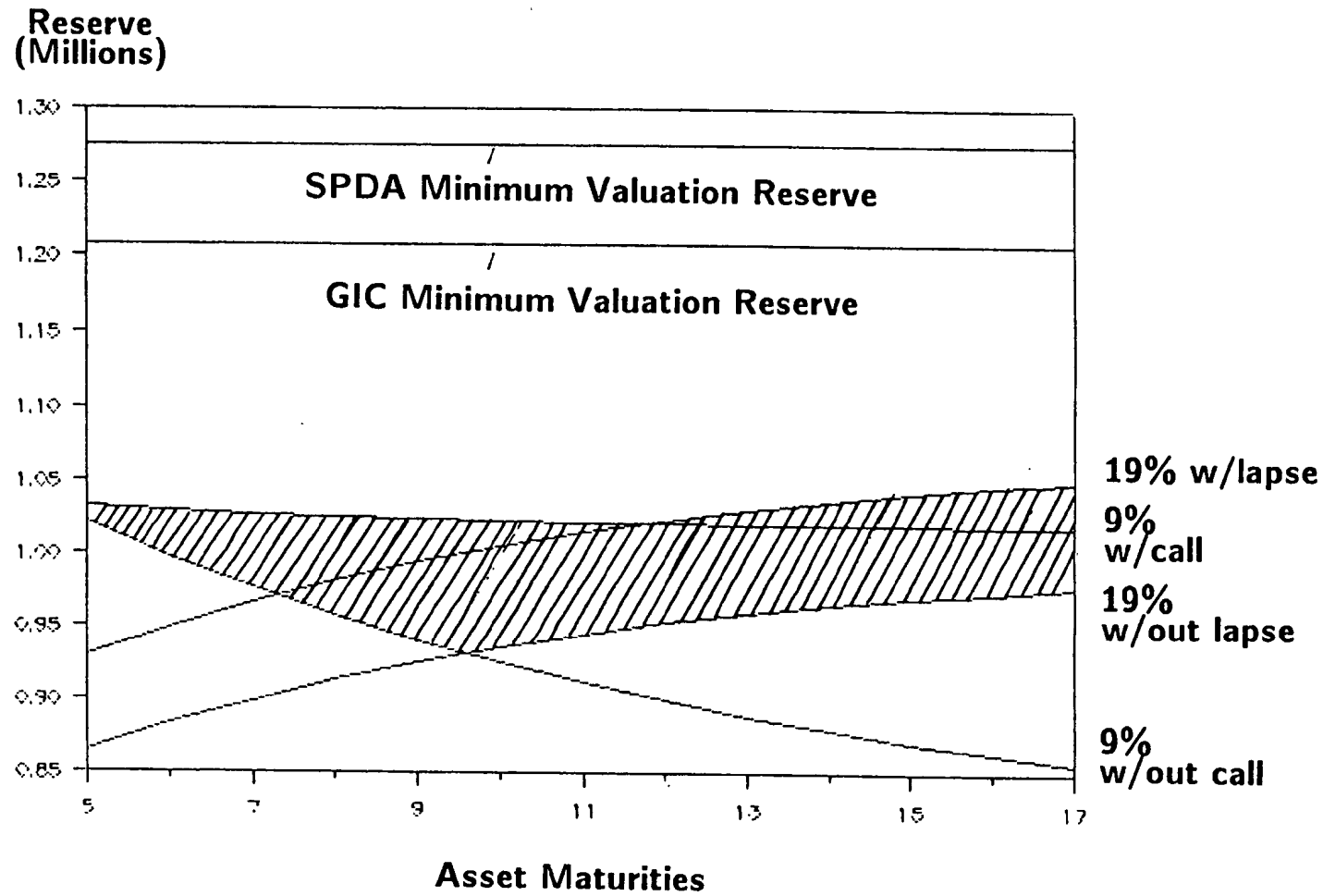
0.89
0.88
0.87
0.86
0.85
5
7
9
11
13
15
17
Asset Maturities
19% w/lapse
9%
w/call
19%
w/out lapse
9%
w/out call

FIGURE 10-5

the benefit of long assets in a declining interest environment or of short assets in an increasing interest environment. Note also that the required reserve varies over a range of about 7 percent. I think we can all agree that a 7 percent difference in reserve levels is material. If I were the valuation actuary for a company that had minimized risk, I certainly would like to reap the benefit by holding a lower statement reserve.

It is interesting to look at where current statutory minimums are relative to these reserves, which is illustrated in Figure 10-6. I think the graph speaks for itself; current minimums are really ultraconservative, given that the good and sufficient reserve represented by the shaded area has been designed to survive a ±500 basis point change in interest rates. This is a typical relationship between current statutory minimums and good and sufficient reserves for many products. Unless valuation laws are overhauled to get minimum standards closer to good and sufficient reserves, I see no basis for expecting the valuation actuary concept to endure. There would simply be no gain for what amounts to considerable pain. Ideally, I think companies that control risk should get a better break on reserves than companies that do not. Thus, simply reducing the statutory minimum to, say, 1.05 would not do the job. The only practical way to achieve the goal of directly relating reserve levels to the underlying risks is to place greater reliance on the findings of the valuation actuary. I think the charge to the valuation actuary should be to find the point in the shaded area that appropriately reflects the combination of lapse and call risk for his company.

The cash flows underlying Figure 10-7 also help us to understand the limitations associated with Macaulay duration, which is a subject that has received considerable recent attention. The intersection of the no call/no lapse lines


Reserve
(Millions)
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1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
SPDA Minimum Valuation Reserve
GIC Minimum Valuation Reserve
19% w/lapse
9%
w/call
19%
w/out lapse
9%
w/out call
5
7
9
11
13
15
17
Asset Maturities

FIGURE 10-6

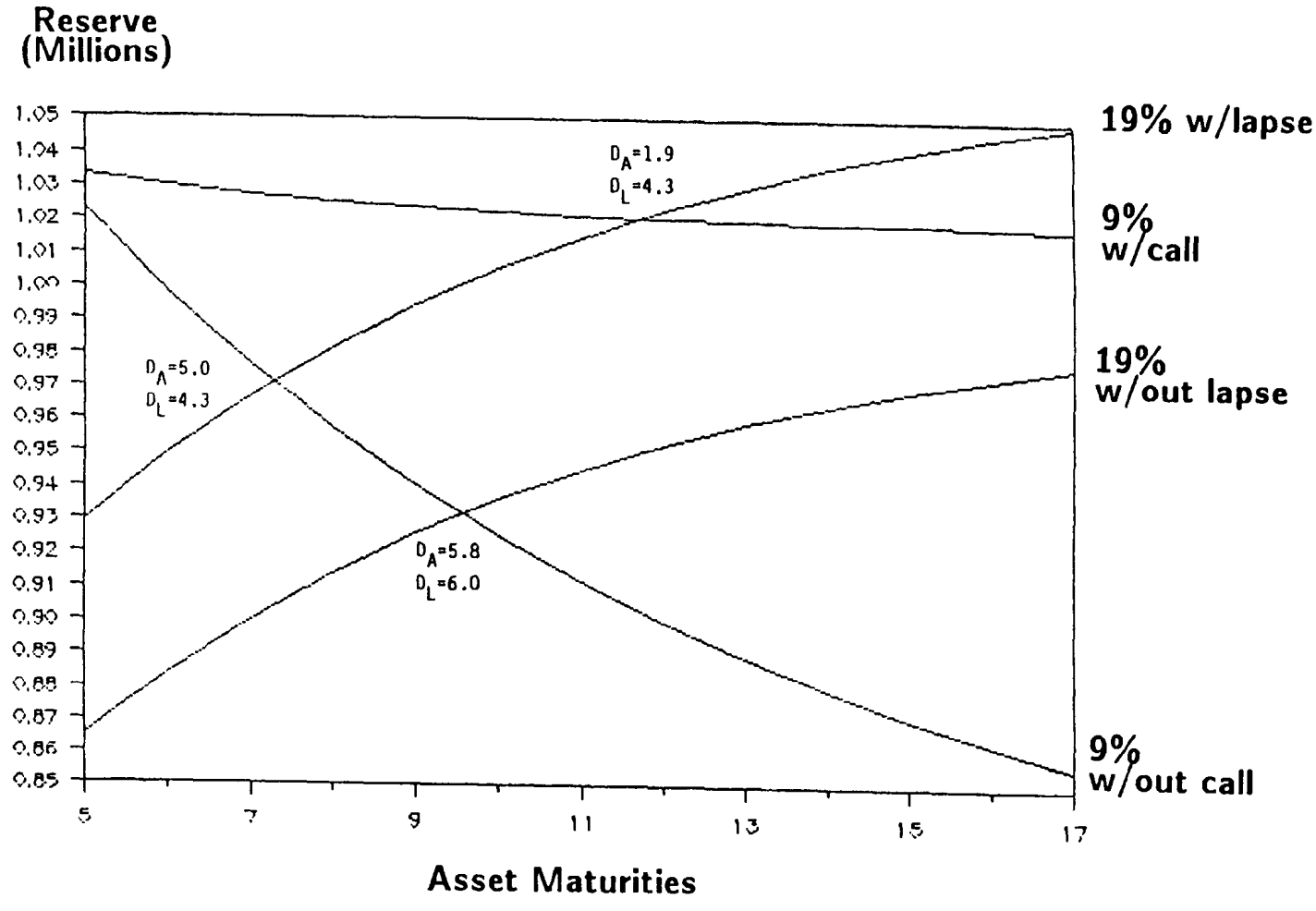

Reserve
(Millions)
1.05
1.04
1.03
1.02
1.01
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
0.89
0.88
0.87
0.86
0.85
5
7
9
11
13
15
17
Asset Maturities
D_A=1.9
D_L=4.3
D_A=5.0
D_L=4.3
D_A=5.8
D_L=6.0
19% w/lapse
9%
w/call
19%
w/out lapse
9%
w/out call

FIGURE 10-7

represents assets and liabilities that are reasonably well matched on a Macaulay duration basis. A bond with a 9-1/2-year maturity has a duration of 5.8, and the duration of a 6-year bullet liability is, of course, 6.0. As you move to the next intersection, the duration of the shorter asset declines to 5.0, and the duration of the liability declines to 4.3. The change in the duration of the liability from 6.0 to 4.3 gives some indication of the underlying volatility of the liability cash flows. When you move to the third intersection, the duration of the liabilities remains at 4.3, while the duration of the assets drops to 1.9. Call risk produces the greatest potential for cash flow shift in this example. All of these durations are calculated, incidentally, at 14 percent.

The fact that the cash flows can shift so much is the reason that simply matching Macaulay durations does not necessarily ensure that mismatch risk is contained. Option pricing theory, which is what Joe Buff would have talked about, attempts to put a single value on this potential of the asset and liability cash flows to shift, and we will certainly hear more about this in the years to come.

I have only covered a fraction of the material that is in the formal report, and I would encourage you to study the report carefully, with particular attention to the need for rebalancing at each policy anniversary. I have used "required reserve" and "good and sufficient reserve" interchangeably in my presentation, but I want to stress that they are not necessarily the same. Additionally, good and sufficient reserves do not necessarily equate to statutory or GAAP. The concept of good and sufficient reserves is truly a dynamic one, and we undoubtedly still have much to learn. It will certainly provide a challenge to

valuation actuaries in the future. I think it is clear that this challenge can only be met when we truly master the nuts and bolts of cash flow analysis.

MR. JOSEPH J. BUFF: The theory behind duration analysis as a tool for C-3 risk management is presented in my chapter for the Valuation Actuary Handbook. Attendees of the 1986 Symposium for the Valuation Actuary were sent as advance reading a panel discussion talk I presented at the Society's 1986 Boston meeting. Both pieces explain how

1. Option pricing techniques can be used to determine a market value for an asset or liability, even if the cash flows are interest sensitive.

2. Duration can be defined as a measurement of the sensitivity of market value to interest rate changes. This extends Macaulay duration to cash flows that are a function of interest rates.

3. Adjusting the relationship between asset and liability durations can immunize profit targets against future interest rate movements, at least approximately. Thus, duration analysis can be used to measure and control C-3 risk exposure.

My materials for the Proceedings of the 1986 Symposium for the Valuation Actuary summarize the rationale behind duration analysis and then present the results of a duration analysis for a specific, representative block of new issues of a typical single premium deferred annuity product. Several blocks of business can be combined using the "aggregation property" described below. Although the test case shown here assumed 0 profit margin for simplicity, the calculations

could just as easily have included a profit target such as 3 percent of premium deposit or 0.25 percent of cash value per year.

The materials consist of the following:

1. A description of the case study product design and assumptions, as well as quantitative results and general conclusions.

2. A practical discussion of how to implement asset/liability management.

3. Table 10-10, the 40 interest rate scenarios used to test the results of the duration analysis by application of a traditional simulations analysis.

4. Figure 10-8, which discusses duration and convexity, documents the input and output of the test case SPDA, and demonstrates the pitfalls of using Macaulay duration to try to analyze interest-sensitive cash flows.

5. Figure 10-9, which graphically displays the results of the simulations testing of the duration analysis model.

Very briefly, the duration analysis and its testing by a traditional simulations model demonstrate the following:

1. Option pricing methods allow the pricing of an SPDA (that is, setting of interest rates credited to policyholders) and the setting of investment strategy (that is, selecting assets whose duration matches the liability duration) so that profitability can be immunized against future interest rate volatility, at least approximately.

2. Macaulay duration can give seriously misleading information about C-3 risk exposure when liabilities and/or assets are interest sensitive.

3. The simulations testing showed that average present value of book profit over 20 years was very close to 0, where the credited rates recommended by the duration analysis for "breaking even" were used at issue and subsequently reset by formula. Thus, traditional simulations modeling verifies that option pricing theory is a valuable aid to product pricing in an environment of volatile interest rates.

4. The simulations testing showed that the dispersion of present value of book profit was minimized when the initial product cash flow was invested in an asset whose duration matched the initial liability duration. Thus, traditional simulations modeling verifies that duration analysis is a valuable aid to setting investment strategies that reduce interest rate risk. If liability durations had been recomputed periodically and the asset portfolio's duration rebalanced accordingly, an even greater level of immunization (reduced dispersion of profit across scenarios) would have been obtained.

5. It should be noted that the benefits of duration analysis and duration matching are not limited to SPDA products. Even products that are not very "interest sensitive," such as some GICs or structured settlement annuities, are exposed to C-3 risk if asset and liability durations are not held in proper balance.

SINGLE PREMIUM DEFERRED ANNUITIES

I. Case definition.

A. Product specifications.

1. $20,000 single premium.

2. Interest rate.

a. Initial rate guaranteed 3 years.
b. Ultimate guarantee: 3.5 percent.
c. Rates reset annually beginning year 4.

3. Surrender charges.

a. Seven percent, graded down to 0 percent over 7 years.
b. Free surrender of 10 percent of cash value.

B. Assumptions.

1. Per-policy expenses: $100 acquisition, $25 maintenance inflating at 90-day interest rate less 3.00 percent.

2. Commissions: 6 percent premium, chargebacks during first 12 months.

3. Lapse rate: 5 percent all years, plus interest sensitive excess lapses.

4. Federal income tax: 36.8 percent of gain from operations.

5. Reserves: equal cash surrender values.

6. Mortality: none assumed.

C. Traditional pricing results.

1. Break-even interest spread is 0.60 percent.

2. Current (3/31/86) interest environment does not allow spread to be earned at issue with competitive rate. Three choices:

   a. Credit low rate: no sales.
   b. Invest higher-yielding, riskier assets.
   c. Accept initial loss; make it up on renewals.

D. Key baseline assumptions for the SPDA duration model.

1. Valuation date is 3/31/86. The starting yield curve in pricing the cash flows was the 3/31/86 yield curve for A-rated noncallable corporate bonds (7.07 percent for three-month bonds; 8.10 percent for ten-year bonds).

2. Interest-sensitive excess lapses are ten times the excess of competitor rate over credited rate, with a maximum of 30 percent annually. No excess lapse if interest rate differential is less than 0.25 percent. The lapse function also assumes that policyholders will want to break even on the surrender charge over a 3-year period.

3. Competitor rate each quarter is larger of A-rated, three-month and ten-year new money rates, minus a margin. The margin begins at 1 percent to produce an initial competitor rate of 9.25 percent annual, effective at 3/31/86, and it grades to 1 percent over the first two years of the projections, to reflect a "correction" toward historical margin levels.

4. Calculations are on a "break-even" basis (that is, 0 profit margin).

II. SPDA duration analysis.

A. General model for pricing interest-sensitive cash flow streams produces quantifiers of the product's risk/return posture.

1. Market value of liability.

2. Duration of liability.

3. Convexity of liability.

B. Uses of the risk/return quantifiers.

1. Setting credited rates and margins, profit targets (pricing).

2. Choosing investment strategies.

3. Comparing product design alternatives.

4. Comparing credited rate reset strategies.

C. Applying the general model.

1. Pricing: iterate on initial credited rate and/or renewal margin until the liability market value equals the premium deposit.

2. Investment strategies: duration and convexity of the liabilities establish targets for the asset portfolio's duration and convexity.

D. Determining a credited rate strategy.

1. This is critical to the design and administration of the product.

2. Rules must be set for use by the model.

3. Meeting this requirement helps management focus on definable credited rate strategy questions.

4. Will a portfolio earning rate, an external reference ("index"), or a combination of both drive the renewal credited rates?

5. What about piercing the bailout (if any)?

E. Model used to analyze some representative crediting rate strategies.

1. Reset off of five-year A-rated new money rate once yearly, after initial rate is fixed for the first three policy years.

2. A renewal margin of 200 basis points (2 percent) will be subtracted from this new money rate.

3. Mark to market strategy: move SPDA credited rate up and down to track changes in the five-year rate net of the margin.

4. Downward ratchet: credited rate is the lesser of the five-year rate net of margin and the previous credited rate. Thus, the only way this rate can change is to decrease.

F. Review of quantitative results from running the model.

1. For a break-even initial credited rate of 8.1 percent, the mark to market crediting rate strategy produces a market value liability equal to the $20,000 premium deposit. The initial duration is 2.3 years, and the initial convexity is 25.2 years squared.

2. For a break-even initial credited rate of 8.5 percent, the downward ratchet crediting rate strategy produces a market value liability equal to the $20,000 premium deposit. The initial duration is 2.5 years, and the initial convexity is 26.1 years squared.

3. All else being equal, the downward ratchet strategy allows a higher initial credited rate than the mark to market strategy.

4. Sensitivity testing shows that raising lapses, all else being equal, increases the market value liability. Raising the initial credited rate, all else being equal, also increases the market value liability.

G. Some observations and recommendations.

1. Calculations take account of the entire starting yield curve.

2. Acquisition costs are amortized over the entire 20-year projection period.

3. The calculations tentatively suggest that the most profitable product strategy would use a downward ratchet method.

4. The cost of raising credited rates to control lapses exceeds the costs of allowing lapses to occur. May not work for recurring premium or front-end load products.

5. Crediting strategy has critical impact on the product's risk/return posture.

H. Pitfalls of Macaulay duration.

1. The Macaulay duration of scenarios' flows can be used to estimate the duration of the SPDA (or other interest-sensitive) liability.

2. Macaulay duration gives the wrong answer for the duration of a put option (SPDA withdrawal guarantees).

3. For sample SPDA, the Macaulay duration exceeded the correct duration by an average of about four years.

I. Conclusions.

1. Duration matching can be used to immunize the ratio of surplus to liabilities. Duration matching is a dynamic strategy, especially if interest rates change rapidly.

2. Macaulay duration along interest rate scenarios will not give useful information about the duration of the liability.

3. Policyholder interest-crediting strategy has critical impact on the financial performance of the SPDA.

4. For single premium, rear-end load products, it is generally more profitable to allow lapses to occur than it is to raise credited rates in order to discourage lapses.

III. SPDA simulation analysis.

A. Cash flow projections use the same interest rate scenarios as the duration model.

1. Lattice path, not random walk.

2. Three-month and 10-year rates are listed in Table 10-10.

B. Regular and interest-sensitive assumptions are the same as for duration model analysis.

C. Graphs of results are in Figure 10-9.

1. Three sets of results.

a. Baseline assumptions: mark to market reset.
b. Baseline assumptions: downward ratchet rate.
c. Mark to market: lapse sensitivity test.

2. Each graph has five lines.

a. Top line indicates best result among 40 scenarios.
b. Second line indicates 20th percentile.
c. Middle line indicates median result.
d. Fourth line indicates 80th percentile.
e. Fifth line indicates worst result among 40 scenarios.

D. Interpretation of results.

1. Baseline assumption results verify that duration model produces answer with least variation in results.

2. The median present value of book profits at 8 percent is close to zero, but not exactly:

a. Simulations used static strategies.
b. Values are statutory profits.

3. Higher lapses lower median values.

a. Give more cost to withdrawal put option.
b. "Worst case" not much affected, because not much in force.

IMPLEMENTATION OF ASSET/LIABILITY MANAGEMENT

I. Asset systems requirements.

- A. Market values.
  - 1. How computed?
  - 2. How often?
- B. Durations.
  - 1. Macaulay or price change?
  - 2. Convexity.
- C. Asset segmentation.
- D. Internal coupon stripping.

II. Asset data requirements.

- A. Basic requirements.
  - 1. Asset description.
  - 2. Coupon.
  - 3. Maturity or reset date?
  - 4. Periodicity.
  - 5. Call/put provisions.
    - a. Schedules.
    - b. Refunding versus cash call.
  - 6. Sinking fund provisions.
- B. Other considerations.
  - 1. Private placements.
    - a. Market values.
    - b. Redemption provisions.
  - 2. Mortgage pass-throughs.
    - a. Collateral.
    - b. Pool number.

3. CMOs.

   a. Issuer.
   b. Collateral.
   c. Payment schedule.

4. Commercial and residential mortgages.

   a. Prepayment protection.
   b. Collateral.

III. Liability data requirements.

A. "Masterfile" data.

1. Valuation cell characteristics—variations by the following:

   a. Policy form.
   b. Issue month (or quarter) and issue year.
   c. Sex and issue age.

2. Data needed for each valuation cell.

   a. Number of policies in force.
   b. Current accumulation value.
   c. Current credited rates.
   d. Bailout rates.

B. Pricing assumptions.

1. Conventional assumptions.

   a. Commissions and expenses.
   b. Mortality rates.
   c. Lapse rates.
   d. Annuitization rates.
   e. Policyholder election rates if significant choices, such as period of rate guarantee upon renewal, can be made.

2. Interest sensitivity assumptions.

   a. Competitive environment.
   b. Lapse rates.

      i. Policy lapses, for single premium and recurring premium products.

      ii. Premium stop-pays, for recurring premium products.

   c. Policy loan rates, if applicable.
   d. Credited rate reset strategy.

i. Portfolio basis—single rate or generation.

ii. External reference—contractual or judgmental.

iii. Rules for using (a) and (b) to get reset rates.

e. Expense inflation.
f. New sales, if an open block is being modeled.

IV. Practical aspects of asset/liability management.

A. Postauditing: what reports do you need to keep track of?

1. Economic forecast/scenario.

a. Interest rate forecast/assumptions.
b. Inflation forecast.

2. Cash flow variance report.

a. Investment income.
b. Maturities and amortization.
c. Cash from operations.
d. Surrenders.
e. Policy loans.

3. Portfolio mix.

a. Taxable bonds.

i. Less than 1 year.
ii. 1 year to 5 years.
iii. Medium term.
iv. Long term.

b. Tax-exempt bonds.
c. Mortgages.
d. Common stock (market).
e. Preferred stock (market).
f. Policy loans.
g. Money market.

4. Interest-sensitive reserve projections.

a. Universal life.
b. SPDA.
c. Interest-sensitive whole life.

B. Asset segmentation.

1. Actual allocation by product—real portfolio.

2. Notational segmentation—paper portfolio.
3. Problems of segmentation.

    a. Too few assets.
    b. Recognition of capital gains.
    c. Interest-credited subsidy.

4. Considerations in restructuring a portfolio.

C. Organization and communication: managing the credited rate.

1. Who should be on the team—marketing officer, investment officer, actuary, CEO.

2. Setting investment policy.

    a. Insurance considerations.
    b. Investment considerations.
    c. Match the insurance considerations to the investment considerations.

3. Team effort.

    a. Asset/liability management process.

4. Avoiding common errors in asset/liability management.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

TABLE 10-10 A

SCENARIO	Q1/1	Q2/1	Q3/1	Q4/1	Q1/2	Q2/2	Q3/2	Q4/2	Q1/3	Q2/3	Q3/3	Q4/3	Q1/4	Q2/4	Q3/4	Q4/4	Q1/5	Q2/5	Q3/5	Q4/5
1	7.07	7.80	7.27	6.82	7.48	7.04	6.81	7.23	6.55	7.10	6.62	7.19	7.76	8.42	9.14	9.91	11.03	12.00	11.22	10.50
	8.10	8.35	8.17	8.01	8.24	8.07	7.84	8.11	7.88	8.15	7.92	8.20	8.42	8.68	9.01	9.44	9.95	10.55	9.98	9.50
2	7.07	7.80	8.46	9.23	8.71	8.19	7.69	8.41	7.61	7.10	7.71	8.36	9.04	8.42	9.14	9.91	11.03	12.00	11.22	10.50
	8.10	8.35	8.68	9.09	8.75	8.48	8.29	8.53	8.33	8.15	8.38	8.63	8.96	8.68	9.01	9.44	9.95	10.55	9.98	9.50
3	7.07	7.80	7.27	7.93	8.71	9.53	10.41	11.40	12.01	13.04	12.15	13.19	14.26	15.48	14.42	13.44	12.84	12.00	13.07	12.22
	8.10	8.35	8.17	8.42	8.75	9.16	9.66	10.23	10.90	11.66	10.97	11.75	12.62	13.60	12.71	11.91	11.19	10.55	11.23	10.57
4	7.07	7.80	8.46	7.93	7.48	8.19	7.69	8.41	8.86	8.26	8.97	9.73	10.52	9.80	10.63	9.91	11.03	12.00	13.07	14.23
	8.10	8.35	8.68	8.42	8.24	8.48	8.29	8.53	8.85	8.58	8.91	9.33	9.83	9.38	9.90	9.44	9.95	10.55	11.23	12.00
5	7.07	7.80	7.27	7.93	7.48	8.19	7.69	8.41	7.61	7.10	7.71	7.19	6.67	6.22	6.75	7.32	7.00	6.54	6.12	5.73
	8.10	8.35	8.17	8.42	8.24	8.48	8.29	8.53	8.33	8.15	8.38	8.20	7.97	7.69	8.01	8.28	8.04	7.75	7.43	7.09
6	7.07	7.80	7.27	6.82	7.48	8.19	7.69	7.23	6.55	7.10	7.71	8.36	9.04	8.42	9.14	9.91	9.47	8.86	9.64	10.50
	8.10	8.35	8.17	8.01	8.24	8.48	8.29	8.11	7.88	8.15	8.38	8.63	8.96	8.68	9.01	9.44	9.06	8.76	9.09	9.50
7	7.07	7.80	8.46	7.93	8.71	9.53	10.41	11.40	10.31	11.20	12.15	13.19	14.26	15.48	16.80	15.66	17.42	16.29	17.73	16.58
	8.10	8.35	8.68	8.42	8.75	9.16	9.66	10.23	9.71	10.30	10.97	11.75	12.62	13.60	14.70	13.70	14.80	13.78	14.86	13.81
8	7.07	7.80	7.27	6.82	7.48	7.04	7.69	8.41	7.61	7.10	6.62	7.19	6.67	7.24	7.85	7.32	8.14	8.86	9.64	10.50
	8.10	8.35	8.17	8.01	8.24	8.07	8.29	8.53	8.33	8.15	7.92	8.20	7.97	8.24	8.47	8.28	8.51	8.76	9.09	9.50
9	7.07	7.80	8.46	9.23	10.13	11.09	10.41	11.40	12.01	11.20	10.44	9.73	10.52	9.80	9.14	9.91	9.47	8.86	9.64	9.02
	8.10	8.35	8.68	9.09	9.59	10.17	9.66	10.23	10.90	10.30	9.77	9.33	9.83	9.38	9.01	9.44	9.06	8.76	9.09	8.77
10	7.07	7.80	8.46	7.93	7.48	7.04	7.69	7.23	6.55	6.11	6.62	6.18	6.67	7.24	6.75	7.32	7.00	7.61	7.12	7.75
	8.10	8.35	8.68	8.42	8.24	8.07	8.29	8.11	7.88	7.62	7.92	7.66	7.97	8.24	8.01	8.28	8.04	8.31	8.06	8.33
11	7.07	7.80	8.46	7.93	8.71	8.19	8.95	9.79	10.31	9.62	10.44	9.73	10.52	9.80	10.63	9.91	9.47	10.31	9.64	9.02
	8.10	8.35	8.68	8.42	8.75	8.48	8.81	9.22	9.71	9.27	9.77	9.33	9.83	9.38	9.90	9.44	9.06	9.48	9.09	8.77
12	7.07	7.80	8.46	9.23	10.13	9.53	8.95	9.79	8.86	8.26	7.71	7.19	6.67	7.24	7.85	8.52	9.47	8.86	8.28	7.75
	8.10	8.35	8.68	9.09	9.59	9.16	8.81	9.22	8.85	8.58	8.38	8.20	7.97	8.24	8.47	8.72	9.06	8.76	8.53	8.33
13	7.07	7.80	7.27	7.93	8.71	8.19	7.69	7.23	7.61	8.26	7.71	7.19	7.76	7.24	6.75	6.29	7.00	6.54	6.12	6.66
	8.10	8.35	8.17	8.42	8.75	8.48	8.29	8.11	8.33	8.58	8.38	8.20	8.42	8.24	8.01	7.73	8.04	7.75	7.43	7.77
14	7.07	7.80	7.27	7.93	8.71	9.53	8.95	8.41	8.86	8.26	8.97	8.36	9.04	8.42	7.85	8.52	9.47	10.31	9.64	10.50
	8.10	8.35	8.17	8.42	8.75	9.16	8.81	8.53	8.85	8.58	8.91	8.63	8.96	8.68	8.47	8.72	9.06	9.48	9.09	9.50
15	7.07	7.80	7.27	6.82	7.48	8.19	8.95	8.41	7.61	7.10	6.62	7.19	7.76	7.24	6.75	6.29	6.01	6.54	6.12	6.66
	8.10	8.35	8.17	8.01	8.24	8.48	8.81	8.53	8.33	8.15	7.92	8.20	8.42	8.24	8.01	7.73	7.42	7.75	7.43	7.77

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

TABLE 10-10 B

SCENARIO	Q1/6	Q2/6	Q3/6	Q4/6	Q1/7	Q2/7	Q3/7	Q4/7	Q1/8	Q2/8	Q3/8	Q4/8	Q1/9	Q2/9	Q3/9	Q4/9	Q1/10	Q2/10	Q3/10	Q4/10
1	9.40	8.76	8.16	7.61	8.25	7.69	7.17	6.68	7.34	7.97	8.65	8.08	7.54	8.18	7.64	7.13	6.66	7.23	7.87	8.54
	9.10	8.79	8.57	8.37	8.80	8.40	8.14	7.84	8.15	8.42	8.64	8.42	8.15	8.42	8.14	7.83	7.49	7.81	8.10	8.35
2	9.40	10.20	9.50	8.85	8.25	7.69	8.34	7.77	8.54	7.97	7.44	8.08	7.54	7.03	6.57	6.13	6.66	7.23	6.76	6.31
	9.10	9.52	9.13	8.83	8.60	8.40	8.62	8.41	8.64	8.42	8.16	8.42	8.15	7.84	7.50	7.14	7.49	7.81	7.47	7.11
3	12.74	13.82	14.99	13.97	15.16	16.44	15.32	14.27	13.48	14.64	15.91	17.29	16.13	17.52	19.06	20.71	19.33	18.02	16.83	18.28
	11.25	12.04	12.93	12.10	12.99	13.99	13.04	12.19	11.42	12.21	13.09	14.08	13.09	14.05	15.12	16.29	15.06	13.94	12.93	13.83
4	14.84	16.11	17.47	18.97	20.59	19.17	17.85	16.63	15.70	14.64	15.91	14.84	13.84	12.91	12.05	13.09	14.24	15.46	16.83	18.28
	12.87	13.86	14.97	16.19	17.54	16.27	15.11	14.04	13.08	12.21	13.09	12.21	11.42	10.73	10.12	10.70	11.36	12.10	12.93	13.83
5	5.13	5.56	6.03	5.62	6.10	5.68	6.16	6.68	6.31	6.85	6.39	5.97	6.48	6.05	6.57	7.13	7.75	7.23	7.87	8.54
	6.74	7.11	7.47	7.13	7.48	7.14	7.50	7.84	7.51	7.85	7.51	7.16	7.51	7.15	7.50	7.83	8.12	7.81	8.10	8.35
6	9.40	8.76	9.50	10.30	9.60	8.94	8.34	9.04	9.94	9.27	10.07	9.40	10.21	11.09	12.05	13.09	12.23	11.40	12.40	11.57
	9.10	8.79	9.13	9.56	9.16	8.85	8.62	8.87	9.21	8.88	9.22	8.88	9.21	9.62	10.12	10.70	10.09	9.57	10.04	9.52
7	14.84	13.82	12.87	11.99	13.01	12.12	13.15	12.25	11.58	12.57	13.65	12.74	11.89	12.91	14.03	13.09	12.23	13.27	12.40	13.47
	12.87	12.04	11.30	10.65	11.35	10.69	11.39	10.72	10.14	10.74	11.43	10.74	10.14	10.73	11.40	10.70	10.09	10.65	10.04	10.59
8	10.94	10.20	11.06	11.99	13.01	14.11	15.32	14.27	13.48	14.64	13.65	12.74	11.89	12.91	12.05	13.09	14.24	13.27	14.44	15.69
	10.00	9.52	10.04	10.65	11.35	12.14	13.04	12.19	11.42	12.21	11.43	10.74	10.14	10.73	10.12	10.70	11.36	10.65	11.30	12.02
9	8.08	8.76	9.50	10.30	11.18	10.41	11.29	12.25	11.58	10.79	11.73	12.74	11.89	12.91	14.03	15.25	16.59	18.02	16.83	15.69
	8.54	8.79	9.13	9.56	10.08	9.59	10.11	10.72	10.14	9.83	10.14	10.74	10.14	10.73	11.40	12.18	13.01	13.94	12.93	12.02
10	8.94	8.47	8.03	8.54	7.09	7.69	7.17	7.77	8.54	9.27	10.07	9.40	10.21	11.09	12.05	11.24	12.23	11.40	10.65	11.57
	8.07	7.78	7.47	7.81	8.12	8.40	8.14	8.41	8.64	8.88	9.22	8.88	9.21	9.62	10.12	9.60	10.09	9.57	9.14	9.52
11	9.40	8.76	9.50	8.85	8.25	7.69	7.17	6.68	6.31	6.85	6.39	6.94	7.54	8.18	7.64	7.13	6.66	6.22	5.81	5.42
	9.10	8.79	9.13	8.83	8.60	8.40	8.14	7.84	7.51	7.85	7.51	7.85	8.15	8.42	8.14	7.83	7.49	7.13	6.77	6.40
12	8.94	8.47	7.02	6.54	6.10	6.61	6.16	6.68	6.31	6.85	7.44	6.94	6.48	6.05	5.65	6.13	5.73	5.35	5.00	5.42
	8.07	7.78	8.10	7.81	7.48	7.82	7.50	7.84	7.51	7.85	8.16	7.85	7.51	7.15	6.79	7.14	6.78	6.41	6.04	6.40
13	8.94	7.53	7.02	6.54	6.10	6.61	6.16	6.68	7.34	7.97	7.44	8.08	8.77	9.52	8.89	8.30	9.02	8.41	7.87	8.54
	8.07	8.35	8.10	7.81	7.48	7.82	7.50	7.84	8.15	8.42	8.16	8.42	8.64	9.88	9.63	8.40	8.61	8.38	8.10	8.35
14	10.94	11.87	11.06	10.30	11.18	12.12	11.29	12.25	13.48	12.57	11.73	10.94	11.89	11.09	12.05	11.24	10.50	9.79	10.65	9.94
	10.00	10.60	10.04	9.56	10.08	10.69	10.11	10.72	11.42	10.74	10.14	9.83	10.14	9.62	10.12	9.60	9.18	8.83	9.14	8.79
15	8.94	8.47	8.03	8.54	8.10	8.68	8.30	4.94	8.43	8.89	8.50	8.13	4.79	8.20	8.65	8.27	8.73	8.22	8.76	8.31
	8.07	7.78	7.47	7.81	7.48	7.14	6.78	6.42	6.79	7.16	6.80	6.43	6.06	6.43	6.79	6.42	6.78	7.13	7.47	7.11

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/11	Q2/11	Q3/11	Q4/11	Q1/12	Q2/12	Q3/12	Q4/12	Q1/13	Q2/13	Q3/13	Q4/13	Q1/14	Q2/14	Q3/14	Q4/14	Q1/15	Q2/15	Q3/15	Q4/15
1	8.25	7.65	7.11	7.68	8.29	8.98	9.68	8.98	9.71	10.49	11.34	10.53	11.38	10.56	11.42	12.33	11.46	12.38	11.49	10.67
	8.54	8.34	8.10	8.37	8.60	8.85	9.19	8.89	9.23	9.65	10.17	9.69	10.21	9.73	10.25	10.87	10.30	10.92	10.34	9.88
2	6.09	5.66	5.26	5.67	6.13	5.69	6.15	6.64	7.17	6.68	7.20	6.68	7.22	7.80	8.43	9.10	9.84	9.14	9.87	10.67
	7.45	7.12	6.77	7.14	7.50	7.17	7.53	7.87	8.19	7.90	8.22	7.94	8.26	8.54	8.77	9.03	9.38	9.07	9.42	9.86
3	17.66	16.37	15.20	16.43	15.23	14.15	13.12	14.18	15.34	16.58	15.38	16.63	17.98	19.44	21.04	22.75	21.11	19.59	18.17	16.86
	14.82	13.80	12.87	13.85	12.92	12.08	11.34	12.13	13.02	14.01	13.07	14.06	15.17	16.39	17.73	19.21	17.81	16.53	15.36	14.31
4	17.66	19.08	17.71	16.43	15.23	16.48	17.81	19.25	17.87	19.32	17.93	19.38	20.96	22.67	21.04	22.75	24.63	26.65	24.71	26.75
	14.82	16.01	14.88	13.85	12.92	13.90	14.99	16.19	15.04	16.25	15.10	16.32	17.66	19.13	17.73	19.21	20.83	22.60	20.92	22.70
5	8.25	8.91	9.63	10.40	11.23	10.43	11.27	10.46	11.31	10.49	11.34	10.53	9.77	10.56	11.42	10.59	9.84	10.64	9.87	9.17
	8.54	8.79	9.12	9.54	10.05	9.58	10.08	9.62	10.13	9.65	10.17	9.69	9.30	9.73	10.25	9.77	9.38	9.82	9.42	9.11
6	9.60	8.91	9.63	8.93	8.29	7.70	7.15	7.72	7.17	7.75	8.37	9.04	9.77	9.07	8.43	9.10	9.84	9.14	8.48	7.88
	9.09	8.79	9.12	8.82	8.60	8.40	8.16	8.44	8.19	8.47	8.70	8.96	9.30	8.99	8.77	9.03	9.38	9.07	8.85	8.65
7	11.17	10.37	9.63	10.40	9.65	8.96	9.68	8.98	8.35	7.75	8.37	7.77	7.22	6.70	7.24	6.72	7.27	6.75	6.27	6.77
	9.98	9.51	9.12	9.54	9.16	8.85	9.19	8.89	8.67	8.47	8.70	8.50	8.26	7.97	8.29	8.00	8.33	8.04	7.72	8.07
8	13.01	14.05	15.20	16.43	17.75	19.21	17.81	16.52	17.87	19.32	17.93	19.38	17.98	19.44	18.05	16.73	18.11	16.80	18.17	16.86
	11.22	11.99	12.87	13.85	14.93	16.13	14.99	13.95	15.04	16.25	15.10	16.32	15.17	16.39	15.23	14.18	15.30	14.24	15.36	14.31
9	15.15	16.37	17.71	16.43	15.23	14.15	15.28	16.52	17.87	19.32	17.93	16.63	17.98	16.68	15.49	14.36	15.54	16.80	18.17	19.65
	12.82	13.80	14.88	13.85	12.92	12.08	12.96	13.95	15.04	16.25	15.10	14.06	15.17	14.12	13.18	12.33	13.23	14.24	15.36	16.60
10	9.60	10.37	9.63	10.40	11.23	10.43	9.68	10.46	9.71	9.02	9.74	10.53	9.77	9.07	8.43	7.82	7.27	7.85	8.48	9.17
	9.09	9.51	9.12	9.54	10.05	9.58	9.19	9.62	9.23	8.92	9.26	9.69	9.30	8.99	8.77	8.58	8.33	8.61	8.85	9.11
11	5.24	5.66	5.26	4.88	5.27	4.90	4.54	4.22	3.92	3.64	3.93	4.25	4.59	4.95	5.35	4.97	5.37	4.99	5.39	5.01
	6.75	7.12	6.77	6.42	6.80	6.45	6.10	5.75	5.41	5.09	5.44	5.80	6.17	6.55	6.93	6.58	6.96	6.61	7.00	6.64
12	5.24	5.66	5.26	4.88	5.27	5.69	5.28	4.91	4.58	4.92	4.57	4.94	5.33	4.95	5.35	4.97	4.62	4.99	4.63	5.01
	6.75	7.12	6.77	6.42	6.80	7.17	6.82	6.47	6.12	6.50	6.15	6.52	6.91	6.55	6.93	6.58	6.23	6.61	6.25	6.64
13	7.09	6.58	6.11	5.67	5.27	4.90	4.54	4.22	4.58	4.23	3.93	3.65	3.94	4.26	3.96	4.27	3.97	3.69	3.99	4.31
	8.07	7.79	7.47	7.14	6.80	6.45	6.10	5.75	6.12	5.78	5.44	5.11	5.46	5.82	5.48	5.85	5.51	5.17	5.53	5.90
14	8.25	8.91	8.27	8.93	9.65	10.43	9.68	10.46	11.31	10.49	11.34	12.26	11.38	12.29	11.42	12.33	11.46	12.38	11.49	12.42
	8.54	8.79	8.57	8.82	9.16	9.58	9.19	9.62	10.13	9.65	10.17	10.78	10.21	10.82	10.25	10.87	10.30	10.92	10.34	10.97
15	5.24	5.66	6.11	5.67	6.13	5.69	5.28	5.71	5.30	5.73	6.19	5.74	5.33	4.95	5.35	4.97	4.62	4.99	5.39	5.82
	6.75	7.12	7.47	7.14	7.50	7.17	6.82	7.20	6.85	7.22	7.59	7.25	6.91	6.55	6.93	6.58	6.23	6.61	7.00	7.38

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 C

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/16	Q2/16	Q3/16	Q4/16	Q1/17	Q2/17	Q3/17	Q4/17	Q1/18	Q2/18	Q3/18	Q4/18	Q1/19	Q2/19	Q3/19	Q4/19	Q1/20	Q2/20	Q3/20	Q4/20
1	9.91	9.20	8.55	9.23	9.99	10.79	10.03	10.84	11.72	10.87	11.76	10.93	10.15	9.43	8.76	8.14	7.56	8.17	8.84	8.21
	9.47	9.16	8.93	9.20	9.56	10.01	9.61	10.06	10.60	10.11	10.66	10.17	9.76	9.45	9.22	9.03	8.77	9.08	9.34	9.14
2	11.53	12.47	11.58	12.51	13.54	14.63	15.83	14.70	13.64	12.66	13.70	14.82	13.78	12.78	13.83	14.95	13.88	15.01	13.95	15.08
	10.39	11.02	10.44	11.07	11.80	12.62	13.55	12.69	11.92	11.24	11.98	12.82	12.05	11.37	12.12	12.97	12.19	13.05	12.27	13.13
3	18.23	19.72	21.35	23.09	21.43	23.17	21.51	19.96	18.52	20.03	18.60	17.26	18.68	20.21	21.89	23.68	25.64	23.79	22.09	20.49
	15.43	16.68	18.05	19.56	18.14	19.66	18.23	16.93	15.74	17.02	15.83	14.75	15.91	17.21	18.63	20.20	21.92	20.32	18.86	17.52
4	28.95	31.34	29.08	31.46	34.10	31.58	34.23	37.09	40.19	37.21	34.51	37.39	34.66	37.56	34.84	37.73	34.97	32.42	30.10	32.58
	24.66	26.80	24.78	26.93	29.29	27.06	29.44	32.04	34.89	32.20	29.75	32.38	29.91	32.56	30.08	32.75	30.25	27.97	25.88	28.14
5	8.51	9.20	8.55	9.23	8.58	7.96	8.61	9.31	8.65	9.34	8.68	9.39	10.15	10.97	10.20	11.02	10.24	11.07	10.29	11.12
	8.89	9.16	8.93	9.20	8.98	8.78	9.02	9.29	9.07	9.34	9.12	9.40	9.76	10.22	9.82	10.29	9.88	10.35	9.94	10.41
6	8.51	7.91	8.55	9.23	9.99	10.79	11.67	10.84	11.72	10.87	11.76	10.93	10.15	10.97	10.20	9.47	8.80	8.17	8.84	8.21
	8.89	8.69	8.93	9.20	9.56	10.01	10.55	10.06	10.60	10.11	10.66	10.17	9.76	10.22	9.82	9.51	9.28	9.08	9.34	9.14
7	6.29	6.80	6.32	5.86	6.34	5.89	5.47	5.08	5.49	5.10	5.52	5.96	6.44	5.99	5.57	5.17	4.80	4.46	4.83	5.22
	7.75	8.11	7.79	7.45	7.83	7.49	7.13	6.77	7.17	6.81	7.21	7.61	8.00	7.65	7.29	6.93	6.56	6.20	6.60	7.01
8	18.23	19.72	21.35	19.80	21.43	23.17	21.51	19.96	21.60	20.03	18.60	20.13	21.78	20.21	21.89	23.68	21.97	20.39	18.95	17.58
	15.43	16.68	18.05	16.78	18.14	19.66	18.23	16.93	18.33	17.02	15.83	17.11	18.53	17.21	18.63	20.20	18.74	17.41	16.20	15.10
9	18.23	19.72	18.31	16.98	18.38	19.87	21.51	23.28	21.60	20.03	18.60	20.13	18.68	20.21	21.89	20.30	18.84	17.49	18.95	17.58
	15.43	16.68	15.51	14.44	15.68	16.84	18.23	19.76	18.33	17.02	15.83	17.11	15.91	17.21	18.63	17.31	16.10	15.01	16.20	15.10
10	8.51	7.91	7.35	6.82	7.38	7.96	7.40	8.00	8.65	9.34	10.11	9.39	10.15	10.97	11.87	11.02	10.24	11.07	11.98	11.12
	8.89	8.69	8.44	8.15	8.48	8.78	8.53	8.83	9.07	9.34	9.71	9.40	9.76	10.22	10.78	10.29	9.88	10.35	10.91	10.41
11	4.65	4.32	4.02	4.34	4.03	4.35	4.05	3.76	3.49	3.77	4.08	3.41	4.10	4.43	4.79	4.44	4.80	4.46	4.15	3.86
	6.28	5.93	5.58	5.98	5.61	5.99	5.64	5.30	4.98	5.33	5.70	6.09	5.73	6.12	6.52	6.16	6.56	6.20	5.84	5.49
12	5.41	5.02	5.43	5.86	5.45	5.89	6.36	6.88	6.39	5.93	6.41	6.93	6.44	5.99	5.57	6.01	5.59	6.04	5.62	6.07
	7.03	6.67	7.06	7.45	7.10	7.49	7.87	8.23	7.91	7.57	7.95	8.32	8.00	7.65	7.29	7.70	7.34	7.74	7.38	7.79
13	4.65	4.32	4.02	3.73	3.47	3.74	3.48	3.23	3.49	3.24	3.02	2.80	3.03	2.82	2.62	2.43	2.63	2.84	2.64	2.85
	6.28	5.93	5.58	5.25	4.92	5.27	4.95	4.64	4.98	4.68	4.37	4.08	4.39	4.11	3.84	3.59	3.86	4.16	3.89	4.19
14	11.53	12.47	13.49	12.51	11.63	12.56	13.59	12.62	11.72	10.87	10.11	9.39	8.72	8.10	8.76	8.14	8.80	9.51	8.84	8.21
	10.39	11.02	11.74	11.07	10.49	11.13	11.85	11.18	10.60	10.11	9.71	9.40	9.17	8.97	9.22	9.03	9.28	9.56	9.34	9.14
15	8.29	8.80	7.35	6.82	7.38	6.85	7.40	6.88	6.39	6.90	7.46	6.93	6.44	6.96	7.53	8.44	8.80	8.17	8.84	8.21
	7.75	8.11	8.44	8.15	8.48	8.19	8.53	8.23	7.91	8.28	8.62	8.32	8.00	8.37	8.72	9.03	9.28	9.08	9.34	9.14

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 D

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/1	Q2/1	Q3/1	Q4/1	Q1/2	Q2/2	Q3/2	Q4/2	Q1/3	Q2/3	Q3/3	Q4/3	Q1/4	Q2/4	Q3/4	Q4/4	Q1/5	Q2/5	Q3/5	Q4/5
16	7.07	7.80	8.46	9.23	8.71	9.53	8.95	9.79	10.31	9.62	8.97	9.73	9.04	8.42	7.85	7.32	8.14	7.61	7.12	7.75
	8.10	8.35	8.68	9.09	8.75	9.16	8.81	9.22	9.71	9.27	8.91	9.33	8.96	8.68	8.47	8.28	8.51	8.31	8.06	8.33
17	7.07	7.80	8.46	7.93	7.48	7.04	6.61	7.23	7.61	8.26	7.71	7.19	7.76	8.42	9.14	9.91	9.47	8.86	8.28	7.75
	8.10	8.35	8.68	8.42	8.24	8.07	7.84	8.11	8.33	8.58	8.38	8.20	8.42	8.68	9.01	9.44	9.06	8.76	8.53	8.33
18	7.07	7.80	8.46	7.93	8.71	9.53	8.95	9.79	10.31	11.20	12.15	13.19	12.24	13.29	14.42	15.66	14.95	16.29	17.73	19.32
	8.10	8.35	8.68	8.42	8.75	9.16	8.81	9.22	9.71	10.30	10.97	11.75	11.05	11.83	12.71	13.70	12.80	13.78	14.86	16.04
19	7.07	7.80	7.27	6.82	6.43	7.04	7.69	7.23	6.55	7.10	7.71	7.19	6.67	7.24	6.75	6.29	6.01	5.63	5.26	5.73
	8.10	8.35	8.17	8.01	7.80	8.07	8.29	8.11	7.88	8.15	8.38	8.20	7.97	8.24	8.01	7.73	7.42	7.08	6.73	7.09
20	7.07	7.80	7.27	6.82	6.43	6.05	6.61	7.23	6.55	7.10	7.71	7.19	6.67	7.24	7.85	7.32	7.00	7.61	8.28	9.02
	8.10	8.35	8.17	8.01	7.80	7.54	7.84	8.11	7.88	8.15	8.38	8.20	7.97	8.24	8.47	8.28	8.04	8.31	8.53	8.77
21	7.07	6.70	7.27	7.93	7.48	8.19	8.95	8.41	8.86	8.26	8.97	8.36	7.76	7.24	6.75	6.29	6.01	5.63	6.12	6.66
	8.10	7.95	8.17	8.42	8.24	8.48	8.81	8.53	8.85	8.58	8.91	8.63	8.42	8.24	8.01	7.73	7.42	7.08	7.43	7.77
22	7.07	6.70	6.25	5.86	6.43	7.04	7.69	7.23	7.61	8.26	7.71	7.19	6.67	7.24	6.75	6.29	6.01	5.63	6.12	6.66
	8.10	7.95	7.74	7.49	7.80	8.07	8.29	8.11	8.33	8.58	8.38	8.20	7.97	8.24	8.01	7.73	7.42	7.08	7.43	7.77
23	7.07	6.70	7.27	6.82	6.43	6.05	5.68	5.34	4.84	4.51	4.90	4.57	4.24	3.96	4.29	4.65	5.17	5.63	5.26	5.73
	8.10	7.95	8.17	8.01	7.80	7.54	7.25	6.94	6.61	6.27	6.64	6.30	5.96	5.62	5.98	6.35	6.72	7.08	6.73	7.09
24	7.07	6.70	6.25	6.82	7.48	7.04	7.69	7.23	6.55	7.10	6.62	6.18	5.74	6.22	5.80	6.29	6.01	5.63	5.26	4.92
	8.10	7.95	7.74	8.01	8.24	8.07	8.29	8.11	7.88	8.15	7.92	7.66	7.35	7.69	7.39	7.73	7.42	7.08	6.73	6.37
25	7.07	6.70	7.27	6.82	7.48	7.04	7.69	7.23	7.61	8.26	7.71	8.36	9.04	9.80	9.14	8.52	9.47	10.31	11.22	12.22
	8.10	7.95	8.17	8.01	8.24	8.07	8.29	8.11	8.33	8.58	8.38	8.63	8.96	9.38	9.01	8.72	9.06	9.48	9.98	10.57
26	7.07	6.70	7.27	7.93	7.48	7.04	7.69	8.41	8.86	8.26	7.71	7.19	6.67	7.24	6.75	6.29	7.00	7.61	7.12	6.66
	8.10	7.95	8.17	8.42	8.24	8.07	8.29	8.53	8.85	8.58	8.38	8.20	7.97	8.24	8.01	7.73	8.04	8.31	8.06	7.77
27	7.07	6.70	6.25	6.82	6.43	6.05	5.68	5.34	5.63	5.25	4.90	4.57	4.24	3.96	3.69	4.00	3.82	4.16	3.89	4.23
	8.10	7.95	7.74	8.01	7.80	7.54	7.25	6.94	7.28	6.97	6.64	6.30	5.96	5.62	5.29	5.64	5.30	5.65	5.31	5.66
28	7.07	6.70	7.27	7.93	7.48	8.19	7.69	7.23	7.61	8.26	8.97	8.36	9.04	8.42	7.85	8.52	8.14	7.61	7.12	6.66
	8.10	7.95	8.17	8.42	8.24	8.48	8.29	8.11	8.33	8.58	8.91	8.63	8.96	8.68	8.47	8.72	8.51	8.31	8.06	7.77
29	7.07	6.70	6.25	5.86	5.53	5.20	5.68	5.34	4.84	5.25	5.69	6.18	5.74	6.22	6.75	6.29	7.00	7.61	7.12	7.75
	8.10	7.95	7.74	7.49	7.21	6.90	7.25	6.94	6.61	6.97	7.32	7.66	7.35	7.69	8.01	7.73	8.04	8.31	8.06	8.33
30	7.07	6.70	6.25	6.82	7.48	8.19	7.69	8.41	8.86	9.62	8.97	9.73	9.04	8.42	9.14	8.52	9.47	8.86	9.64	9.02
	8.10	7.95	7.74	8.01	8.24	8.48	8.29	8.53	8.85	9.27	8.91	9.33	8.96	8.68	9.01	8.72	9.06	8.76	9.09	8.77

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 E

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

TABLE 10-10 F

SCENARIO	Q1/6	Q2/6	Q3/6	Q4/6	Q1/7	Q2/7	Q3/7	Q4/7	Q1/8	Q2/8	Q3/8	Q4/8	Q1/9	Q2/9	Q3/9	Q4/9	Q1/10	Q2/10	Q3/10	Q4/10
16	6.94	7.53	7.02	7.61	8.25	7.69	7.17	7.77	7.34	6.85	6.39	6.94	6.48	6.05	6.57	6.13	5.73	6.22	5.81	5.42
	8.07	8.35	8.10	8.37	8.60	8.40	8.14	8.41	8.15	7.85	7.51	7.85	7.51	7.15	7.50	7.14	6.78	7.13	6.77	6.40
17	8.08	7.53	7.02	7.61	7.09	6.61	7.17	6.68	7.34	6.85	6.39	5.97	6.48	6.05	5.65	6.13	5.73	6.22	6.76	6.31
	8.54	8.35	8.10	8.37	8.12	7.82	8.14	7.84	8.15	7.85	7.51	7.16	7.51	7.15	6.79	7.14	6.78	7.13	7.47	7.11
18	17.29	16.11	14.99	13.97	13.01	12.12	11.29	12.25	13.48	12.57	13.65	14.84	13.84	12.91	14.03	15.25	14.24	15.46	14.44	13.47
	14.89	13.86	12.93	12.10	11.35	10.69	10.11	10.72	11.42	10.74	11.43	12.21	11.42	10.73	11.40	12.16	11.36	12.10	11.30	10.59
19	5.13	4.79	5.19	4.83	5.24	5.68	6.16	6.68	6.31	5.89	5.50	5.13	4.79	5.20	4.86	4.53	4.83	5.35	5.81	6.31
	6.74	6.39	6.76	6.40	6.77	7.14	7.50	7.84	7.51	7.16	6.80	6.43	6.06	6.43	6.06	6.70	6.05	6.41	6.77	7.11
20	8.08	8.76	9.50	10.30	9.60	8.94	9.70	9.04	8.54	7.97	8.65	9.40	10.21	11.09	10.35	11.24	10.50	11.40	10.65	11.57
	8.54	8.79	9.13	9.56	9.16	8.85	9.19	8.87	8.64	8.42	8.64	8.88	9.21	9.62	9.20	9.60	9.18	9.57	9.14	9.52
21	8.94	7.53	8.16	8.85	8.25	8.94	9.70	10.52	9.94	9.27	8.65	9.40	10.21	9.52	10.35	11.24	12.23	11.40	10.65	9.94
	8.07	8.35	8.57	8.83	8.60	8.85	9.19	9.62	9.21	8.88	8.64	8.88	9.21	8.88	9.20	9.60	10.09	9.57	9.14	8.79
22	8.94	8.47	7.02	7.61	8.25	8.94	8.34	9.04	8.54	9.27	10.07	9.40	10.21	11.09	12.05	13.09	12.23	11.40	12.40	13.47
	8.07	7.78	8.10	8.37	8.60	8.85	8.62	8.87	8.64	8.88	9.22	8.88	9.21	9.62	10.12	10.70	10.09	9.57	10.04	10.59
23	5.13	4.79	4.46	4.83	4.51	4.20	4.55	4.94	5.43	5.06	4.73	4.41	4.79	4.47	4.18	3.90	4.24	4.60	5.00	4.66
	6.74	6.39	6.03	6.40	6.04	5.69	6.06	6.42	6.79	6.43	6.07	5.71	6.06	5.71	5.36	5.02	5.35	5.69	6.04	5.68
24	4.41	4.12	3.84	3.58	3.33	3.61	3.92	4.25	4.67	5.06	4.73	5.13	5.57	6.05	6.57	6.13	5.73	5.35	5.00	4.66
	6.02	5.67	5.33	5.00	4.68	5.01	5.35	5.70	6.06	6.43	6.07	6.43	6.79	7.15	7.50	7.14	6.78	6.41	6.04	5.68
25	12.74	11.87	11.06	11.99	11.18	12.12	11.29	10.52	11.58	10.79	11.73	12.74	11.89	12.91	12.05	11.24	10.50	11.40	10.65	9.94
	11.25	10.60	10.04	10.65	10.08	10.69	10.11	9.62	10.14	9.63	10.14	10.74	10.14	10.73	10.12	9.60	9.18	9.57	9.14	8.79
26	8.94	7.53	7.02	6.54	7.09	7.69	8.34	7.77	7.34	7.97	7.44	8.08	7.54	7.03	6.57	6.13	6.66	7.23	6.76	7.34
	8.07	8.35	8.10	7.81	8.12	8.40	8.62	8.41	8.15	8.42	8.16	8.42	8.15	7.84	7.50	7.14	7.49	7.81	7.47	7.79
27	4.41	4.79	5.19	5.62	5.24	5.68	5.30	5.74	6.31	5.89	5.50	5.97	6.48	6.05	5.65	6.13	6.66	6.22	6.76	6.31
	6.02	6.39	6.76	7.13	6.77	7.14	6.78	7.15	7.51	7.16	6.80	7.16	7.51	7.15	6.79	7.14	7.49	7.13	7.47	7.11
28	5.97	6.47	6.03	5.62	5.24	4.88	4.55	4.94	5.43	5.06	5.50	5.97	6.48	6.05	6.57	6.13	5.73	6.22	5.81	5.42
	7.44	7.78	7.47	7.13	6.77	6.41	6.06	6.42	6.79	6.43	6.80	7.16	7.51	7.15	7.50	7.14	6.78	7.13	6.77	6.40
29	8.08	7.53	7.02	6.54	6.10	6.61	6.16	5.74	6.31	6.85	6.39	5.97	6.48	6.05	5.65	5.27	4.93	4.60	5.00	5.42
	8.54	8.35	8.10	7.81	7.48	7.82	7.50	7.15	7.51	7.85	7.51	7.16	7.51	7.15	6.79	6.42	6.05	5.69	6.04	6.40
30	9.40	10.20	11.08	10.30	9.60	8.94	9.70	9.04	8.54	7.97	7.44	8.08	7.54	7.03	6.57	7.13	6.66	7.23	7.87	7.34
	9.10	9.52	10.04	9.56	9.16	8.85	9.19	8.87	8.64	8.42	8.16	8.42	8.15	7.84	7.50	7.83	7.49	7.81	8.10	7.79

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/11	Q2/11	Q3/11	Q4/11	Q1/12	Q2/12	Q3/12	Q4/12	Q1/13	Q2/13	Q3/13	Q4/13	Q1/14	Q2/14	Q3/14	Q4/14	Q1/15	Q2/15	Q3/15	Q4/15
16	4.51	4.86	5.26	4.88	4.53	4.90	5.28	5.71	6.17	6.66	7.20	7.77	8.40	9.07	9.81	9.10	8.46	9.14	8.48	7.88
	6.03	6.40	6.77	6.42	6.08	6.45	6.82	7.20	7.56	7.90	8.22	8.50	8.74	8.99	9.34	9.03	8.81	9.07	8.85	8.65
17	6.09	5.66	6.11	5.67	5.27	5.69	5.28	4.91	4.56	4.23	3.93	4.25	3.94	3.66	3.41	3.68	3.97	3.69	3.43	3.70
	7.45	7.12	7.47	7.14	6.80	7.17	6.82	6.47	6.12	5.78	5.44	5.80	5.46	5.13	4.81	5.15	5.51	5.17	4.85	5.20
18	11.17	10.37	11.21	12.11	13.08	12.15	11.27	10.46	11.31	10.49	11.34	12.26	11.38	12.29	13.30	14.36	15.54	14.42	15.59	16.86
	9.98	9.51	10.02	10.61	11.30	10.65	10.09	9.62	10.13	9.65	10.17	10.78	10.21	10.82	11.53	12.33	13.23	12.38	13.29	14.31
19	5.24	5.66	6.11	6.60	6.13	5.69	5.28	4.91	4.56	4.92	5.32	4.94	5.33	4.95	4.60	4.97	4.62	4.99	5.39	5.01
	6.75	7.12	7.47	7.81	7.50	7.17	6.82	6.47	6.12	6.50	6.88	6.52	6.91	6.55	6.20	6.58	6.23	6.61	7.00	6.64
20	11.17	10.37	11.21	10.40	11.23	12.15	13.12	12.17	11.31	12.22	13.21	14.27	13.25	12.29	11.42	12.33	11.46	12.38	13.38	14.47
	9.98	9.51	10.02	9.54	10.05	10.65	11.34	10.69	10.13	10.73	11.43	12.23	11.48	10.82	10.25	10.87	10.30	10.92	11.63	12.44
21	8.25	8.91	9.63	8.93	8.29	7.70	7.15	7.72	7.17	6.66	6.19	6.68	6.20	6.70	6.23	5.78	6.25	5.80	6.27	6.77
	8.54	8.79	9.12	8.82	8.60	8.40	8.16	8.44	8.19	7.90	7.59	7.94	7.62	7.97	7.65	7.31	7.68	7.35	7.72	8.07
22	11.17	12.07	13.05	12.11	11.23	12.15	11.27	10.46	9.71	10.49	9.74	10.53	9.77	9.07	8.43	7.82	7.27	7.85	7.29	6.77
	9.98	10.57	11.26	10.61	10.05	10.65	10.09	9.62	9.23	9.65	9.26	9.69	9.30	8.99	8.77	8.58	8.33	8.61	8.36	8.07
23	3.88	4.18	4.52	4.20	4.53	4.90	5.28	4.91	4.56	4.23	4.57	4.25	3.94	3.66	3.41	3.18	3.42	3.69	3.99	4.31
	5.33	5.69	6.05	5.71	6.08	6.45	6.82	6.47	6.12	5.78	6.15	5.80	5.46	5.13	4.81	4.50	4.83	5.17	5.53	5.90
24	3.88	3.60	3.89	4.20	4.53	4.21	3.91	3.63	3.92	3.64	3.93	3.65	3.39	3.15	3.41	3.16	2.94	2.73	2.95	2.74
	5.33	5.01	5.35	5.71	6.08	5.73	5.39	5.07	5.41	5.09	5.44	5.11	4.79	4.49	4.81	4.50	4.21	3.94	4.23	3.96
25	8.25	7.65	7.11	6.60	6.13	6.62	6.15	6.64	6.17	6.66	6.19	6.68	7.22	6.70	6.23	6.72	7.27	6.75	7.29	7.88
	8.54	8.34	8.10	7.81	7.50	7.84	7.53	7.87	7.56	7.90	7.59	7.94	8.26	7.97	7.65	8.00	8.33	8.04	8.36	8.65
26	7.09	7.65	7.11	7.68	8.29	8.96	9.68	8.98	9.71	9.02	8.37	7.77	7.22	7.80	8.43	7.82	7.27	7.85	8.48	9.17
	8.07	8.34	8.10	8.37	8.60	8.85	9.19	8.89	9.23	8.92	8.70	8.50	8.26	8.54	8.77	8.58	8.33	8.61	8.85	9.11
27	6.09	6.58	7.11	6.60	7.13	7.70	7.15	7.72	8.35	9.02	8.37	9.04	9.77	10.56	9.81	10.59	9.84	10.64	11.49	10.67
	7.45	7.79	8.10	7.81	8.13	8.40	8.16	8.44	8.67	8.92	8.70	8.96	9.30	9.73	9.34	9.77	9.38	9.82	10.34	9.86
28	5.24	4.86	4.52	4.20	3.90	3.62	3.91	4.22	3.92	3.64	3.93	3.65	3.94	3.66	3.96	4.27	3.97	4.29	3.99	4.31
	6.75	6.40	6.05	5.71	5.37	5.05	5.39	5.75	5.41	5.09	5.44	5.11	5.46	5.13	5.48	5.85	5.51	5.87	5.53	5.90
29	4.51	4.18	3.89	4.20	4.53	4.90	4.54	4.22	3.92	3.64	3.93	4.25	3.94	4.26	4.60	4.97	4.62	4.29	3.99	3.70
	6.03	5.69	5.35	5.71	6.08	6.45	6.10	5.75	5.41	5.09	5.44	5.80	5.46	5.82	6.20	6.58	6.23	5.87	5.53	5.20
30	7.09	6.58	7.11	6.60	6.13	6.62	7.15	6.64	7.17	7.75	7.20	6.68	7.22	7.80	8.43	9.10	9.84	9.14	8.48	7.88
	8.07	7.79	8.10	7.81	7.50	7.84	8.16	7.87	8.19	8.47	8.22	7.94	8.26	8.54	8.77	9.03	9.38	9.07	8.85	8.65

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 G

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/16	Q2/16	Q3/16	Q4/16	Q1/17	Q2/17	Q3/17	Q4/17	Q1/18	Q2/18	Q3/18	Q4/18	Q1/19	Q2/19	Q3/19	Q4/19	Q1/20	Q2/20	Q3/20	Q4/20
16	8.51	7.91	7.35	7.94	8.58	7.96	7.40	8.00	8.65	9.34	8.68	8.07	8.72	8.10	7.53	8.14	7.56	8.17	7.60	7.06
	8.89	8.69	8.44	8.74	8.98	8.78	8.53	8.83	9.07	9.34	9.12	8.92	9.17	8.97	8.72	9.03	8.77	9.08	8.83	8.53
17	4.00	3.72	3.45	3.21	2.98	2.77	2.99	2.78	3.01	3.24	3.51	3.79	3.52	3.27	3.54	3.29	3.06	3.30	3.07	2.85
	5.56	5.22	4.90	4.59	4.30	4.02	4.32	4.04	4.34	4.66	5.00	5.36	5.03	4.72	5.06	4.75	4.44	4.78	4.47	4.19
18	15.65	16.92	18.31	16.98	18.38	17.05	15.83	17.13	15.89	17.18	18.60	20.13	21.78	23.57	21.89	23.68	25.64	23.79	22.09	23.90
	13.35	14.37	15.51	14.44	15.58	14.51	13.55	14.59	13.62	14.67	15.83	17.11	18.53	20.08	18.63	20.20	21.92	20.32	18.86	20.45
19	4.65	5.02	5.43	5.86	6.34	5.89	6.36	5.91	5.49	5.10	5.52	5.12	5.54	5.99	6.47	6.01	6.50	7.02	7.60	8.21
	6.28	6.67	7.06	7.45	7.83	7.49	7.87	7.53	7.17	6.81	7.21	6.85	7.25	7.65	8.05	7.70	8.09	8.47	8.83	9.14
20	15.65	14.52	15.71	16.98	18.38	17.05	15.83	17.13	15.89	14.74	15.96	14.82	13.76	14.88	13.83	12.83	13.88	15.01	16.26	17.58
	13.35	12.50	13.42	14.44	15.58	14.51	13.55	14.59	13.62	12.75	13.69	12.82	12.05	12.90	12.12	11.43	12.19	13.05	14.02	15.10
21	7.32	7.91	8.55	7.94	7.38	8.85	7.40	8.88	8.39	8.90	8.41	8.93	7.49	8.10	8.76	9.47	10.24	9.51	8.84	9.55
	8.40	8.69	8.93	8.74	8.48	8.19	8.53	8.23	7.91	8.28	7.95	8.32	8.67	8.97	9.22	9.51	9.88	9.56	9.34	9.62
22	8.29	5.84	6.32	5.86	5.45	5.08	4.71	5.08	5.49	5.93	5.52	5.12	5.54	5.99	5.57	5.17	5.59	5.19	5.62	5.22
	7.75	7.41	7.79	7.45	7.10	6.74	6.38	6.77	7.17	7.57	7.21	6.85	7.25	7.65	7.29	6.93	7.34	6.97	7.38	7.01
23	4.00	3.72	3.45	3.21	3.47	3.22	3.48	3.76	4.06	3.77	4.08	4.41	4.10	3.81	3.54	3.29	3.06	3.30	3.57	3.86
	5.56	5.22	4.90	4.59	4.92	4.61	4.95	5.30	5.67	5.33	5.70	6.09	5.73	5.39	5.08	4.75	4.44	4.78	5.13	5.49
24	2.55	2.37	2.56	2.37	2.21	2.38	2.22	2.06	1.91	2.07	2.23	2.08	2.24	2.08	2.25	2.09	2.28	2.44	2.64	2.46
	3.70	3.45	3.71	3.47	3.23	3.48	3.25	3.03	2.83	3.05	3.29	3.07	3.31	3.09	3.33	3.11	3.35	3.61	3.89	3.63
25	8.51	7.91	8.55	7.94	8.58	9.27	8.61	8.00	8.65	8.03	8.68	8.07	7.49	6.96	7.53	6.99	7.56	7.02	7.60	7.06
	8.89	8.69	8.93	8.74	8.98	9.26	9.02	8.83	9.07	8.87	9.12	8.92	8.67	8.37	8.72	8.42	8.77	8.47	8.83	8.53
26	8.51	9.20	8.55	7.94	7.38	8.85	8.36	8.88	8.39	8.90	8.41	8.93	7.49	6.96	7.53	8.14	8.80	9.51	8.84	9.55
	8.89	9.18	8.93	8.74	8.48	8.19	7.87	8.23	7.91	8.28	7.95	8.32	8.67	8.37	8.72	9.03	9.28	9.56	9.34	9.62
27	11.53	10.71	11.58	12.51	11.63	12.56	13.59	14.70	13.84	14.74	13.70	12.72	11.81	12.78	13.83	14.95	16.17	17.49	16.26	15.08
	10.39	9.91	10.44	11.07	10.49	11.13	11.85	12.69	11.92	12.75	11.98	11.30	10.72	11.37	12.12	12.97	13.93	15.01	14.02	13.13
28	4.00	3.72	3.45	3.73	3.47	3.22	3.48	3.76	3.49	3.77	4.08	3.79	3.52	3.81	3.54	3.29	3.55	3.84	4.15	4.49
	5.56	5.22	4.90	5.25	4.92	4.61	4.95	5.30	4.98	5.33	5.70	5.36	5.03	5.39	5.06	4.75	5.09	5.46	5.84	6.24
29	4.00	3.72	4.02	4.34	4.03	3.74	3.48	3.23	3.49	3.77	4.08	3.79	4.10	3.81	3.54	3.82	4.13	4.46	4.15	4.49
	5.56	5.22	5.58	5.98	5.61	5.27	4.95	4.64	4.98	5.33	5.70	5.36	5.73	5.39	5.06	5.42	5.80	6.20	5.84	6.24
30	8.51	9.20	9.95	10.75	9.99	9.27	10.03	9.31	8.65	8.03	7.46	8.07	7.49	6.96	6.47	6.99	7.56	7.02	6.53	7.06
	8.89	9.18	9.51	9.96	9.56	9.25	9.61	9.29	9.07	8.87	8.62	8.92	8.67	8.37	8.05	8.42	8.77	8.47	8.14	8.53

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/1	Q2/1	Q3/1	Q4/1	Q1/2	Q2/2	Q3/2	Q4/2	Q1/3	Q2/3	Q3/3	Q4/3	Q1/4	Q2/4	Q3/4	Q4/4	Q1/5	Q2/5	Q3/5	Q4/5
31	7.07	6.70	6.25	6.82	6.43	7.04	6.61	6.21	5.63	6.11	6.69	6.18	5.74	6.22	5.80	6.29	7.00	6.54	7.12	7.75
	8.10	7.95	7.74	8.01	7.80	8.07	7.84	7.58	7.28	7.62	7.32	7.66	7.35	7.69	7.39	7.73	8.04	7.75	8.06	8.33
32	7.07	6.70	6.25	5.86	5.53	6.05	6.61	6.21	6.55	7.10	7.71	8.36	9.04	8.42	7.85	7.32	7.00	7.61	8.28	9.02
	8.10	7.95	7.74	7.49	7.21	7.54	7.84	7.58	7.88	8.15	8.38	8.63	8.96	8.68	8.47	8.28	8.04	8.31	8.53	8.77
33	7.07	6.70	7.27	6.82	6.43	7.04	7.69	8.41	7.61	7.10	7.71	8.36	7.76	8.42	9.14	9.91	9.47	10.31	11.22	10.50
	8.10	7.95	8.17	8.01	7.80	8.07	8.29	8.53	8.33	8.15	8.38	8.63	8.42	8.68	9.01	9.44	9.06	9.48	9.98	9.50
34	7.07	6.70	7.27	6.82	6.43	6.05	6.61	7.23	6.55	7.10	6.82	7.19	6.67	7.24	7.85	7.32	7.00	6.54	7.12	6.66
	8.10	7.95	8.17	8.01	7.80	7.54	7.84	8.11	7.88	8.15	7.92	8.20	7.97	8.24	8.47	8.28	8.04	7.75	8.06	7.77
35	7.07	6.70	7.27	7.93	7.48	7.04	6.61	7.23	7.61	8.28	8.97	8.36	7.76	8.42	9.14	9.91	11.03	10.31	11.22	10.50
	8.10	7.95	8.17	8.42	8.24	8.07	7.84	8.11	8.33	8.58	8.91	8.63	8.42	8.68	9.01	9.44	9.95	9.48	9.98	9.50
36	7.07	6.70	6.25	5.86	6.43	6.05	6.61	6.21	5.63	6.11	6.62	6.18	6.67	7.24	7.85	8.52	8.14	8.86	9.64	9.02
	8.10	7.95	7.74	7.49	7.80	7.54	7.84	7.58	7.28	7.62	7.92	7.66	7.97	8.24	8.47	8.72	8.51	8.76	9.09	8.77
37	7.07	6.70	6.25	6.82	7.48	8.19	8.95	8.41	7.61	7.10	7.71	8.36	7.76	7.24	6.75	6.29	7.00	7.61	8.28	9.02
	8.10	7.95	7.74	8.01	8.24	8.48	8.81	8.53	8.33	8.15	8.38	8.63	8.42	8.24	8.01	7.73	8.04	8.31	8.53	8.77
38	7.07	6.70	6.25	6.82	6.43	6.05	6.61	6.21	5.63	5.25	4.90	4.57	4.93	4.60	4.29	4.00	4.45	4.16	3.89	3.64
	8.10	7.95	7.74	8.01	7.80	7.54	7.84	7.58	7.28	6.97	6.64	6.30	6.67	6.32	5.98	5.64	6.00	5.65	5.31	4.98
39	7.07	6.70	7.27	7.93	8.71	8.19	7.69	8.41	8.86	8.26	7.71	8.36	9.04	8.42	9.14	9.91	11.03	12.00	13.07	12.22
	8.10	7.95	8.17	8.42	8.75	8.48	8.29	8.53	8.85	8.58	8.38	8.63	8.96	8.68	9.01	9.44	9.95	10.55	11.23	10.57
40	7.07	6.70	7.27	7.93	8.71	9.53	8.95	8.41	8.86	8.26	7.71	8.36	9.04	8.42	7.85	8.52	9.47	8.86	8.28	7.75
	8.10	7.95	8.17	8.42	8.75	9.16	8.81	8.53	8.85	8.58	8.38	8.63	8.96	8.68	8.47	8.72	9.06	8.76	8.53	8.33

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 I

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/6	Q2/6	Q3/6	Q4/6	Q1/7	Q2/7	Q3/7	Q4/7	Q1/8	Q2/8	Q3/8	Q4/8	Q1/9	Q2/9	Q3/9	Q4/9	Q1/10	Q2/10	Q3/10	Q4/10
31	6.94	7.53	7.02	7.61	8.25	8.94	9.70	10.52	11.58	10.79	11.73	10.94	10.21	9.52	10.35	11.24	12.23	13.27	14.44	15.69
	8.07	8.35	8.10	8.37	8.60	8.85	9.19	9.62	10.14	9.63	10.14	9.63	9.21	8.88	9.20	9.60	10.09	10.65	11.30	12.02
32	9.40	10.20	9.50	10.30	11.18	10.41	11.29	10.52	11.58	10.79	10.07	10.94	11.89	12.91	14.03	13.09	14.24	15.46	16.83	15.69
	9.10	9.52	9.13	9.56	10.08	9.59	10.11	9.62	10.14	9.63	9.22	9.63	10.14	10.73	11.40	10.70	11.36	12.10	12.93	12.02
33	9.40	8.76	9.50	10.30	11.18	10.41	11.29	10.52	9.94	9.27	10.07	9.40	8.77	8.18	8.89	9.66	9.02	9.79	10.65	9.94
	9.10	8.79	9.13	9.56	10.08	9.59	10.11	9.62	9.21	8.88	9.22	8.88	8.64	8.42	8.63	8.86	8.61	8.83	9.14	8.79
34	5.97	5.56	6.03	6.54	6.10	5.68	6.16	5.74	5.43	5.89	6.39	6.94	6.48	7.03	6.57	7.13	7.75	8.41	7.87	8.54
	7.44	7.11	7.47	7.81	7.48	7.14	7.50	7.15	6.79	7.16	7.51	7.85	7.51	7.84	7.50	7.83	8.12	8.38	8.10	8.35
35	9.40	10.20	11.08	10.30	11.18	12.12	13.15	14.27	13.48	12.57	13.65	14.84	16.13	15.04	14.03	15.25	14.24	13.27	12.40	13.47
	9.10	9.52	10.04	9.56	10.08	10.69	11.39	12.19	11.42	10.74	11.43	12.21	13.09	12.19	11.40	12.16	11.36	10.65	10.04	10.59
36	9.40	8.76	9.50	8.85	8.25	8.94	9.70	9.04	9.94	10.79	11.73	10.94	11.89	12.91	12.05	13.09	14.24	13.27	14.44	15.69
	9.10	8.79	9.13	8.83	8.60	8.85	9.19	8.87	9.21	9.63	10.14	9.63	10.14	10.73	10.12	10.70	11.36	10.65	11.30	12.02
37	8.08	8.76	9.50	8.85	9.60	10.41	9.70	10.52	9.94	10.79	11.73	12.74	11.89	12.91	14.03	13.09	14.24	13.27	12.40	13.47
	8.54	8.79	9.13	8.83	9.16	9.59	9.19	9.62	9.21	9.63	10.14	10.74	10.14	10.73	11.40	10.70	11.36	10.65	10.04	10.59
38	3.80	4.12	4.46	4.83	5.24	5.68	6.16	5.74	5.43	5.89	6.50	5.13	5.57	6.05	5.65	5.27	5.73	5.35	5.81	6.31
	5.32	5.67	6.03	6.40	6.77	7.14	7.50	7.15	6.79	7.16	6.80	6.43	6.79	7.15	6.79	6.42	6.78	6.41	6.77	7.11
39	12.74	13.82	12.87	13.97	13.01	12.12	11.29	10.52	11.58	12.57	13.65	14.84	16.13	15.04	16.35	17.77	16.59	15.46	14.44	13.47
	11.25	12.04	11.30	12.10	11.35	10.69	10.11	9.62	10.14	10.74	11.43	12.21	13.09	12.19	13.06	14.01	13.01	12.10	11.30	10.59
40	8.08	7.53	7.02	6.54	7.09	7.69	7.17	7.77	8.54	9.27	8.65	8.08	7.54	7.03	7.64	7.13	7.75	7.23	7.87	7.34
	8.54	8.35	8.10	7.81	8.12	8.40	8.14	8.41	8.64	8.88	8.64	8.42	8.15	7.84	8.14	7.83	8.12	7.81	8.10	7.79

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 J

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/11	Q2/11	Q3/11	Q4/11	Q1/12	Q2/12	Q3/12	Q4/12	Q1/13	Q2/13	Q3/13	Q4/13	Q1/14	Q2/14	Q3/14	Q4/14	Q1/15	Q2/15	Q3/15	Q4/15
31	13.01	12.07	13.05	14.10	13.08	14.15	15.28	16.52	17.87	19.32	17.93	16.63	15.43	14.32	13.30	14.36	13.34	14.42	13.38	14.47
	11.22	10.57	11.26	12.04	11.30	12.08	12.96	13.95	15.04	16.25	15.10	14.06	13.12	12.28	11.53	12.33	11.58	12.38	11.63	12.44
32	13.01	12.07	13.05	14.10	13.08	12.15	13.12	14.18	15.34	14.23	15.38	14.27	13.25	14.32	13.30	14.36	15.54	14.42	15.59	14.47
	11.22	10.57	11.26	12.04	11.30	10.65	11.34	12.13	13.02	12.18	13.07	12.23	11.48	12.28	11.53	12.33	13.23	12.38	13.29	12.44
33	9.60	10.37	11.21	12.11	13.08	14.15	15.28	16.52	15.34	16.58	17.93	19.38	17.98	16.68	18.05	16.73	18.11	19.59	18.17	16.86
	9.09	9.51	10.02	10.61	11.30	12.08	12.96	13.95	13.02	14.01	15.10	16.32	15.17	14.12	15.23	14.18	15.30	16.53	15.36	14.31
34	8.25	7.65	8.27	7.68	7.13	6.62	7.15	6.64	6.17	6.66	6.19	5.74	6.20	5.76	6.23	5.78	6.25	5.80	6.27	5.82
	8.54	8.34	8.57	8.37	8.13	7.84	8.16	7.87	7.56	7.90	7.59	7.25	7.62	7.28	7.65	7.31	7.68	7.35	7.72	7.38
35	13.01	12.07	11.21	12.11	11.23	12.15	13.12	12.17	13.17	12.22	11.34	12.26	13.25	14.32	13.30	14.36	15.54	14.42	13.38	12.42
	11.22	10.57	10.02	10.61	10.05	10.65	11.34	10.69	11.39	10.73	10.17	10.78	11.48	12.28	11.53	12.33	13.23	12.38	11.63	10.97
36	15.15	14.05	13.05	14.10	15.23	14.15	13.12	12.17	11.31	10.49	9.74	9.04	8.40	7.80	7.24	7.82	8.46	7.85	8.48	9.17
	12.82	11.99	11.26	12.04	12.92	12.08	11.34	10.69	10.13	9.65	9.26	8.96	8.74	8.54	8.29	8.58	8.81	8.61	8.85	9.11
37	11.17	12.07	11.21	12.11	13.08	12.15	13.12	14.18	15.34	16.58	17.93	16.63	17.98	19.44	21.04	19.51	18.11	19.59	21.18	19.65
	9.98	10.57	10.02	10.61	11.30	10.65	11.34	12.13	13.02	14.01	15.10	14.06	15.17	16.39	17.73	16.46	15.30	16.53	17.89	16.60
38	6.09	6.58	6.11	5.67	5.27	5.69	6.15	6.64	6.17	6.66	6.19	5.74	6.20	5.76	5.35	4.97	4.62	4.99	4.63	4.31
	7.45	7.79	7.47	7.14	6.80	7.17	7.53	7.87	7.56	7.90	7.59	7.25	7.62	7.28	6.93	6.58	6.23	6.61	6.25	5.90
39	13.01	12.07	11.21	10.40	11.23	12.15	13.12	14.18	15.34	14.23	13.21	14.27	13.25	14.32	15.49	14.36	15.54	14.42	13.38	14.47
	11.22	10.57	10.02	9.54	10.05	10.65	11.34	12.13	13.02	12.18	11.43	12.23	11.48	12.28	13.18	12.33	13.23	12.38	11.63	12.44
40	6.09	6.58	6.11	6.60	6.13	5.69	5.28	5.71	6.17	5.73	5.32	4.94	5.33	5.76	6.23	5.78	6.25	5.80	5.39	5.01
	7.45	7.79	7.47	7.81	7.50	7.17	6.82	7.20	7.56	7.22	6.88	6.52	6.91	7.28	7.65	7.31	7.68	7.35	7.00	6.64

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TILLINGHAST/MORGAN STANLEY SPDA
INTEREST RATE SCENARIOS
LATTICE PATHS WITH EXPECTATIONS HYPOTHESIS

SCENARIO	Q1/16	Q2/16	Q3/16	Q4/16	Q1/17	Q2/17	Q3/17	Q4/17	Q1/18	Q2/18	Q3/18	Q4/18	Q1/19	Q2/19	Q3/19	Q4/19	Q1/20	Q2/20	Q3/20	Q4/20
31	15.65	16.92	18.31	16.98	18.38	17.05	18.45	19.96	21.60	20.03	18.60	17.26	18.68	17.34	16.11	17.41	16.17	17.49	18.95	20.49
	13.35	14.37	15.51	14.44	15.58	14.51	15.66	16.93	18.33	17.02	15.83	14.75	15.91	14.83	13.65	14.92	13.93	15.01	16.20	17.52
32	13.43	14.52	13.49	12.51	13.54	12.56	11.67	10.84	11.72	12.66	11.76	10.93	11.81	12.78	13.83	12.83	13.88	12.89	13.95	12.95
	11.68	12.50	11.74	11.07	11.80	11.13	10.55	10.06	10.60	11.24	10.66	10.17	10.72	11.37	12.12	11.43	12.19	11.50	12.27	11.58
33	15.65	16.92	18.31	19.80	21.43	19.87	21.51	23.28	21.60	23.36	25.30	27.39	25.41	27.51	29.82	32.28	29.93	27.76	30.10	27.89
	13.35	14.37	15.51	16.78	18.14	16.84	18.23	19.76	18.33	19.86	21.55	23.40	21.67	23.53	25.57	27.80	25.72	23.81	25.88	23.95
34	6.29	5.84	5.43	5.86	6.34	5.89	5.47	5.91	6.39	6.90	7.46	8.07	8.72	9.43	8.76	9.47	8.80	8.17	8.84	9.55
	7.75	7.41	7.06	7.45	7.83	7.49	7.13	7.53	7.91	8.28	8.62	8.92	9.17	9.45	9.22	9.51	9.28	9.08	9.34	9.62
35	11.53	10.71	9.95	10.75	9.99	10.79	10.03	10.84	11.72	10.87	10.11	10.93	11.81	10.97	10.20	9.47	8.80	9.51	8.84	9.55
	10.39	9.91	9.51	9.96	9.56	10.01	9.61	10.06	10.60	10.11	9.71	10.17	10.72	10.22	9.82	9.51	9.28	9.56	9.34	9.62
36	8.51	9.20	9.95	9.23	8.58	9.27	10.03	9.31	8.65	8.03	8.68	9.39	8.72	9.43	10.20	9.47	10.24	9.51	10.29	11.12
	8.89	9.16	9.51	9.20	8.98	9.25	9.61	9.29	9.07	8.87	9.12	9.40	9.17	9.45	9.82	9.51	9.88	9.56	9.94	10.41
37	18.23	19.72	21.35	23.09	25.00	27.04	25.10	27.17	25.20	23.36	21.69	20.13	21.78	23.57	21.89	23.68	25.64	23.79	25.78	27.89
	15.43	16.68	18.05	19.56	21.22	23.03	21.32	23.15	21.43	19.86	18.43	17.11	18.53	20.08	18.63	20.20	21.92	20.32	22.05	23.95
38	4.65	4.32	4.02	4.34	4.03	4.35	4.71	4.37	4.72	4.39	4.08	3.79	3.52	3.27	3.54	3.29	3.06	3.30	3.57	3.32
	6.28	5.93	5.58	5.86	5.61	5.99	6.38	6.02	6.41	6.05	5.70	5.36	5.03	4.72	5.06	4.75	4.44	4.78	5.13	4.81
39	15.65	14.52	13.49	12.51	11.63	12.56	11.67	12.62	13.64	14.74	13.70	14.82	13.76	12.78	11.87	12.83	11.92	11.07	10.29	9.55
	13.35	12.50	11.74	11.07	10.49	11.13	10.55	11.18	11.92	12.75	11.98	12.82	12.05	11.37	10.78	11.43	10.85	10.35	9.94	9.62
40	4.65	5.02	4.67	4.34	4.03	4.35	4.71	4.37	4.72	5.10	4.74	5.12	5.54	5.15	5.57	6.01	5.59	5.19	4.83	4.49
	6.28	6.67	6.31	5.96	5.61	5.99	6.38	6.02	6.41	6.81	6.44	6.85	7.25	6.89	7.29	7.70	7.34	6.97	6.60	6.24

The top rate is the three-month money market rate on a bond-equivalent basis.

The bottom rate is the ten-year publicly traded corporate bond rate on a bond-equivalent basis.

TABLE 10-10 L

SPDA Risk/Return Quantifiers

- Market Value of Liability.
- Duration of Liability.
- Convexity of Liability.

FIGURE 10-8 A

Uses of Risk/Return Quantifiers

- Setting Credited Rates (Pricing).
- Choosing Investment Strategies.
- Comparing Product Design Alternatives.
  - Profit Targets
  - Surrender Charges
  - Sales Compensation
  - Bailout Provisions
  - Credited Rate Guarantees
  - Expenses
- Comparing Credited Rate Reset Strategies.

FIGURE 10-8 B

Definition of Duration

The duration of a cash flow stream is a measure of its price sensitivity and is equal to minus 100 times the percentage change in the present value of the stream for a one basis point increase in all the forces of interest representing the term structure.

FIGURE 10-8 C

Advantage of Price-Sensitivity Definition of Duration

- Can be used for any interest-rate-based financial instrument.
  - — Noncallable and callable bonds
  - — Mortgages and mortgage-backed securities
  - — Interest rate swaps
  - — Options and futures
- Can be used to analyze asset and liability cash flow streams, whether or not interest sensitive.

FIGURE 10-8 D

Duration — Aggregation Property

- The duration of the combination of two cash flow streams is the market-value-weighted average of the durations of the separate streams.
- This aggregation property follows from the definition of duration as a price sensitivity measure.

Duration — Aggregation Property

(Two-Bond Portfolio)

Portfolio = Bond 1 + Bond 2

Market Value	$B = B_1 + B_2$
Duration	$D = \left(\frac{B_1}{B}\right) \cdot D_1 + \left(\frac{B_2}{B}\right) \cdot D_2$

FIGURE 10-8 F

Duration — Aggregation Property

(Callable Bond)

$$\text{Callable Bond} = \text{Noncallable Bond} - \text{Call Option}$$

Market Value	$B = N - C$
Duration	$D_B = \left(\frac{N}{B}\right) \cdot D_N - \left(\frac{C}{B}\right) \cdot D_C$

FIGURE 10-8 G

Duration — Aggregation Property

(Asset/Liability Management)

Surplus = Assets – Liabilities

Market Value	$S = A - L$
Duration	$D_S = \left(\frac{A}{S}\right) \cdot D_A - \left(\frac{L}{S}\right) \cdot D_L$

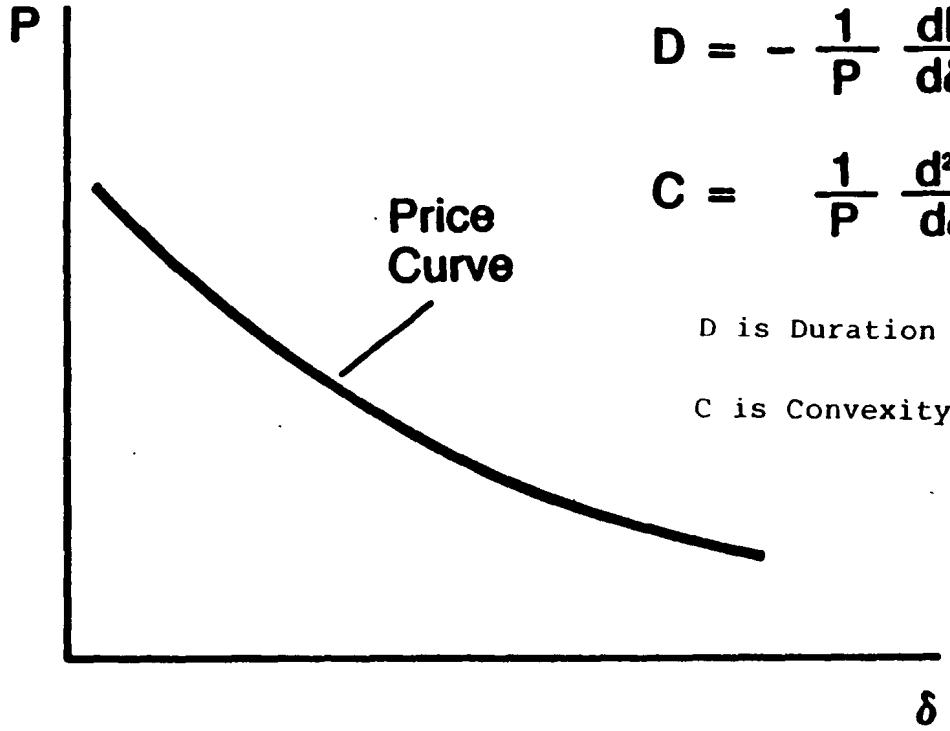
FIGURE 10-8 H

Convexity

- Convexity measures the curvature of the price curve just as duration measures its slope.
- A key component of convexity is the sensitivity of duration to changes in the term structure.
- Both duration and convexity are index numbers that measure the interest rate behavior of a cash flow stream's price curve.

FIGURE 10-8 I

Derivatives of the Price Curve



$$D = -\frac{1}{P}\frac{dP}{d\delta}$$

$$C = \frac{1}{P}\frac{d^2P}{d\delta^2}$$

D is Duration

C is Convexity

FIGURE 10-8 J

Determining a Credited Rate Strategy

- Initial Rate to be Credited.
- Length of Initial Guarantee Period.
- Frequency of Rate Resets after Initial Guarantee Period Has Elapsed.
- Contractual Minimum Rate Guarantees.

FIGURE 10-8 K

Determining a Credited Rate Strategy

- Portfolio Earnings or External Reference?
- Target Margins: Initial and Renewal?
- When to Pierce the Bailout?
- Whether to Follow the Competition
  - Upward Only?
  - Downward Only?
  - Upward and Downward?
- Dynamic or Static Parameters?
  Corridors and Safety Margins?

FIGURE 10-8 L

Credited Rate — Baseline Assumptions

- Fixed for 3 Years Initially.
  Then Changed Annually.
- Renewal Rates Indexed by Non-Callable
  5-Year A-Rated New Money Rates.
- Renewal Margin is 200 Basis Points.
- Minimum Guarantee 3.5%.

Illustrative Reset Strategies

- **Mark to Market**

  Follow the 5-Year Rate Minus Margin.
  Move Credited Rate Up and Down.

- **Downward Ratchet.**

  Refer to the 5-Year Rate Minus Margin.
  Only way Credited Rate can Change
  is to Move Down from Previous Level.

FIGURE 10-8 N

Illustrative Reset Strategies

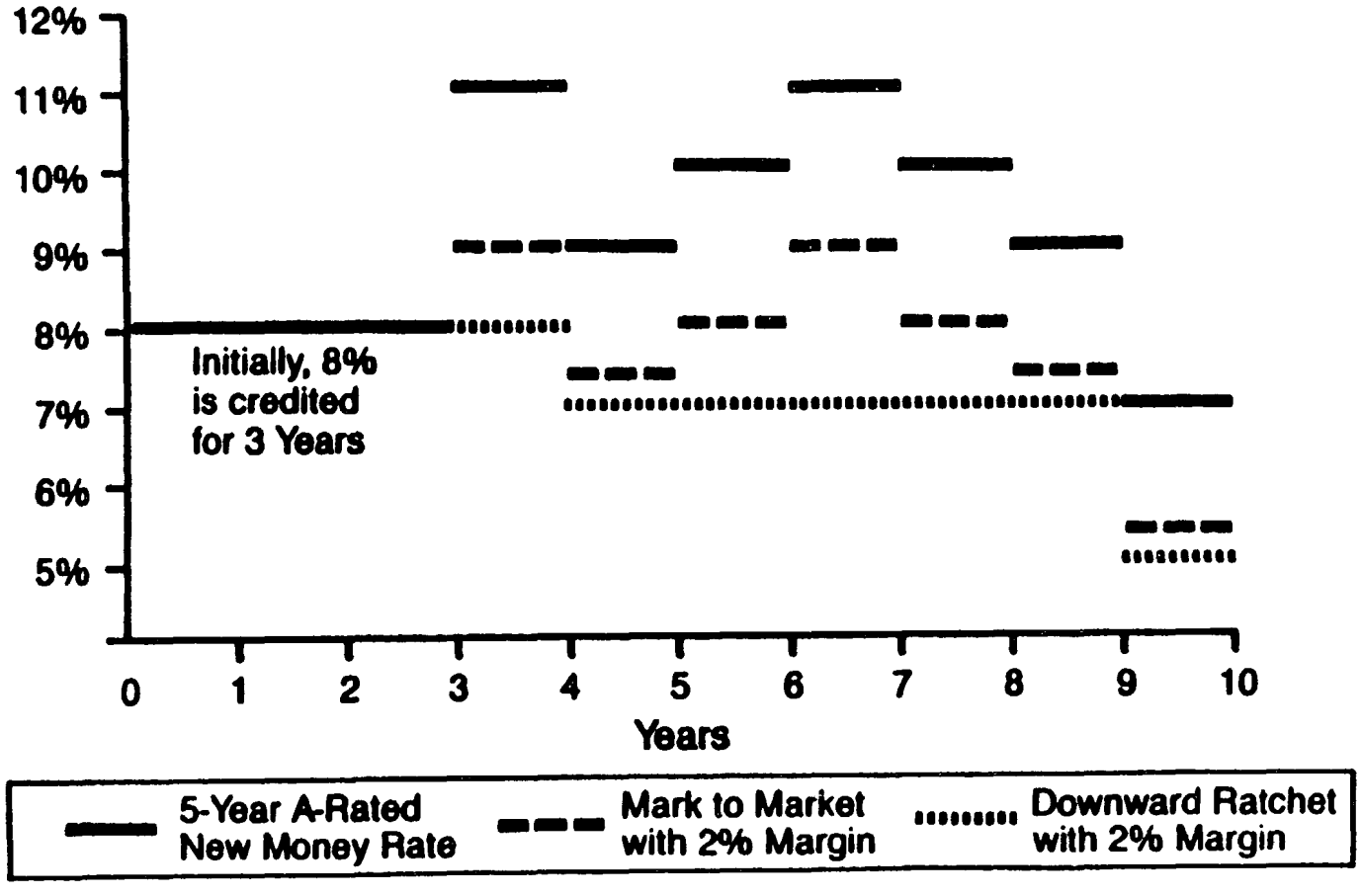


FIGURE 10-8 O

Mark to Market Baseline Results

- Initial Credited Rate 8.1% for 3 Years.
- Market Value Liability $20,000.
- Duration 2.3 Years.
- Convexity 25.2 Years-Squared.

FIGURE 10-8 P

Downward Ratchet Baseline Results

- Initial Credited Rate 8.5% for 3 Years.
- Market Value Liability $20,000
- Duration 2.5 Years.
- Convexity 26.1 Years-Squared.

FIGURE 10-8 Q

Pitfalls of Macaulay Duration
Market to Market Benchmark Case

- Duration is 2.3 years. Verified by Simulation Analyses.
- Macaulay Durations with Same Assumptions:

Minimum	3.7 Years
Maximum	7.8 Years
Mean	6.0 Years

- Mean Macaulay Duration exceeds Correct Value by 3.7 Years.

FIGURE 10-8 R

Pitfalls of Macaulay Duration
Downward Ratchet Benchmark Case

- Duration is 2.5 years. Verified by Simulation Analyses.
- Macaulay Durations with Same Assumptions:

Minimum	4.5 Years
Maximum	8.3 Years
Mean	6.8 Years

- Mean Macaulay Duration exceeds Correct Value by 4.3 Years.

FIGURE 10-8 S

Pitfalls of Macaulay Duration
An Example of Undetected C-3 Risk Exposure

- Target Account to be "Immunized" is Surplus ÷ Liabilities.
- Surplus ÷ Liabilities is Immunized if Asset Duration = Liability Duration, Because:
- Duration (Assets ÷ Liabilities)
  = Duration (Assets) — Duration (Liabilities)
  = The "Duration Gap."

FIGURE 10-8 T

Pitfalls of Macaulay Duration
An Example of Undetected C-3 Risk Exposure

	Duration	Mean Macaulay Duration
Assets	5 Years	4 Years
Liabilities	3 Years	4 Years
Duration Gap	2 Years	0 Years

FIGURE 10-8 U

Pitfalls of Macaulay Duration
An Example of Undetected C-3 Risk Exposure

- Suppose Assets ÷ Liabilities = 1.1
- Suppose Interest Rates Rise by 1%.
- Then Assets ÷ Liabilities Changes to
  $1.1 \times (1 - 2 \times 1\%) = 1.078$.
- Surplus ÷ Liabilities was 10%
  Surplus ÷ Liabilities is now 7.8%
- An "Unexpected" Loss of 22% of
  Relative Surplus has occurred!

FIGURE 10-8 V

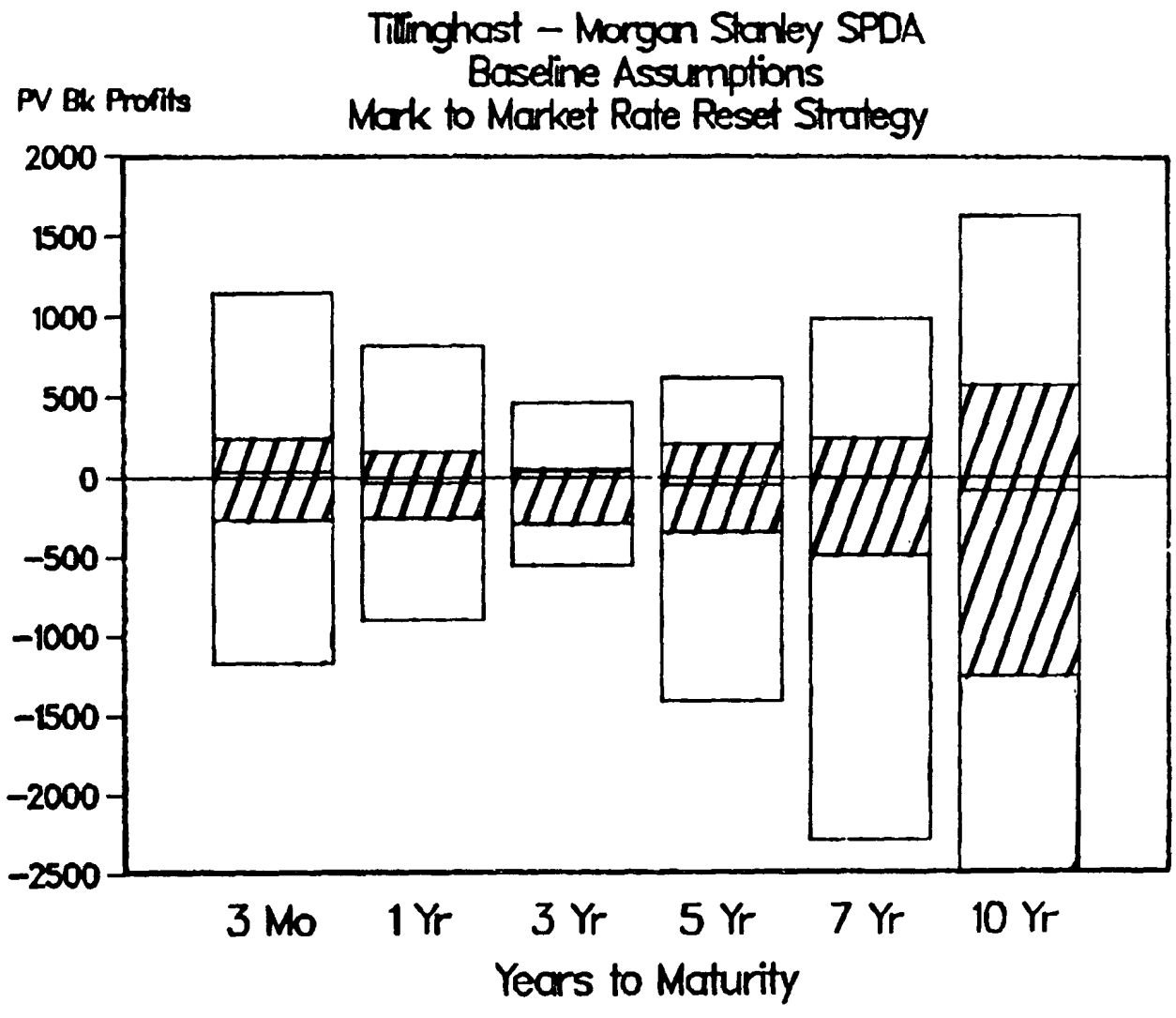

Tillinghast – Morgan Stanley SPDA
Baseline Assumptions
Mark to Market Rate Reset Strategy
PV Bk Profits
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
3 Mo
1 Yr
3 Yr
5 Yr
7 Yr
10 Yr
Years to Maturity

FIGURE 10-9 A

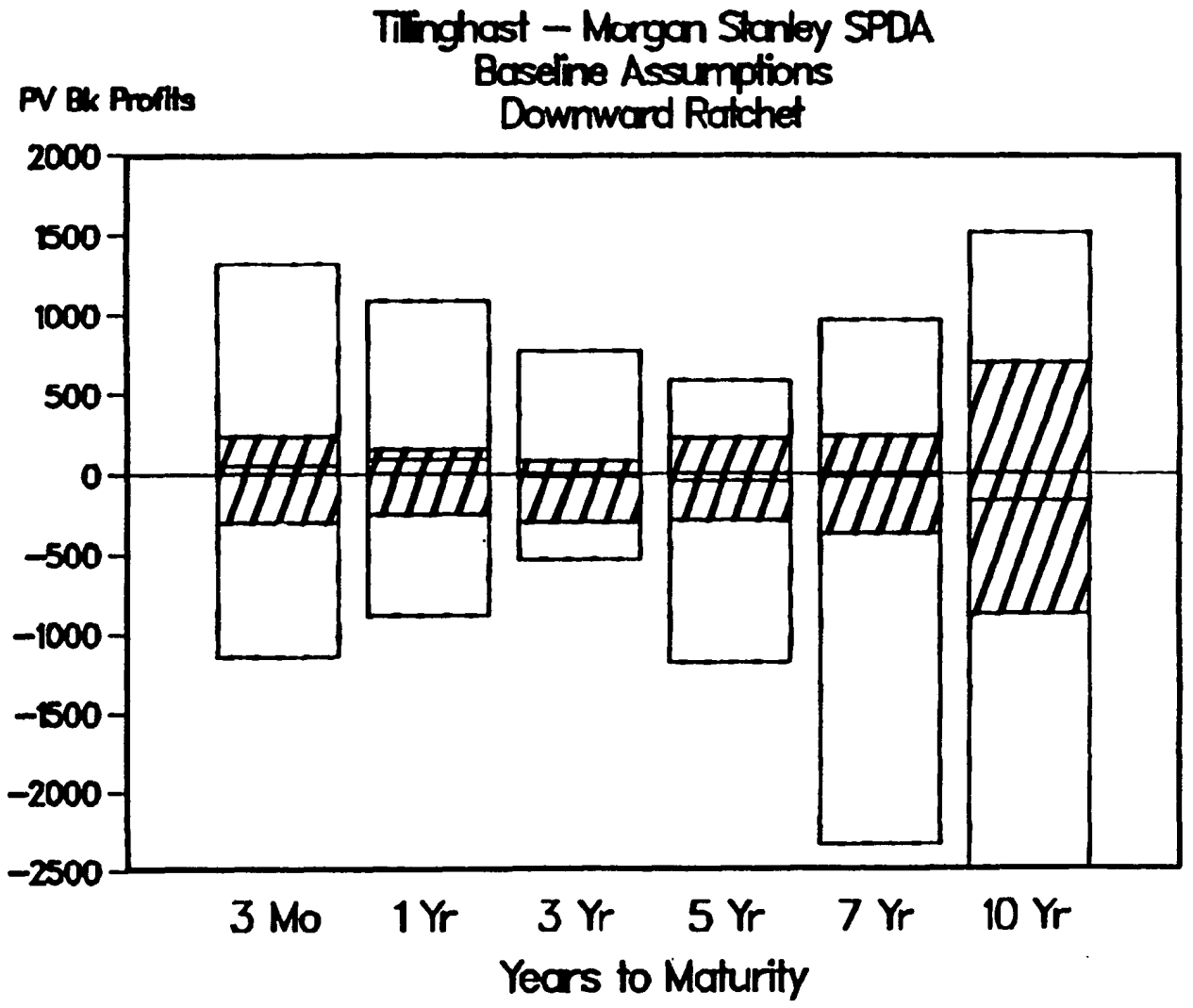

Tillinghast – Morgan Stanley SPDA
Baseline Assumptions
Downward Ratchet
PV Bk Profits
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
3 Mo
1 Yr
3 Yr
5 Yr
7 Yr
10 Yr
Years to Maturity

FIGURE 10-9 B

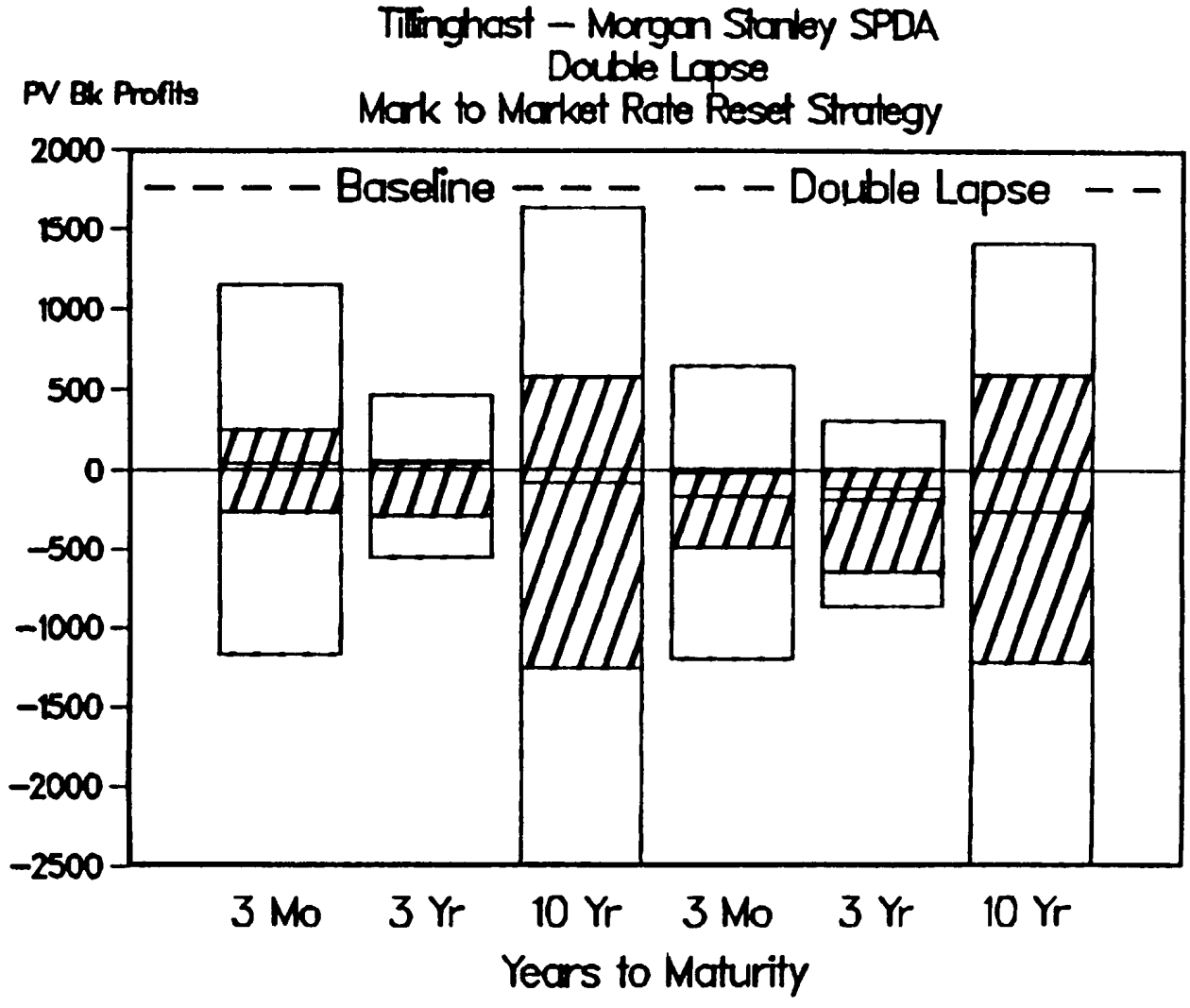

Tillinghast – Morgan Stanley SPDA
Double Lapse
Mark to Market Rate Reset Strategy
PV Blk Profits
Baseline
Double Lapse
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
3 Mo
3 Yr
10 Yr
3 Mo
3 Yr
10 Yr
Years to Maturity

FIGURE 10-9 C

MR. MICHAEL R. TUOHY: In this presentation, I'm going to discuss future interest scenarios and critique those proposed in the New York law. Then I will look at some results for the block of business that Denny Carr described in Session 4 and take you through a sample opinion and a sample actuarial memorandum. To close, I will discuss some ramifications of going through this whole process.

NEW YORK INTEREST SCENARIOS

First of all, let's go back to the New York law and look at what New York has told us should be our interest scenarios. The first scenario is one that remains level, the results of which can be used as a reference point. The second crawls up 50 basis points a year for 10 years and then remains level; the third zooms up 1.0 percent a year for 5 years and zaps back down again over the next 5 years. The next pops up 3.0 percent immediately and then remains level. The last three are the mirror images of the second, third, and fourth—they crawl down, zoom down, and pop down. In addition, New York tells us to include some yield curve inversions.

Table 10-11 shows some sample New York scenarios for 10-year Treasury yields. The starting point was 7.3 percent, which was the yield sometime in July 1986.

TABLE 10-11

NEW YORK LAW

INTEREST SCENARIOS

(10-YEAR TREASURY YIELDS)

	Scenario						
Time	1	2	3	4	5	6	7
0	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
1	7.3	7.8	8.3	10.3	6.8	6.3	4.3
5	7.3	9.8	12.3	10.3	4.8	4.0	4.3
10+	7.3	12.3	7.3	10.3	4.0	7.3	4.3

Scenarios 5 and 6 are not exactly mirror images of scenarios 2 and 3, as a minimum interest level of 4.0 percent is defined. To review the New York recommendations, we randomly generated 200 interest scenarios. In Session 4, Denny Carr described how he developed 40 interest scenarios. The 200 were developed in a similar way. Each scenario started at 7.3 percent, and the rates after 1 year, 5 years, and 10 years were reviewed. The New York suggestions were compared with the 95th and the 5 percentiles of the randomly generated rates. The rates were not significantly different. Table 10-12 shows the scenarios if the 95th and 5th percentiles are substituted for the extreme rates in each of the New York scenarios. Most of the tests described later use these "adjusted" New York scenarios.

TABLE 10-12

ADJUSTED NEW YORK

INTEREST SCENARIOS

(10-YEAR TREASURY YIELDS)

	Scenario						
Time	1	2	3	4	5	6	7
0	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
1	7.3	8.2	8.6	10.6	7.0	6.8	5.5
5	7.3	11.6	13.8	10.6	5.8	4.8	5.5
10+	7.3	15.8	7.3	10.6	4.3	7.3	5.5

Adjustments for A-Rated Bonds

The scenarios considered so far have only related to Treasury bonds. The normal life insurance company bond portfolio includes a large proportion of bonds of lower quality than Treasuries. In our projection, we assumed an average quality of single A. To convert Treasury yields to A-rated bond yields, a multiplier is applied and a constant addition made. The multipliers and the spreads vary by term. Table 10-13 shows some examples:

TABLE 10-13

A-RATED BOND YIELDS

(ADJUSTMENTS TO TREASURY YIELDS)

Maturity	Multiplier	Spread
90 days	1.024	0.50%
3 years	1.033	0.60
10 years	1.049	0.75
20 years	1.058	0.85

For a 90-day bond, the multiplier is 1.024 and a spread of 50 basis points. If the 90-day Treasury rate is 10 percent, this results in a 10.74 percent yield for 90-day A-rated bonds. Similarly, if the 20-year Treasury is yielding 10 percent, the A-rated bond is assumed to yield 11.43 percent. These multipliers and spreads are based on an analysis of past history.

In addition, a default assumption is required. For A-rated bonds, we assumed an annual default rate of 17 basis points. I'll come back to this whole subject of default later.

Mismatch Life Results

Projections were made using the same block of business that Denny Carr analyzed in Session 4 for Mismatch Life. The product is a typical backload universal life. Table 10-14 gives details of certain years' new business production. The valuation is being performed as of December 31, 1990.

TABLE 10-14

MISMATCH LIFE

HISTORICAL SALES GROWTH (000's)

Year	Annual Premium	Lump Sum	Total
1982	$ 16	$ 4	$ 20
1984	80	40	120
1986	112	55	167
1988	136	30	166
1990	160	16	176

It was assumed that the reserve equaled the cash value. Table 10-15 shows the development of the fund values and cash values since 1980.

TABLE 10-15

HISTORICAL LIABILITY GROWTHS (000's)

Year	Fund Value	Cash Value
1982	$ 25	$ 2
1984	200	44
1986	608	241
1988	1,208	638
1990	2,012	1,235

Projections were made using the New York and "adjusted" New York scenarios described earlier. The discounted value of the cumulative surplus at the end of 20 years was computed for each scenario. The assumptions and methods used were identical to those outlined by Denny in Session 4. Table 10-16 and Figure 10-10 show the results.

TABLE 10-16

DISCOUNTED VALUE OF SURPLUS (000's)

Scenario	New York	Adjusted New York
1	$641	$641
2	503	420
3	548	530
4	524	511
5	540	687
6	535	618
7	614	709

For both sets of scenarios, the discounted values are consistently positive, portraying a supposedly healthy, solvent block of business. The values produced by the New York and the adjusted scenarios are different, but not significantly so. For scenarios 2, 3, and 4, the up scenarios, lower discounted values are shown for the adjusted scenarios, which is to be expected as interest rates go consistently higher. Similarly, the New York values are lower for the down scenarios. However, in addition to looking at the surplus at the end of the

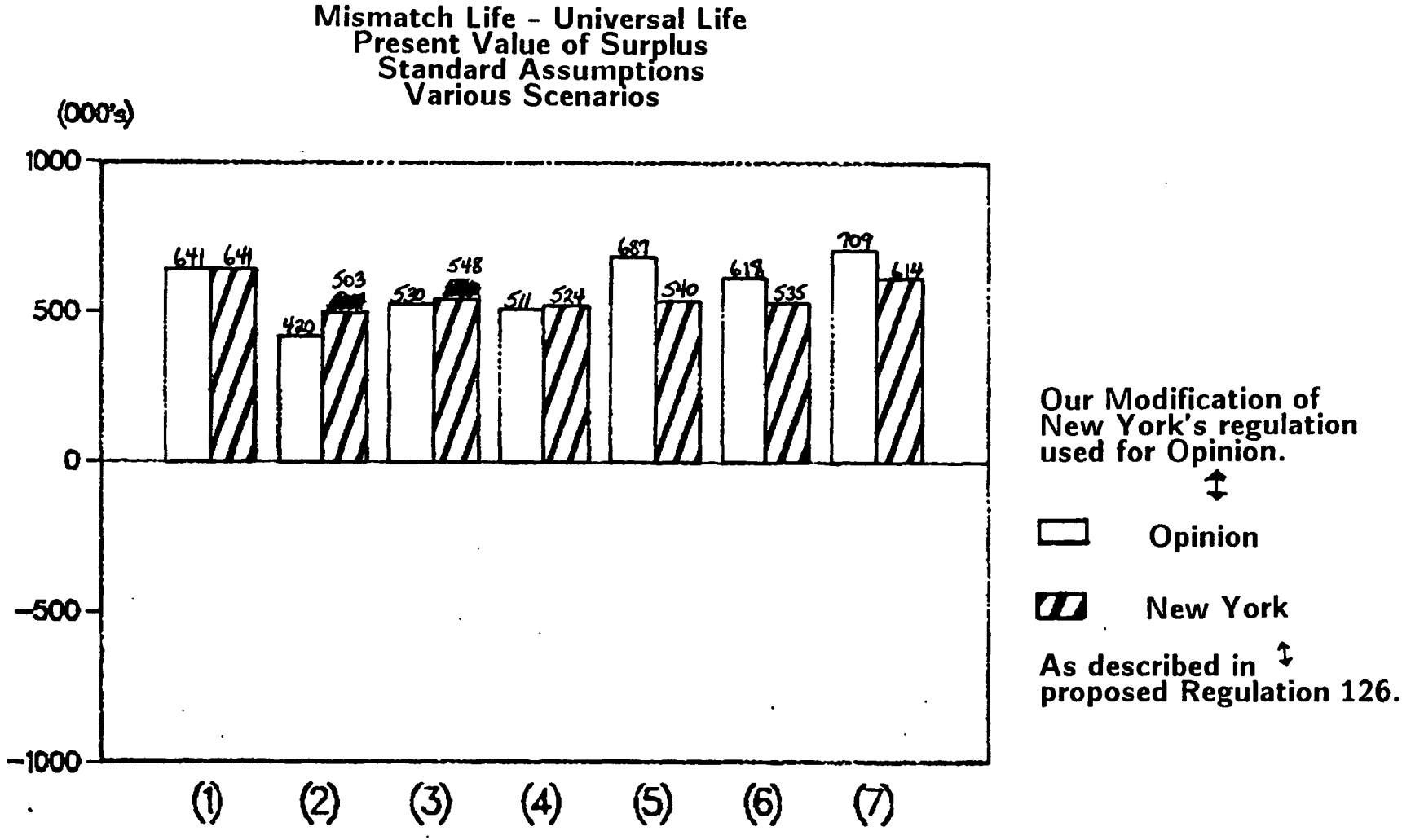

Mismatch Life - Universal Life
Present Value of Surplus
Standard Assumptions
Various Scenarios
(000's)
1000
500
0
-500
-1000
641
641
420
503
530
548
511
524
687
540
618
535
709
614
(1)
(2)
(3)
(4)
(5)
(6)
(7)
Our Modification of New York's regulation used for Opinion.
Opinion
New York
As described in proposed Regulation 126.

FIGURE 10-10

projection period, which is sufficient to satisfy New York's requirements, we look at the progression of this surplus in all years. For two scenarios, cumulative surplus does become negative. Cumulative losses are shown for years 5 through 9 for scenario 3. Similarly, scenario 2 shows cumulative losses in years 8 through 13. Interest rates rise under these two scenarios, and the losses are caused by credited interest being higher than that earned on the matching assets. Also, the reserve basis was assumed to be the cash value, which exacerbates the situation as losses are incurred during the period of surrender charge runoff.

These results suggest that a review of the market value surplus at the end of the projection period should not be the only test applied. A requirement that cumulative book value surplus is never negative appears appropriate.

ACTUARIAL OPINION

However, the actuary of Mismatch Life ignored the year-by-year results and based his opinion on the results at the end of the projection period. A copy of the Actuarial Opinion is shown in Appendix A. A sample actuarial opinion was prepared for this same symposium last year. Three changes have been made to the format to comply with New York requirements. First, it is stated that the actuary was appointed by the board of directors. Second, it is stated, rather controversially, that the reserves are "good and sufficient" rather than "appropriate," which was the description used last year. And third, a comment is included as to what's been happening since the date of the valuation. The report is not prepared until February 15, 1991.

A statement is included saying that events occurring between December 31, 1990, and the date the Opinion was completed were reviewed for materiality, and no material event affecting the Opinion occurred.

ACTUARIAL MEMORANDUM

A sample of an Actuarial Memorandum is shown in Appendix B. I'm going to take you fairly quickly through the structure of this Memorandum. It starts with a fairly broad description of the business in force. Then the in-force reserves are described, along with the basis on which they are calculated. You'll note that reliance is placed on E. Z. Earnings for the preparation of the data.

The third part of the Memorandum outlines the assets that are matching the reserves. Again, reliance as to accuracy of the data is expressed, in this case on Max M. Yield, the chief investment officer. Asset details as to statement value, coupon rate, and maturity date are shown. It shows a fairly healthy situation, with investments in A-rated bonds with coupon rates of 9.25 and 9.75 percent, compared with new money Treasury yields of 7.3 percent, which would suggest a new money A-rated bond yield of about 8.5 percent. Therefore, the assets are showing unrealized gains at the time of the valuation. That's probably the reason why no negative earnings were shown for the "pop up" scenario 4, which increases interest rates 3 percent immediately.

The next section of the report deals with the methodology of how the liability cash flow was projected. The procedures and assumptions that Denny Carr described in Session 4 are shown. Similarly, the methods and assumptions used to project the investment cash flow are outlined. These two sets of assumptions are interrelated and are interactive on a quarterly basis. The interest scenarios are then described, along with the assumed spread between the Treasury and A-rated bond yields. Note that scenarios 3 and 4 did experience an inversion at some stage in their careers. The results are then summarized, showing a fairly

healthy surplus on each of these scenarios. This is the surplus at the end of 20 years. It doesn't tie in with the numbers I showed you earlier, because those were discounted. But as you can see, the worst results in both sets of numbers are shown for scenario 2, the one that crawls up and stays there. All of them show a healthy solvency, however. There follows some rationalization as to why the reserves are good and sufficient. The Memorandum finishes with some limitations, including the point that if actual experience is worse than assumed, then the situation may not be as healthy as portrayed.

STOCHASTICALLY GENERATED SCENARIOS

So, Ernie D. Spread, the actuary, has completed his review and goes on vacation for a while, happy he is associated with a healthy, solvent organization. But is this the way it should have finished? In particular, are the scenarios used the ones that really tell us the whole story? As a check, we ran the projections using 40 stochastically generated scenarios. Table 10-17 and Figure 10-11 show the results of these projections. One New York scenario gives a more optimistic result than all 40 of the stochastically generated scenarios, and the other six show results above the median level. This does suggest that maybe we need to think a bit harder about which scenarios should be used to demonstrate solvency.

Denny Carr showed that if interest rates are assumed to level off after 10 years, then the surplus figures are significantly improved. All seven New York scenarios are level after 10 years. Another reason for the favorable results is that the scenarios have very low volatility. Denny described the recent significant increase in volatility in movements of interest rates. The scenarios being used by Ernie D. Spread are dangerously volatile. A combination of level interest rates after 10 years and low volatility causes the New York scenarios to produce unusually favorable results.

TABLE 10-17

DISCOUNTED VALUE OF SURPLUS (000's)

New York Scenarios		Stochastically Generated Scenarios
1	$ 641	Highest $626
2	503	95th percentile, $577
3	548	
4	524	Median, $434
5	540	
6	535	5th percentile, ($186)
7	614	Lowest, ($228)

It should be noted that the block of business tested was universal life and that significant inward cash flow takes place after 10 years. If we had tested a block of SPDA business, then the conclusions might have been different. However, I think that these results suggest that it may be imprudent to manage your company by just looking at the New York scenarios. Clearly, there is a lot more work needed in the area of selecting the appropriate scenarios to be used in the solvency tests.

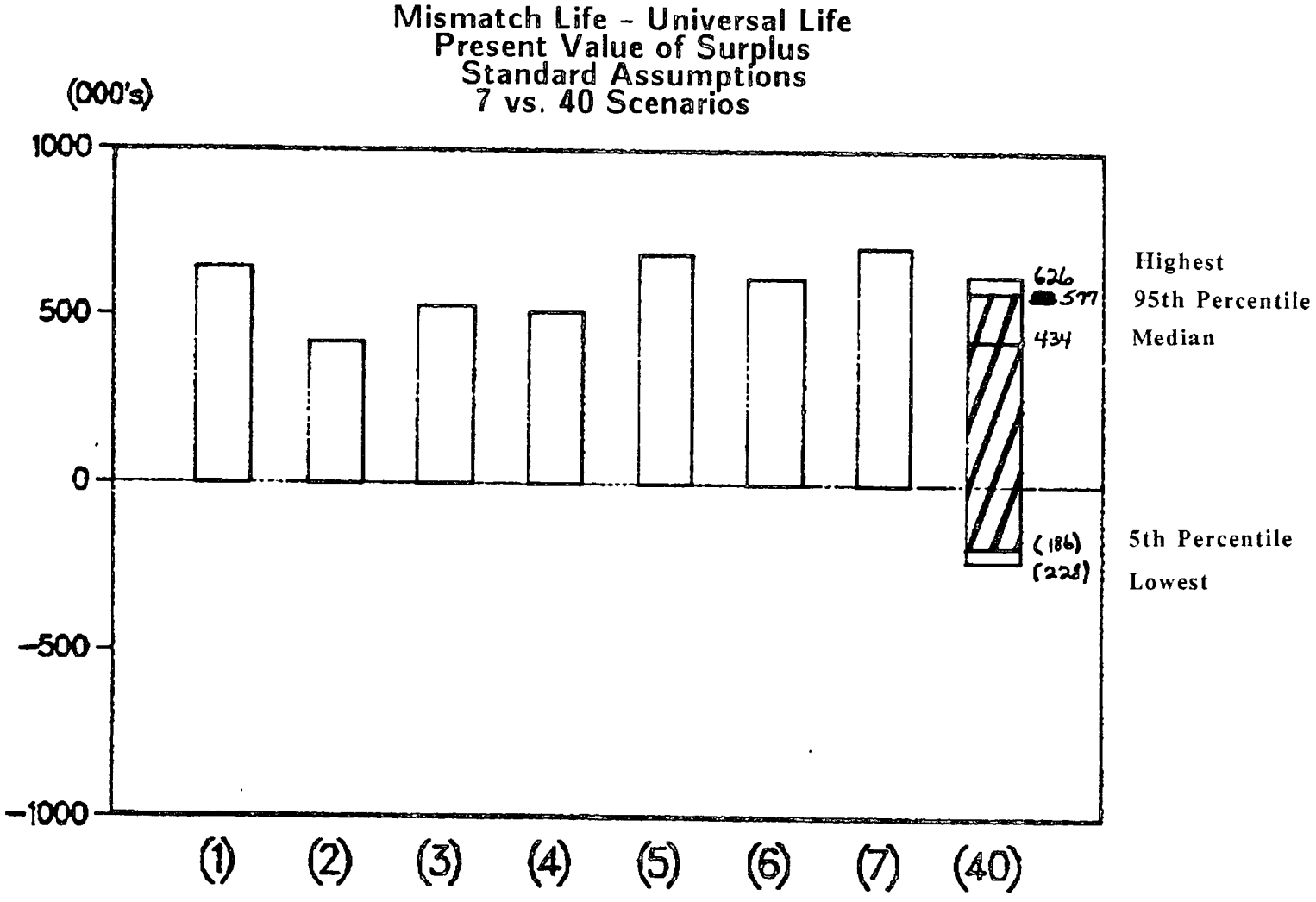

Mismatch Life - Universal Life
Present Value of Surplus
Standard Assumptions
7 vs. 40 Scenarios
(000's)
1000
500
0
-500
-1000
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(40)
626
577
434
(186)
(228)
Highest
95th Percentile
Median
5th Percentile
Lowest

FIGURE 10-11

INTEREST-CREDITING STRATEGY

Now let's move on to some other implications that come out of doing this work. The first relates to interest crediting. You'll find that as Denny showed you in Session 4, results can vary significantly, depending on your interest-crediting strategy. This suggests that some discipline is required in setting that strategy. I'm sure that some of you may have disciplined procedures in place, but I'm equally sure others are pretty undisciplined about how they come up with the credited interest rate on a month-by-month basis. Our research suggests that to achieve satisfactory profitability, discipline is required. It also suggests that the competitor's rate should be part of the formula. Some of the more "macho" actuaries may want to tough it out and always declare earned interest minus 150 basis points, but maybe the in-force business will disappear, and no new sales will be made. If you draw the conclusion that competition is going to be part of the formula, then it is necessary to define competition, which is not that easy. Denny gave a definition of competition, but as we've performed this work over the last year, our definition of competition has moved at least quarterly. This definition is a big assumption, and it's not one that can be made with a high degree of confidence. Clearly, the sensitivity of the results to this assumption must be tested. The only way to increase confidence is to monitor the competition. Who are your real competitors? Keep track of them and develop the definition of competition over the years.

Any interest-crediting strategy and the assumptions that go behind it require regular reviews. You don't lock into a strategy forever. What seems reasonable this year may not be reasonable in 5 years' time, but I'm not suggesting that you only lock into your strategy on a monthly basis.

INVESTMENT STRATEGY

What about investment strategy? There are so many different assumptions that go into this work that to identify very precisely one optimized investment strategy really makes little sense. However, it is possible to identify a certain range of durations of assets that you wouldn't like to be outside.

It is also necessary to define the quality limits. How junky are you prepared to be? I'm going to deal with junk bonds, as Mike Mateia did, later. Calls and prepayments didn't get too much press at last year's symposium. They are getting much more press this year, and not surprisingly, with the call and prepayment action that a lot of us have suffered over the past 12 months. Clearly, this is the year of the prepayment rather than the year of disintermediation, and we are finding that calls and prepayments are just as important as the extra withdrawals.

SYNTHETIC ASSETS

In analyzing a block of business, you might find that you are significantly mismatched and that realignment of your assets is necessary. As Mike Mateja mentioned, you need to think broader than regular mortgages and bonds. There

are a lot of synthetic assets that are being manufactured by the investment bankers, and some of these may fit the liabilities quite nicely. Some of the new mortgage-backed securities, zero coupon bonds, etc., may be better matches to your liabilities than more traditional investments. It is worthwhile keeping abreast of the latest developments.

PAIN THRESHOLDS

In measuring the results of the projections, we have used cumulative surplus and the discounted value of that surplus. But there are certain other measures worth reviewing, which we sometimes refer to as pain thresholds. For example, how low a market value/book value ratio are your comfortable with? Do you want to go through the sleepless nights you had in 1981, when your market values were running at 70 percent of book, or do you want to avoid that? You may wish to select strategies that only have a small probability of the market value/book value ratio dropping below, say, 85 percent.

Also, if you really are the "macho" actuary and crediting earned interest less 1.50 percent whatever the circumstances, you may hit a pain threshold when you find yourself 600 basis points away from the competition. Another statistic to review is the cumulative borrowing/reserve ratio. In most work that's done on this subject, it is assumed that in the event of negative cash flow, borrowing takes place in one form or another. Donna Claire told you in Session 9 that nearly all New York companies assume borrowing; some of them borrow short, others borrow long, and others have negative investments, but nearly all borrow. But this borrowing can get out of hand, and you may have a certain borrowing-to-reserve ratio that causes discomfort. These are a few examples of pain thresholds. This list can be added to, and it's worth thinking through which are

your particular pain thresholds and testing under what circumstances they will be breached.

JUNK BONDS

To close, I would like to return to the subject of junk bonds, because, like Mike Mateja, it's something that worries me. There are several companies claiming they are making their spreads as a result of investing in junk bonds, having only experienced minimal defaults. On average, if you look back at history, the cost of default is significantly less than the cost of the additional yield as you go down the quality curve. But a distorted picture is painted if the results of low-quality investments are projected by increasing the yield of the bonds and deducting the expected average default. Those defaults aren't going to happen nice and regularly on a year-to-year basis. They are going to be uneven, and we need to come up with some way of modeling this. This is an area of research.

One approach is to incorporate randomly generated levels of default in the projection. In order to derive the probability functions, a detailed analysis of the junk bond experience is required. However, considering what has happened to the junk bond market over the last 5 years, junk bond experience of the past is not necessarily going to be repeated in the future. But it's clear that one has to reflect the uneven occurrence of defaults into the projection if one is to take credit for the additional yield that junk bonds provide. I'm not saying that junk bonds are necessarily inappropriate investments; with a sufficiently wide spread of investments, the additional yield may more than compensate for the additional risk. However, the industry urgently requires more research on the subject.

In conclusion, let's look back over the last year since the symposium in 1985. Probably we are now looking at even more unknowns than we were last year. There are more areas for future research that have been identified. But, clearly, there has been progress, if only in identifying these areas of lack of knowledge. I'm hopeful that over the next year or next few years, these areas will be addressed, and addressed successfully.

Appendix A

Statement of Actuarial Opinion
Statutory Annual Statement of the
Mismatch Life Insurance Company
For the Year Ended December 31, 1990

I, Ernie D. Spread, am Vice President and Actuary for Mismatch Life Insurance Company in the state of Domicile, and am a member of the American Academy of Actuaries and meet its qualifications to act as a Valuation Actuary. In a letter to the NAIC Valuation Actuary Bureau dated July 4, 1990, I was appointed by the Board of Directors of Mismatch Life Insurance Company to write this Actuarial Opinion. A copy of the Board's resolution, dated July 4, 1990, was enclosed with the letter.

I have examined the actuarial assumptions and actuarial methods used in determining policy reserves and related actuarial items, as listed below, as shown in the Annual Statement of the Company, as prepared for filing with state regulatory officials, as of December 31, 1990.

(i)	Aggregate Reserve for Life Policies and Contracts (Exhibit 8)	$1,235,346
(ii)	Aggregate Reserve for Accident and Health Policies (Exhibit 9)	0
(iii)	Net Deferred and Uncollected Premiums (Page 2, Line 17)	0
(iv)	Policy and Contract Claims—Liability End of Current Year Incurred by Unreported (Exhibit 11, Part 1, Line 3)	0

I have considered the provisions of the Company's in-force policies and the related administrative expenses. I have considered any reinsurance agreements pertaining to the policies, the interest-crediting philosophy, the characteristics of the Company's assets, and the investment policy adopted by the Company as they might affect future insurance and investment cash flows under the policies and invested assets. My examination included such tests and calculations as I considered necessary to form the opinion stated below.

The unit expenses in the cash flow tests were based on a "going-concern" basis for those contracts in force on the valuation date under consistent sets of assumptions with reasonable margins for adverse deviations, for various paths of future interest rates. Where appropriate, new considerations on lives covered at the valuation date were considered, but no new lives were assumed to be covered except for the above described unit expenses. Particular attention was given to those provisions and characteristics that might cause future insurance and investment cash flows to vary with changes in the level of prevailing interest rates.

In other respects, my examination included such review of the actuarial assumptions and methods, as well as such tests of the actuarial calculations, as I considered necessary under the circumstances.

In making my examination, I have relied upon listings and summaries of policies in force and other associated data prepared by E. Z. Earnings, controller. I relied on the stated investment policy of the Company, including listings and summaries of assets, as provided by Max M. Yield, chief investment officer of the Company. I performed no verification as to the accuracy of these data.

In my opinion, as of December 31, 1990:

1. The policy reserves and other actuarial items shown herein:

   (i) Are computed in accordance with commonly accepted actuarial standards and consistently applied and are fairly stated in accordance with sound actuarial principles.

   (ii) Are based on actuarial assumptions that produce reserves at least as great as those called for in any policy or contract provision as to reserve basis and method and are in accordance with all other policy or contract provisions.

   (iii) Meet the requirements of the insurance laws of the state of Domicile.

   (iv) Are computed on the basis of assumptions consistent with those used in computing the corresponding items in the Annual Statement of the Mismatch Life Insurance Company for the year ending December 31, 1989.

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

2. The anticipated investment cash flows arising from an allocation of assets equal to reserves and other liabilities, plus anticipated considerations to be received from the in-force policies, make good and sufficient provision, according to presently accepted actuarial standards of practice, for the anticipated cash flows required by contractual obligations and the related expenses of the Company.

This opinion is updated annually as required by statute. The impact of unanticipated events subsequent to the date of this opinion is beyond the scope of the opinion. Events occurring between December 31, 1990, and the date the opinion was completed have been reviewed for materiality. No event materially impacting this opinion has occurred. The cash flow portion of this opinion should be viewed recognizing that the Company's future experience will not exactly follow all the assumptions used in the cash flow projection.

Ernie D. Spread, MAAA

February 15, 1991

Appendix B

Actuarial Memorandum
Supporting the Statement of Actuarial Opinion
For the Statutory Annual Statement of the Mismatch Life Insurance Company
For the Year Ended December 31, 1990

RESERVES INCLUDED IN THIS MEMORANDUM

Product Description

Mismatch Life Insurance Company offers nonparticipating Universal Life contracts. The policy is a flexible premium Universal Life policy maturing at age 95. Expense loads are 6 percent of premiums plus $36 per policy each year. Guaranteed cost of insurance rates is based on 1958 CSO mortality, but lower rates currently are being charged. Guaranteed credited interest is 4 percent, and excess interest may be credited. The credited interest rate at December 31, 1990, was 8.22 percent. Surrender charges are applicable to cash surrenders during the first 14 policy years and equal 150 percent of the target premium (for example, $12.00 per $1,000 at issue age 35) for years 1 through 5, grading linearly to 0 in year 15. Current mortality and interest rates are not guaranteed beyond the current policy month.

Policy In Force and Valuation Bases of Reserves

Reserves were calculated equal to the cash surrender values. The in-force and reserves as of December 31, 1990, as show in Exhibit 8 of the Annual Statement of the Company, are illustrated below:

Issue Year	Face Amount (000's)	Fund Value (000's)	Reserves (000's)
1981	$ 456	$ 39,144	$ 36,408
1982	962	71,723	64,797
1983	2,534	170,116	148,830
1984	5,329	299,609	248,451
1985	6,734	314,685	241,958
1986	8,279	315,489	216,141
1987	9,416	273,340	160,348
1988	11,264	234,740	99,572
1989	13,694	183,169	18,841
1990	16,391	109,621	0
Total	$ 75,059	$ 2,011,636	$ 1,235,346

For these figures, I relied upon listings and summaries of policies in force prepared by E. Z. Earnings, Controller. I reviewed the results for reasonableness but performed no verification as to the actuary of these data.

ASSETS INCLUDED IN THIS MEMORANDUM

For the purposes of cash flow projections, invested assets of $1,235,346 were allocated to support Universal Life reserves as of December 31, 1990. A listing of these assets was provided by Max M. Yield, Chief Investment Officer. This listing includes par value and coupon and maturity dates for each security, as well as the book and market values assigned to the security.

I did not verify the calculation of these values or the records of securities held that formed the basis for these calculations. This listing provided the basis for the projections of investment income and asset maturities. The assets are summarized below:

A-RATED BONDS

Statement Value	Coupon Rate	Maturity Date	Call Protection Until
$ 63,620	9.25%	6/91	1/91
85,856	9.25	6/92	1/92
113,652	9.25	6/93	1/93
151,330	9.25	6/94	1/94
203,215	9.25	6/95	1/95
8,030	9.75	6/99	1/90
39,531	9.75	6/00	1/91
63,620	9.75	6/01	1/92
85,239	9.75	6/02	1/93
111,181	9.75	6/03	1/94
142,682	9.75	6/04	1/95
167,389	9.75	6/05	1/96
$ 1,235,346			

PROJECTION OF INSURANCE CASH FLOWS

A model projection was prepared of the Universal Life contracts in force as of December 31, 1990. A description of the product and of the assumptions used for projections is given in Exhibit 1. For each year of issue, the in-force business was modeled into a single cell. The initial model reserves, premiums, and face amount were validated to actual values. Although the characteristics of each model cell would not necessarily generate the same values as the aggregate of all the policies in the cell for different projections, in my opinion, the differences are not material.

The projection of insurance cash flows took into account projected excess interest credits, policy terminations from deaths and surrenders, and maintenance expenses and commissions. It was assumed that level target premiums were received from all in-force policies. Premiums were assumed to be paid quarterly.

Projected excess interest credits were determined based upon current Company practice. The credited rate in each projection quarter is set as the portfolio average earnings rate for the previous quarter, net of investment expenses and

provision for defaults, less 150 basis points, but not more than 50 basis points different than the "competition rate" (defined as the larger of the 2-year rolling average of 5-year Treasury bond yields less 50 basis points, or the current 5-year Treasury bond yield less 25 basis points).

Policy terminations from death were projected using the Company's current assumptions for product pricing, increased by 5 percent as a margin to cover reasonable deviations from expected assumptions. No future improvement of mortality was assumed.

The credited interest rate procedures result in little difference between credited interest rates and competitive interest rates. At the worst differential of the credited rate's being 0.50 percent less than the competitive rate, an extra 0.50 percent lapse rate was assumed. Policy loans and partial withdrawals are insignificant and assumed to be zero.

Maintenance expenses of $35 per policy in force were assumed, which is $2 per policy higher than current experience. Maintenance expenses were assumed to inflate at a rate equal to the current 3-year bond yield less 5 percent. Percentages of premium expenses were 5 percent for commissions and 2 percent for premium tax.

Federal income taxes were assumed payable on gains from operations at a rate of 36.8 percent. Credit was given for negative taxes.

PROJECTION OF INVESTMENT CASH FLOWS

After consultation with the Chief Investment Officer, the investment cash flows were projected as follows. The timing and amounts of coupon income and maturities were projected for the securities held on December 31, 1990, in support of the Universal Life reserves. It was assumed that these securities would be held until maturity or call. In the event of any negative cash flows, funds were assumed to be borrowed at the current 90-day rate plus 2.00 percent.

Investment cash flows, combined with the insurance cash flows, are used first to pay interest on borrowed funds and then to pay off any short-term borrowed balances outstanding. Any net positive cash flow is invested each quarter at the new money interest rate in order to maintain the following desired mix of in-force assets (in order of priority):

Asset	Call Protection	% Total
5-year A bond	5 years	50%
15-year A bond	5 years	50

Where market interest rates were less than average coupon rates on the bonds by at least 200 basis points, it was assumed that the bonds would be called if it were to the borrower's advantage to do so. A 2 percent call premium is applicable. It was assumed that the borrower would have a 1.35 percent refinancing cost.

Capital gains taxes were assumed payable at a rate of 28 percent. Investment expenses were assumed to be an annual rate of 0.12 percent. Defaults for A-rated bonds were assumed to have an annual rate of 0.17 percent.

INTEREST SCENARIOS

The spot curve of U.S. Treasury yields as of December 31, 1990, was established. Projections were made under seven scenarios of future yields. These projected U.S. Treasury yields are summarized in Exhibit 2 for yearly anniversaries of the valuation date. The rates assumed at interim dates and intermediate years to maturity were calculated as linear interpolations of the given rates. U.S. Treasury yields were converted to A bond yields by assuming that the A bond yield equals the U.S. Treasury yield times a multiplier, plus a spread, as follows:

	Maturity			
	90-Day	3-Year	10-Year	20-Year
Multiplier	1.024	1.033	1.049	1.058
Spread	0.50%	0.60%	0.75%	0.85%

Brief descriptions of the seven scenarios follow:

Scenario 1: Rates remain level during the projection period.

2: Rates rise gradually for 10 years and then level off.

3: Rates rise gradually for 5 years and then fall to the original levels.

4: Rates rise sharply for 1 year and then level off.

5: Rates fall gradually for 10 years and then level off.

6: Rates fall gradually for 5 years and then rise to their original level.

7: Rates fall sharply for 1 year and then level off.

In scenarios 3 and 4, the yield curve inverts and then returns to its original shape.

SUMMARY OF RESULTS

Total cash flows, including both insurance and investment cash flows, and allowing for reinvestment of net positive cash flows and borrowing to cover net negative cash flows, were projected to the end of a 20-year period. The market value of assets, based on the assumption that interest rates after such date would be frozen at the prevailing rate on that date, was then compared with policy reserves. Although significant cash flows under Universal Life contracts extend beyond 20 years, the results beyond 20 years are not included here. All scenarios covered in this Memorandum generated higher present values of surplus when extended beyond 20 years.

The results of the projections at the beginning and end of the projection period for all the interest rate scenarios are summarized below:

	Market Value of Assets (000's)	Reserves (000's)	Surplus (000's)
December 31, 1990	$ 1,235	$ 1,235	$ 0
December 31, 2010			
Scenario 1	7,548	6173	1,375
Scenario 2	16,405	15,670	735
Scenario 3	9,317	7,971	1,346
Scenario 4	11,669	10,223	1,446
Scenario 5	5,621	4,393	1,228
Scenario 6	6,211	5,034	1,177
Scenario 7	5,825	4,570	1,255

HOW RESULTS WERE USED IN FORMING THE OPINION

On the basis of the uniformly positive surplus results, it is concluded that the above reserves and the assets held in support of such reserves make good and sufficient provision for the liabilities included in this Memorandum.

LIMITATIONS

The Universal Life business is subject to cash flow matching risks in increasing interest rate environments, both steady increases and increases during the upside portions of interest cycles. When interest rates rise, the portfolio earnings rate will not rise as quickly as competitors' credited interest rates, and earned rates will not support the credited rates. If credited rates are kept less than market rates to maintain the interest earnings, surrenders may increase, forcing the Company to borrow or liquidate assets during periods of high interest rates. This is known as market value risk. (When interest rates decline, high-yielding assets may be called, leading to increased investment activity during periods of low interest rates. This is known as reinvestment risk.)

The exposure to market value risk is determined primarily by the interest-crediting strategy, the amount of policy surrenders, and the maturity structure of the asset portfolio. The maturity structure of the portfolio and the interest credited to the product are controlled by Mismatch Life. If future investments have maturities different than assumed in these projections, or if the interest-crediting strategy is different than assumed in these projections, then the business would be exposed to market value risks not anticipated in these projections.

The exposure to market value risk also is determined by the amount of policy surrenders and the interest rates on similar products being offered by competitors. These items cannot be controlled directly by the Company. If future surrenders or competitors' interest rates are higher than those assumed in the projections, then the business would be exposed to market value risks not anticipated in these projections.

In addition to investment risks, the business is exposed to several other risks. Product-related risks include the level of death claims and maintenance expenses. Other risks are the risk of asset default and changes in federal income tax. To the extent that these items exceed those assumed, the business could be exposed to risks not anticipated in these projections.

Ernie D. Spread, MAAA

February 15, 1991

EXHIBIT 1

MISMATCH LIFE INSURANCE COMPANY—UNIVERSAL LIFE SUMMARY OF MODEL CELL SPECIFICATIONS AND ASSUMPTIONS

Product Specifications

1. Plan. Policy Form UL-1981-90. Universal Life with level net amount at risk.

2. Target premiums. Used as basis for first-year commissions and surrender charges, annual premium per unit.

Issue Age	Target Premium
35	$8.00

3. Expense loads. 6 percent of premium, $36 per policy all years, assessed monthly.

4. Surrender charges. 150 percent of target premium years 1 through 5, decreasing 15 percent of target premium each year, to 0 in year 15.

5. Cost of insurance charges. Guaranteed rates equal to 1958 CSO age last birthday. Current rates per $1,000 as of 12/31/90:

Attained Age	Annual Cost of Insurance
35	$1.58
40	2.36
45	3.16
50	5.14
55	6.99

6. Interest credited. 4 percent guaranteed.

7. Current interest-crediting strategy. Portfolio average earnings rate for previous quarter less 1.5 percent, not more than 0.50 percent different from "competition rate." (Competition rate is larger of 2-year rolling average of 5-year Treasury bond yields less 0.50 percent, or current 5-year Treasury bond yield less 0.25 percent.)

6. Investment strategy. Positive net cash flow invested each quarter to maintain desired mix of in-force assets (in order of priority):

Asset	% Total
5-year A bond	50%
10-year A bond	50

EXHIBIT 1
(Continued)

Assumptions

1. Model plan. Issue age 35, male.

2. Premiums. Target premium paid each year in force. Quarterly mode.

3. Withdrawals. No loans or partial withdrawals, except for lapse.

4. Lapse rates. Base rates as follows:

Policy year	
	1—18%
	2—12
	3—8
	4+—5

Addition to base rates due to competition rate (i') being higher than current rate (i) = $200(i - i)^2$, for example:

i' - i	Additional Lapse
0.50%	0.5%

5. Mortality. A percentage of the 1965 to 1970 Select and Ultimate, Male table, as follows:

Duration	Percentage
1	62%
5	58
10	53
15	49
20	52

6. Expenses.

Maintenance: $35 per policy.
Commissions: 5 percent premiums.
Premium tax: 2 percent premiums.
Inflation: Maintenance expense inflated at rate equal to 3-year bond rate less 5 percent.

7. Federal income tax. 36.8 percent on statutory gain from operations.

EXHIBIT 2

MISMATCH LIFE INSURANCE COMPANY—UNIVERSAL LIFE

Scenarios

#1—Level

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	6.00	6.60	7.30	7.40
1992	6.00	6.60	7.30	7.40
1993	6.00	6.60	7.30	7.40
1994	6.00	6.60	7.30	7.40
1995	6.00	6.60	7.30	7.40
1996	6.00	6.60	7.30	7.40
1997	6.00	6.60	7.30	7.40
1998	6.00	6.60	7.30	7.40
1999	6.00	6.60	7.30	7.40
2000+	6.00	6.60	7.30	7.40

#2—Slow Up and Level

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	6.70	7.40	8.20	8.30
1992	7.40	8.10	9.00	9.10
1993	8.10	8.90	9.90	10.00
1994	8.80	9.60	10.70	10.80
1995	9.50	10.40	11.60	11.70
1996	10.20	11.20	12.40	12.50
1997	10.90	12.00	13.30	13.40
1998	11.60	12.70	14.10	14.20
1999	12.30	13.50	15.00	15.20
2000+	13.00	14.20	15.80	16.00

#3—Up, Then Down

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	7.10	7.70	8.60	8.70
1992	8.10	8.90	9.90	10.00
1993	10.60	10.60	11.20	11.20
1994	13.80	12.40	12.50	12.40
1995	16.60	14.20	13.80	13.50
1996	13.80	12.40	12.50	12.40
1997	10.60	10.60	11.20	11.20
1998	8.10	8.90	9.90	10.00
1999	7.10	7.70	8.60	8.70
2000+	6.00	6.60	7.30	7.40

#4—Sharp Up, Then Level

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	11.70	10.50	10.60	10.50
1992	12.70	10.90	10.60	10.40
1993	12.70	10.90	10.60	10.40
1994	11.70	10.50	10.60	10.50
1995	8.70	9.50	10.60	10.70
1996	8.70	9.50	10.60	10.70
1997	8.70	9.50	10.60	10.70
1998	8.70	9.50	10.60	10.70
1999	8.70	9.50	10.60	10.70
2000+	8.70	9.50	10.60	10.70

#5—Slow Down,Then Level

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	5.70	6.30	7.00	7.10
1992	5.50	6.00	6.70	6.80
1993	5.20	5.80	6.40	6.50
1994	5.00	5.50	6.10	6.20
1995	4.80	5.20	5.80	5.90
1996	4.50	5.00	5.50	5.60
1997	4.30	4.70	5.20	5.30
1998	4.00	4.40	4.90	4.90
1999	3.80	4.10	4.60	4.60
2000+	3.50	3.90	4.30	4.30

#6—Down, Then Up

Date 12/31	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	5.60	6.10	6.80	6.90
1992	5.20	5.70	6.30	6.40
1993	4.80	5.20	5.80	5.90
1994	4.30	4.80	5.30	5.40
1995	3.90	4.30	4.80	4.80
1996	4.30	4.80	5.30	5.40
1997	4.80	5.20	5.80	5.90
1998	5.20	5.70	6.30	6.40
1999	5.60	6.10	6.80	6.90
2000+	6.00	6.60	7.30	7.40

EXHIBIT 2
(Continued)

Date 12/31	#7—Sharp Down, Then Level			
	90-Day	3-Year	10-Year	20-Year
1990	6.00%	6.60%	7.30%	7.40%
1991	4.50	5.00	5.50	5.60
1992	4.50	5.00	5.50	5.60
1993	4.50	5.00	5.50	5.60
1994	4.50	5.00	5.50	5.60
1995	4.50	5.00	5.50	5.60
1996	4.50	5.00	5.50	5.60
1997	4.50	5.00	5.50	5.60
1998	4.50	5.00	5.50	5.60
1999	4.50	5.00	5.50	5.60
2000+	4.50	5.00	5.50	5.60