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**COURSE 230 "LIGHT": A "LESS FILLING"  
OVERVIEW OF THE FELLOWSHIP EXAM ON  
PRINCIPLES OF ASSET/LIABILITY MANAGEMENT**

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During the last five years, the Fellowship syllabus has been strengthened with a number of exams on investment and finance topics. This teaching session will introduce Course 230 to "seasoned" actuaries who missed the opportunity to study this material on their road to Fellowship. The focus of this session will be only to expose the various subjects covered, identify reading materials, and highlight a few topics.

MR. ROBERT R. REITANO: I will provide an overview of the examination syllabus and the development activities of the Investment Course Context Committee (ICCC). Judy Strachan will review two chapters of the John McGinn and Donald Tuttle book, *Managing Investment Portfolios* [published 1991], on investment policy development for institutional investors, and in particular, life insurers. She'll be followed by Gordon Klein who will be reviewing one of the chapters in the Z. Bodie, A. Kane and A. Marcus book, *Investments*, on option pricing [published 1992].

I'm a second vice president of the Investment Policy & Research Department at the John Hancock. My primary interests in research and applications, besides the obvious general area of investment policy development, are the development of risk capital management strategies, multivariate duration risk measures and management, and the immunization applications of that theory. As an offshoot of that work, I consider myself a student of option pricing and stochastic dynamics models, but I would very much emphasize student of these fields. I'm not really someone who is contributing to them, beyond my efforts in expository writing and teaching.

Judy, who will be following me, is an education actuary with the Society of Actuaries. She's the staff actuary for the Finance & Investment Management Practice Area, as well as the Finance Track, and Courses 230 and 220 and 150. Before joining the Society of Actuaries last August, Judy spent 11 years with the John Hancock and worked in the group insurance area, as well as in the agency department as director of finance.

Gordon Klein is with Polysystems in Chicago. His current duties include analysis and design of valuation and projection systems, cash-flow testing and the development of all types of life insurance and annuity products. He joined the Exam 230 Committee when it was originally called Exam V-380, but I will be giving more details on that change in a moment. Gordon has been the vice chairperson for that Examination Committee for the last two years. He's also the vice chairperson of the Committee for Exam, F-485, Advanced Portfolio Management, and is a vice chairperson of the Committee on Papers and serves on the finance group of the Committee on Papers.

So with those introductions, let me begin by giving you a bit of an historical perspective on the exam structure that we have. For those of you who have begun to develop gray hairs in your head, you probably remember that prior to 1987, everything we learned about economics, investments, duration matching, and so forth was found on what used to be called Part 7. In particular, Irwin Vanderhoof's very nice study note on duration matching, which was based on a *Transactions* paper he wrote, was on Part 7, as well as an investment text, which was getting dated even in my day. More recently, we had Exam 220 which evolved from Part 7; it was an attempt at bringing together a variety of investment topics. Of course, there was considerable interest in the Society of Actuaries in the developing investment markets and in the actuarial community as a result of the late 1970s and early 1980s when we experienced unprecedented volatility in interest rates. We also saw unprecedented disintermediation in our life insurance products, and it became quite clear to actuaries that there was very much an asset side of our balance sheet and it had a great deal to do with our responsibilities in thinking about our company's financial health.

Greg Carney chaired a task force in 1989, the goal of which was to determine what every actuary should know about investments. This charge was quite a tall order. The people on that task force were Joe Buff, Luc Girard, Pete Hepokoski, Eric Lofgren, Dick Mattison and Rob Stapleford, many of whom have remained very active in either developing exams or participating in activities with the Investment Section Council. This report was presented to the Board of Governors of the Society of Actuaries in 1989, and at that time they also considered whether there should be an investment track. The Board of Governors decided that they wouldn't recommend a track at that time because the focus of the effort was to be on the development of examination materials. They recognized that a track involved a certain amount of structural and political delays with the Education and Examination (E&E) process. The simple development of examination materials did not. Furthermore, it was decided that over the next two to three years the Investment Course Content Committee would be formed and would be charged with enhancing Course 220, a core exam, and developing another three or four investment electives. Bruce Moore was the first chairperson of that committee, which included Irwin Vanderhoof, Luc Girard and Rob Stapleford. I was the second chairperson. Dick Mattison and many, many others were also involved. Greg Carney was our board liaison. I should note that while we all worked hard on this committee, Rob is recognized by all as the engine that made us go.

After that job was completed the Executive Committee asked the E&E Committee to pursue the development of an investment or a financial track. A task force chaired by Bruce Moore was asked to study if there should be a new track and whether the current slate of investment examinations were adequate. They concluded that investment education needed to be strengthened for all actuaries because Exam 220 wasn't enough according to the Carney Report. The ICCC knew that when it developed the course. Second, the committee recommended that there be a broad-based finance track, rather than just an investment track; this track should include not only finance as one thinks about finance in the Treasury Department of a company, but also financial reporting.

COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

The ICCC then changed its name to the Finance Course Content Committee (FCCC), and we were charged with developing four new courses that would have a broader focus than our investment exams and with developing the finance track. Of course, we needed to re-recruit for that purpose. Most of the people on the ICCC had a much broader investment background than a financial reporting background. Our first step was to include Exam 230 on the core. Exam 230 was originally the first elective exam in our program, and it represented the materials we couldn't quite squeeze onto Exam 220, but we still thought every actuary should know. In its first appearance it was called Exam V-380. The final form of the finance track was approved in 1993, and the structure of it is similar to most tracks: there are 90 required credits and 60 elective credits.

Table 1 is a listing of the investment and finance examinations. The first set of examinations that we developed before the track was introduced were Courses 220 through F-590. That's why they're in that particular order. Those examinations, through corporate strategy and solvency management, were developed before the issue of the Finance track was settled. Exams F-385, F-482C/F-483U and F-585 were developed to fill in the necessary requirements for a track. As I said before, for the finance track you are required to take 90 credits. The 90 credits range on the table from F-580, Corporate Finance, down to F-585, Applied Corporate Finance. F-480 and F-485 are possible electives, giving 30 credits out of a total of 60 that you need to complete for the finance track. As I noted earlier, 230 is now a core exam. Course 230, of course, is what we're going to be talking about.

TABLE 1  
INVESTMENT AND FINANCE COURSE SUMMARY

Course	Title	Credits
220	Introduction to Asset Management and Corporate Finance	30
230	Principles of Asset/Liability Management	15
F480	Advanced Asset/Liability Management	15
F485	Advanced Portfolio Management	15
F580	Corporate Finance	15
F590	Corporate Strategy and Solvency Management	10
F385	Financial Management	20
F482C/ F483U	Advanced Financial Management (Canada/U.S.)	25
F585	Applied Corporate Finance	20

Now I'll review the development of the core exams, 220 and 230. I already gave you an overview. The Carney report, which started it all, came out in 1989. It identified five areas in which all actuaries should have knowledge. It's actually a very fascinating report, it obviously reflected a tremendous amount of effort and thinking, and Greg is to be commended for chairing that effort. The Carney Report

recommended that actuaries need to have broad exposure to the financial markets, the instruments in them, and how those markets operated. They need to have a good understanding of the yield-curve components and yield-curve dynamics, such as the credit implications of the yield curve, and the implications of the yield curve's shape. Option characteristics and option pricing theory are also integral to actuarial work. We all are exposed to embedded options. Anyone who works in an insurance company is exposed to what's called a short straddle on Wall Street. We have options on both sides of the balance sheet. So, if you don't understand option pricing theory, you're at a distinct disadvantage. Everyone is familiar with New York Regulation 126 and cash-flow testing requirements, but scenario testing noted here includes stochastic scenario testing and understanding the implications of that theory for both cash-flow testing and solvency testing purposes. Finally, the various legal requirements associated with the investment markets were identified as a necessary area of actuarial expertise.

The Carney Report also recommended that this investment knowledge is needed for three core areas of actuarial responsibility: the pricing function, the evaluation and control of risk, and the valuation. I think that the evaluation and control of risk is, in many respects, where the finance track addressed its focus and filled in what might have been recognized as something of a gap but pricing and valuation also received needed attention.

Now let me review Exam 230. Exam 230 is made up of three main topics. One is asset management, another is pricing valuation and product design, and the last is tools and techniques. We on the Investment Course Content Committee thought about exams in a structural way, and these are three important structural categories that we ought to address. So, as we reviewed materials, we asked what topics fit into the general classification of asset management. Which of them fit into applications which was another name for pricing, valuation and product design? Which fit into tools and techniques? We also had a couple of other categories.

Under asset management we have several topics. Investment policy objectives, equity portfolio management, and portfolio monitoring and rebalancing which are from the John McGinn and Donald Tuttle book, *Managing Investment Portfolios* which is also used on the Certified Financial Analyst (CFA) exams.

Judy will be reviewing investment policy objectives, and in particular, investment policy development for insurance companies. The topics default returns on high-yield bonds and foreign investment and currency management address credit and foreign risks and are now covered by three study notes.

For pricing, valuation and product design, we used a single-premium deferred-annuity (SPDA) immunization paper which was published by Morgan Stanley and written by Jim Tilley and some of his associates. For tools and techniques, we go back to McGinn & Tuttle for fixed-income portfolio construction. We have three chapters from *Investments* on option pricing, forwards, and futures. As I mentioned a moment ago, Gordon Klein will be reviewing the chapter on option pricing. Swaps and option-adjusted spreads are covered in *The Handbook of Fixed Income Securities* by F. J. Fabozzi. The final topic is another Tilley contribution to this exam on stochastic interest rate generators. His "An Actuarial Layman's Guide to Building Stochastic

## COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

Interest Rate Generators" was published in *Transactions*, Volume XLIV, 1992, page 509. Jim won the Annual Prize for it. Well, that's a quick overview of how we got to Exam 230 and the material in it.

Judy will review investment policy development for the life insurance companies.

MS. JUDY L. STRACHAN: I'm going to focus on McGinn & Tuttle's *Managing Investment Portfolios*. This is a book that was edited by John McGinn and Donald Tuttle. Both of the editors are chartered financial analysts. The text is used on the CFA exam. That was actually a goal of the Objectives Committee when they chose it. They wanted the material on the track to be material that other investment professionals had to learn so that we would be in the same position as other investment professionals. It was published in 1990. When you are reading it, you will find that a few sections of the text are dated, but, in general, it's still a very good overview of the issues.

I'm first going to run through the chapters from McGinn & Tuttle that are on Course 230. Chapter 4 is the chapter I'm going to focus my talk on. It's titled "Determination of Portfolio Policies." Next is Chapter 8, "Portfolio Construction for a Fixed-Income Portfolio." Chapter 9 is "Equity Portfolio Management." Chapter 13 is "Managing the Investor's Portfolio," and Chapter 14 is "Evaluating Portfolio Performance." This text is also used for Course 485, Advanced Portfolio Management. It follows neatly from Course 230, by using Chapter 7, "Asset Allocation," and Chapter 10, "Real Estate Portfolio Management."

So, as I mentioned, I'm going to focus on Chapter 4. Because I have a life insurance background, I'm going to focus on Chapter 4 for a life insurance company. If you look at Chapter 4, "Determination of Portfolio Policies," it also covers employee benefit funds, nonlife insurance companies, and commercial banks. We are going to focus on part of Chapter 4.

The considerations for each type of organization are very similar. So, you should be able to generalize from the part of Chapter 4 that I'm focusing on to the other types of funds. The four major issues, if you're determining an investment policy for a life insurance company, are your return requirements, your risk tolerance, your liquidity requirements and your tax and regulatory issues as they apply to your situation.

We will look at each issue. In setting your return requirements or your minimum return requirements, you are talking about how you are going to manage your spread. This is the spread between what you need to credit your policyholders with and what you're earning on your portfolio. You cannot look at a return requirement without thinking about a risk trade-off. So, you need to always think in terms of a return/risk trade-off. As you set your return requirements and your return/risk trade-off, you're going to have to think about things like what products you are selling. Do you have a traditional whole-life portfolio? Are you selling variable flexible annuities? You are going to have very different return/risk trade-offs.

You need to look at your market niche. Are you selling to relatively unsophisticated policyholders who are really looking at you to be certain that you have the money to pay their claim when they have a claim event? Or are you looking at sophisticated

policyholders who are undecided between you and the mutual fund down the street, or even between your annuity and your mutual fund? Those are the factors you look at when you examine your market niche. Finally, how much surplus growth do you need to cover your premium volume increase? How much surplus growth do you need to cover infrastructure improvements of the company? Do you need a new, major administrative system? Those are the types of surplus growth issues to be considered. Also, while you're looking at your return requirements, you need to be thinking of issues like how large is your portfolio, and can it be segmented? Do you want to segment or keep all your assets together in one portfolio? There will be certain efficiency issues and certain appropriateness issues depending on how you make that decision.

In looking at risk tolerance you've got all the issues you had with your risk return trade-offs. In addition, when you're talking about risk tolerance, you have sort of externally-imposed issues to look at like risk-based capital (RBC) and the market value of your assets. These are appearance issues, and the last three are real issues. For the external or appearance issues, you could have a perfectly sound company but look bad on a RBC-ratio basis. So, you need to manage your portfolio not only to look at your current RBC position but also your goal. Your company probably has a goal for what it wants its RBC ratios to be. Of course, if you have an appearance problem on that issue, you are going to have to be more conservative in your investment policy.

Similarly there are now requirements that your trading assets and your assets classified as assets available for sale have to be marked to market. That's going to cause volatility in either your balance statement or your income statement or both, depending on how you have your assets allocated. You need to think about the effect that will have on the way your company looks to your policyholders and to the regulators.

The last three issues are a real problem. You need to look at the cash-flow volatility that you could afford based on your underlying product mix. You need to evaluate management's tolerance for cash-flow volatility. For your reinvestment risk, you need to think about several issues. Can you afford to have a large mortgage portfolio and have it all prepaid because interest rates dropped? For your credit risks, you want to think about your asset allocation. Do you want your whole portfolio in junk bonds, or do you need to be in investment grade bonds?

The next major issue is your liquidity requirements. Risk tolerance and liquidity requirements are closely related. The volatile interest rate environment we're under now means you have to pay more attention to maturity and duration requirements. You also have to look at your portfolio, your product mix, your company size, and particularly your assets' segmentation. You can be a fairly small company and still customize your portfolio by product by allowing only 25% of the assets within a segment to be customized and the rest to be general assets for the corporation.

The final major issue is tax and regulatory concerns. The new National Association of Insurance Commissioners (NAIC) model investment law is addressing specific limits on all types of assets, particularly junk bonds and foreign investments. These will apply to your general account. Within separate accounts you can have more flexibility, but

## COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

if you're talking about your general account, you have certain limitations on both eligible asset classes and on the size of asset allocation within those classes. That will constrain what you can do. You could decide that since you are selling entirely flexible variable annuities, you want your general account to be in a diversified portfolio of junk bonds. However, the regulators won't let you do that.

Similarly, changes in income tax are an issue you have to look at. The big issues, at least recently, are the fact that your income and your capital gains are taxed the same. It limits the need to look as closely at whether you are getting your investment income from capital appreciation or from coupons. You also need to look at your alternative minimum tax situation. It is important to keep your product mix in mind when reviewing your tax position. For example, if you are investing for a pension fund, it's not as important to invest in tax-free assets because the buildup in a pension fund is not taxable.

Once you go through all those issues, and you have thought about the company's product mix, the markets you're selling to, your portfolio size and all the other issues, you are going to need to set an investment policy. You will need to develop a policy by segment. Within each segment you will want to set an investment policy by asset class. You will need, for example, to look at your return requirements for your flexible variable annuities and, within that segment, what your return requirement is for your bonds, your mortgages, your real estate and what your risk tolerance is for those same assets. Finally you will need to step back and say, I've done all my segments. What will my overall investment policy be? What assets are going to be common? What are my common investment objectives for each of those four major issues?

My talk focused on life insurance companies. The same sorts of issues, the same sorts of thought process and the same logic would apply to any of the institutions, banks, nonlife insurance companies, and pension funds.

MR. REITANO: We'll now turn it over to Gordon.

MR. GORDON E. KLEIN: I'm going to be discussing some of the material that's in the book *Investments*. This book, as Bob mentioned, is used on the CFA exams, and also parts of it are used on Exam 220. People don't have to buy a new book for Exam 230. The material that's on Exam 230 is Chapters 19 and 20 and 21. Chapter 19 discusses options. It includes a discussion of the Black Scholes formula for valuing a European call option. Chapter 20 discusses some of the problems that are involved in the valuation of call options or put options and some of the limitations of the Black Scholes formula. And Chapter 21 discusses futures.

It would take much longer than we are allotted for this session to talk about all of this material. Therefore, I'm going to restrict myself to Chapter 19 and a little bit of Chapter 20. I'm going to talk about options not futures, and, of course, it will not be a complete discussion of options. So, I'd recommend to people who are involved in this area at all to get this book or a similar book and read up on options in more detail.

The first thing I want to talk about is why options are important to actuaries. Why do actuaries need to know anything about options? The first reason I can think of is that whenever you're talking to your investment people, they're going to be using the language of options and other investment terms; you need to be able to discuss these things with them. For instance, if you're doing cash-flow testing and you're modeling puts and calls or assets with embedded options like collateralized mortgage obligations (CMOs), you need to be able to talk to your investment people and understand what they're saying.

Another reason is that many features of insurance products really can be thought of as options of one type or another. This means that the models that are used to price options can also be used or modified for use in pricing insurance products. As an example, single-premium deferred annuities and most life insurance policies have cash values that can be taken, and this can be thought of as a put option that the company is giving to the policyholder. It's an option to sell the policy back at a pre-determined price to the insurance company. Even if the insurance company really wouldn't want to buy it back at that price, they're obligated to do so.

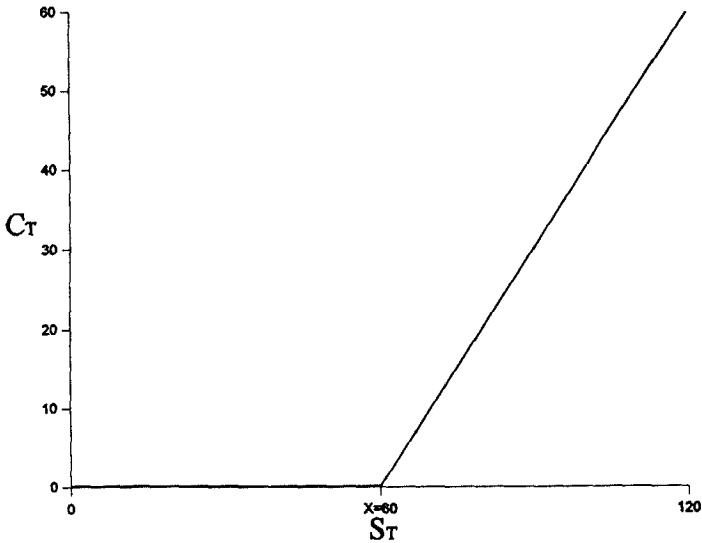
If you price a deferred annuity without recognizing that this option has been granted, then it's just like giving it away for free, and some companies in the past have done that. Maybe none do anymore but I doubt it. Another example is that you may want to design a product around options that are available. Usually, insurance companies that are fairly large can have options or other financial instruments custom-made for them, so if they can think of something that they want, they can usually find someone who will design it for them, or they can use things that are readily available. An example from the banking industry and somewhat from the insurance industry is the certificates of deposit that guarantee that you will get at least a percentage of the increase in some stock index, like the Standard and Poor's (S&P) 500. The bank selling that CD is really selling you a call option on the S&P 500, and at the same time it buys one itself as something of a reinsurance transaction.

So, we really have three reasons for learning about options. One is to be able to talk with your investment people and understand what they're talking about. Number two is for pricing insurance products that behave like options. And number three is for investing to hedge the risks that are in those insurance products.

So, we've talked about why you need to know what options are. Now we should talk about what options are. The easiest way to think about options is to visualize how they behave under particular circumstances. There are two basic types of options, calls and puts. A call gives you the right but not the obligation to purchase something at an agreed-upon price during some future period. For example, you might buy a call that gives you the right to buy 100 shares of XYZ stock at a price of \$60 any time between now and the end of June (7 years from now). Now, if the XYZ stock is worth more than \$60 per share on June 30, then this option will be worth the excess of the stock price over \$60; if the stock price is less than \$60, then the call option is worth nothing. So, the value of the call option on the expiration date ( $C_T$ ) is the difference between the stock price and the exercise price ( $X$ ) of 60, unless that difference is negative. If we wanted to graph this in terms of the stock price ( $S_T$ ), we'd have something that looks like Chart 1.



CHART 1



To the left of  $X$ , the call is worth nothing, and to the right, it increases in value as the stock price goes up. To get net payoff for this call you have to take into account that you had to pay for it at the beginning. So, if we graph  $C_T$  (your payoff at the end) minus  $C_0$  (the purchase price of the call), this displays the net payoff of the call at time  $0$ . If we graph that as a function of  $S_T$ , then it's going to look like Chart 2. It can go negative because we had to pay for the call.

A put option is the opposite of a call. It gives you the right but not the obligation to sell something in particular at an agreed-upon price during some future period. For example, you might buy a put option that gives you the right to sell 100 shares of the Widget Company stock at a price of \$40 at any time between now and June. If the Widget Company stock is worth less than \$40 per share on June 30, then you've made money, and your payoff is the difference between \$40 and the  $S_T$ . For instance, if the stock price is \$30, then you can buy it at \$30 and sell it at \$40, and you'll make \$10 per share.

On the other hand, if the stock price is more than \$40, then the put expires and it is worthless. It's worthless because you wouldn't want to buy stock at \$50 and sell it for \$40. So, if we graph the payoff here (Chart 3), we have  $P_T$  as a function of the stock price; the strike price,  $X$ , is \$40. If you want to look at your net gain, it's  $P_T$  minus  $P_0$ , again as a function of the stock price. Everything's going to shift down by an amount of  $P_0$ , which is what you paid for the put (see Chart 4).

RECORD, VOLUME 20

CHART 2

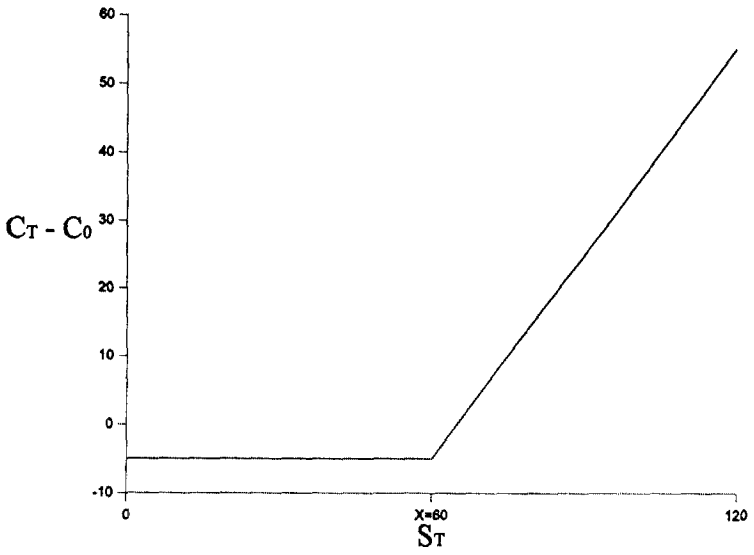


CHART 3

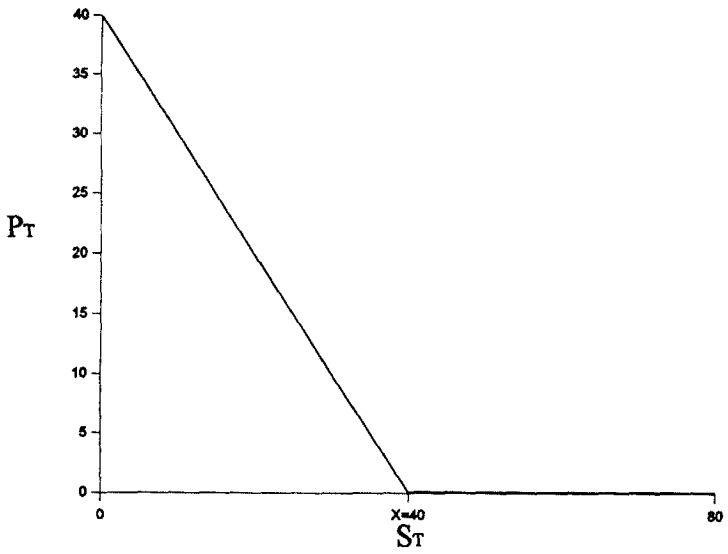
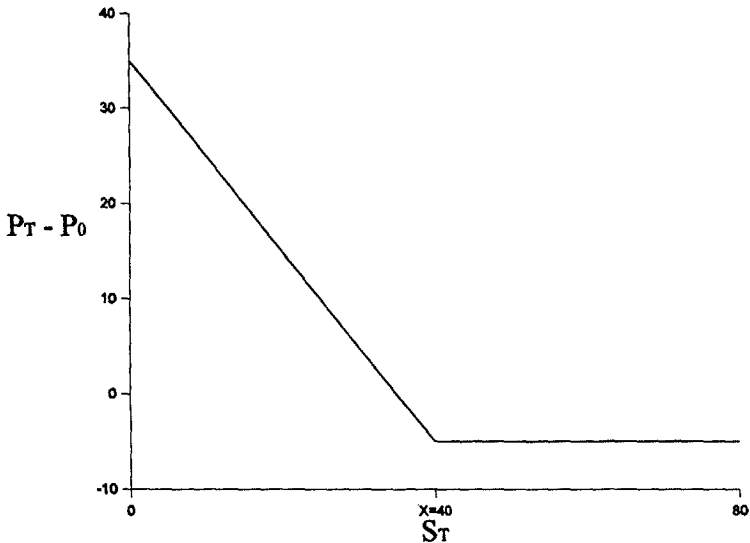


CHART 4



One distinction that can be made in options is the difference between an American option and a European option. An American option allows the holder of the option to exercise it at any time between when they bought it and when it expires. A European option can only be exercised on the expiration date. This is an important distinction because some option formulas are only valid for European options. This is true of the Black Scholes formula and of the put/call parity theorem, which we'll talk about in a second. In general, American options are more difficult to value because of the possibility of exercise at any time between now and the expiration date; whereas with European options, you have to look at only one possible date of exercise.

A couple of parallels can be drawn between options and more familiar actuarial subjects. The first one is that options can be thought of as stop-loss insurance. For example, if your company guaranteed that a single-premium deferred annuity would credit at least 75% of the increase in the S&P 500, then you have a risk. The risk is that your assets may not perform well enough to credit this rate and still earn a profit. This risk can be hedged by buying call options on the S&P 500, and this is similar to the purchase of stop-loss reinsurance to cover the risk of claims on a block of insurance policies exceeding a particular amount.

Tony Zeppetella, who incidentally is on the 230 Committee, has derived the Black Scholes formula for valuing call options in a different way than Black and Scholes. Tony looked at a call as stop-loss insurance. He used the formula for valuing stop-loss insurance and some assumptions similar to those of Black and Scholes and came up with the same formula. I think this is an interesting way of looking at options. I think that this approach makes much more sense to actuaries than reading the Black and Scholes derivation. If you're interested, this is in the *Investment Section*

## RECORD, VOLUME 20

*Newsletter* of either August or September 1989, I'm not sure which. This approach was also taken in "Option Pricing Techniques" by Professor Jousseau. He went into it in more detail with different assumptions and came up with some different results, but it was also taking more of an actuarial approach of looking at the option as stop loss. Neither one of those papers is on 230 so we're digressing a bit.

Another parallel with insurance is that these graphs of the price of an option can be manipulated in a way that is reminiscent of commutation functions. I think most actuaries remember the questions from what was Part 4, and is now Course 150—you have insurance with a benefit that goes up for a while, then it's level, and then it goes down, and goes back up, and goes all over the place; and you had to come up with a net single premium in terms of commutation functions. I would say that if you like that type of problem, you'll probably like the sort of thing that we're going to talk about next which is similar in that we're taking these basic building blocks and cutting and pasting them together to match or hedge a particular risk.

So far we've just talked about what happens if you buy a call or buy a put, but every time somebody buys a call or a put, somebody else is selling one, and they have a payoff that's just the opposite of the payoff here. Charts 5 and 6 are graphs of the payoff to the seller of a call or a put. Now, you can cut and paste these four basic elements and come up with ways of looking at more complicated transactions.

CHART 5

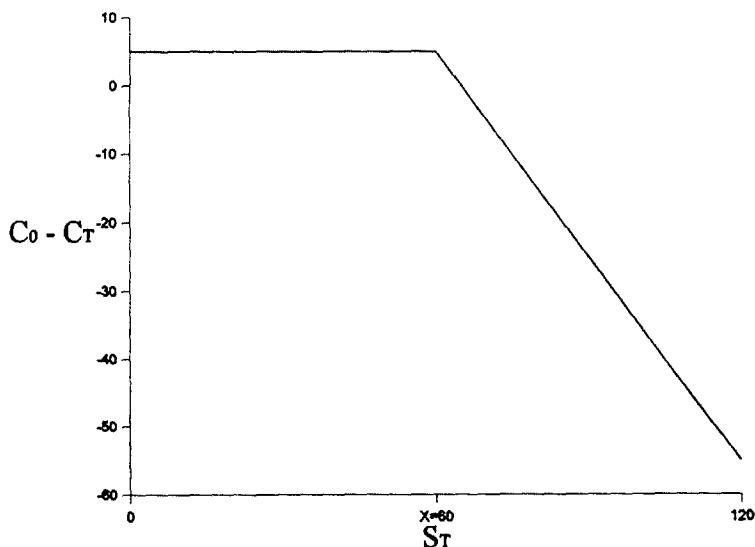
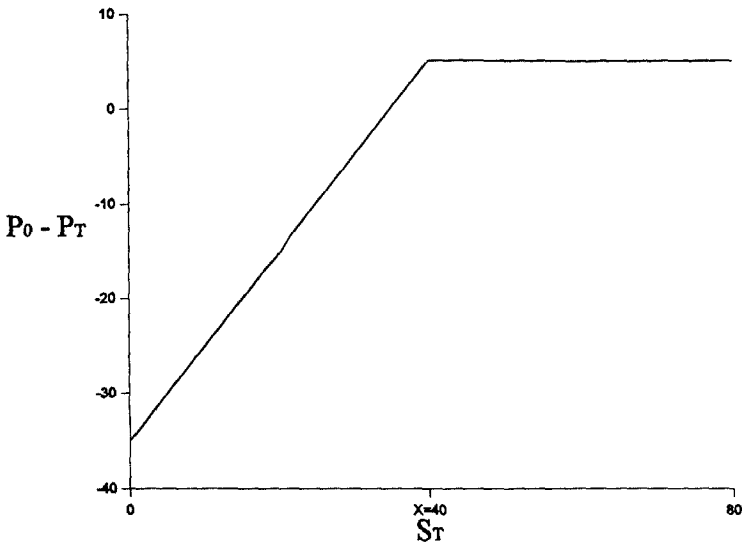


CHART 6



I think I've defined all the terms we need except  $r$ , which is a risk-free rate. So, the first thing we're going to do is put some of these things together and come up with a relationship between call prices and put prices. We're going to do this in steps. First let's look at your payoff if you sell a call and buy a put. When you sell a call, the payoff looks like Chart 1, and if you add the payoff from buying a put with the same strike price, it looks like Chart 7. A straight line. Now, consider that you also bought the underlying stock. We haven't yet graphed the payoff for buying a stock, but it is just the identity function, because it is a graph of  $S_T$  versus  $S_T$ . Now, if we add this identity function to the line in Chart 7, so that we also buy the stock, then what we're going to end up with is a horizontal line that goes across at a value of  $X$  (Chart 8). So, what does this mean? We have  $P_T$ , minus  $C_T$  because we sold the call plus  $S$  since we bought the stock. So at time  $T$ , regardless of what happens to the price of the stock, our payoff is the same,  $X$ .

This situation is referred to as a hedge. You can kind of think of a hedge as a means of protection. Here we can think of it as having offsetting risks or as a collection of different transactions such that, no matter what happens in the future, we're going to have the same payoff. Now, that may be too strict a definition because you'll probably never have anything that's a hedge if you define it that way. So, maybe what we should say is that over some reasonable range, you have a payoff with a slope close to zero. That's a looser definition and one that can be met in practice. In the example here, we have a perfect hedge.

CHART 7

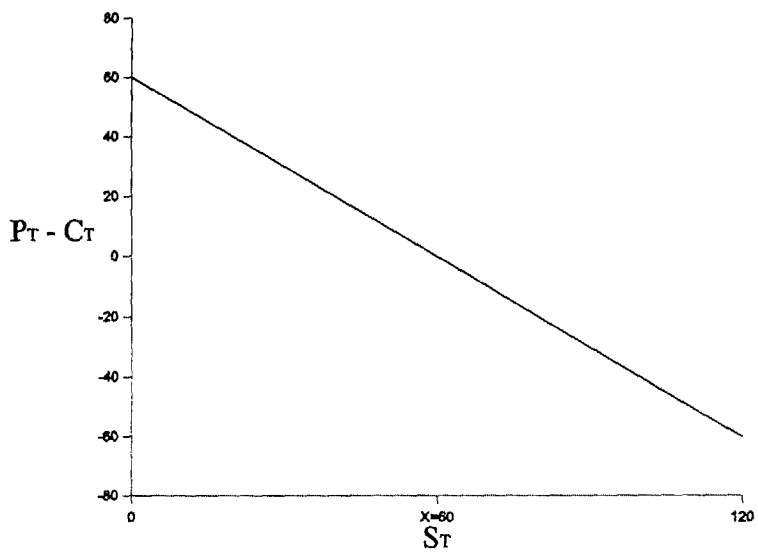
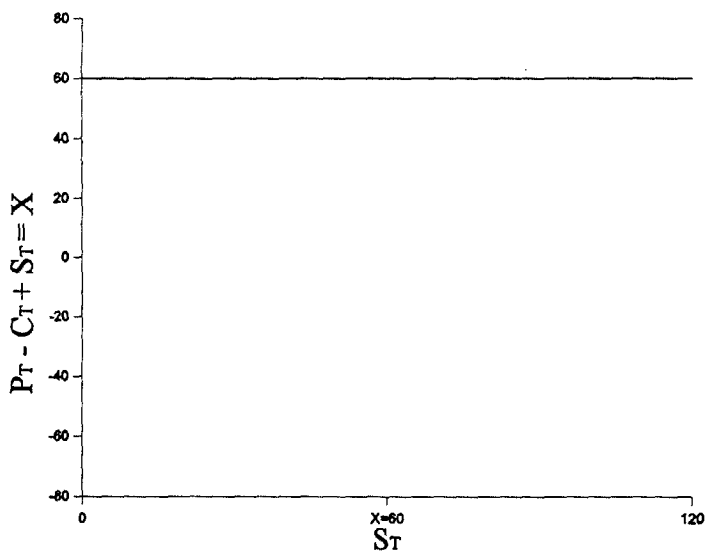


CHART 8



## COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

Now, because we have the same payoff no matter what, we really have no risk, and, therefore, we shouldn't earn any return higher than the risk-free rate of return. We should earn the same return that we would get if we put our money in Treasury Bills. We haven't taken into account the time value of money. At time  $0$  we received  $CO$  because we sold a call. We paid out  $PO$  when we bought a put. And we paid out  $SO$  when we bought the stock. And then at time  $T$  we get  $X$ . To adjust for interest, we need to divide  $X$  by one plus the effective risk-free rate all raised to the  $T$  power where  $T$  is in years. This gives the formula. So, what we're doing is investing  $(CO - PO - SO)$  risk-free, and as a result we're going to have  $X$ . This formula relates the theoretical price of a put and a call because the other inputs are known at time  $0$ . They are constants, so if you know either the price of a put or the price of a call, you can determine the other. Theoretically, this is supposed to work, but I should point out that this formula only works for European options because we only looked at exercise at time  $T$ . If you had an American option, then this hedge could be destroyed because you might have, for instance, exercise of the put at time  $T/3$  and then at exercise of the call at time  $2T/3$ . You don't have perfectly offsetting risks, you don't have the hedge with the American options.

This example shows how you can combine a security with the puts and the calls on the security and arrive at a hedged portfolio. This is an important thing for actuaries to understand because many insurance and annuity products have embedded options. The type of analysis that was done here can be used to hedge the risks that are taken when the options are included in the liability portfolio.

We could come up with another example that isn't directly based on actuarial work, but it might have practical applications anyway. Let's say that you decided that interest rates are so low that you want to go out and buy a house, but for some personal reason you don't want to buy that house until a year from now. Maybe you're planning on moving to a different town or something, or maybe you have a child who's a senior in high school, and you don't want to move while they're a senior. You want to buy a house for investment purposes and get a mortgage because you like the interest rates, but you don't want to do it now. You want to do it a year from now. The question, then, is how can you use options to lock in the interest rates where they are now, and protect against the risk of an increase? Well, first, we have to look at what risk you're taking by deciding to finance your house a year from now. One risk is obviously that interest rates will go up in the next year. If interest rates go up, your mortgage payment will go up, and that's exactly what you don't want to happen because you decided that you like where interest rates are and where your mortgage payment would be. Chart 9 is a picture of your risk. The solid curve shows mortgage payments as a function of the interest rate on mortgages a year from now.

We need to look at the present value of the mortgage payments. We're going to discount the payments with the current interest rate. If the interest rate goes down, then you're better off; and if it goes up, you're worse off. So, if interest rates are 8%, and, if they stay there, you won't care. In Chart 10, we see a risk of a loss to the right, and to the left is a gain. You need an option that will hedge the risk. In other words, you need an option whose value goes up as interest rates go up. If interest rates go up, you want an option that's going to give you the amount of

RECORD, VOLUME 20

money that the graph in Chart 11 shows as your loss, so that you're even with where you would have been had they stayed the same.

CHART 9

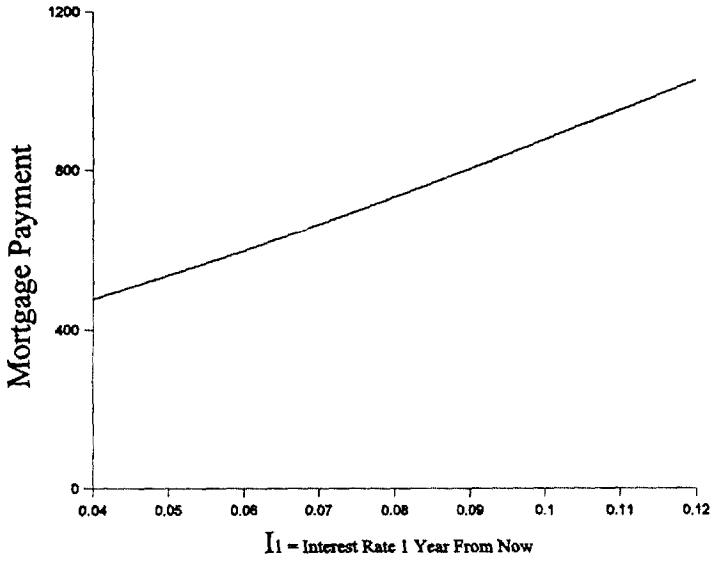


CHART 10

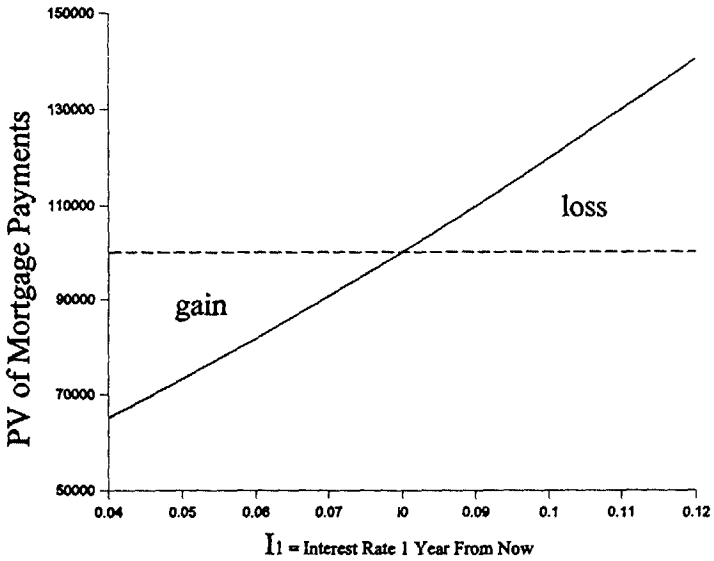
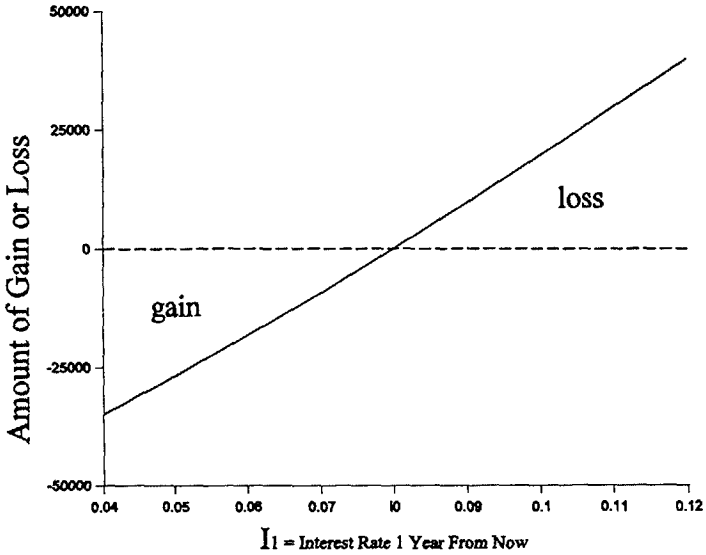




CHART 11



Now, I probably don't have to mention this but when interest rates go up, bond prices go down. So, you need an option that's going to pay off when the bond prices go down. In other words, you need a put on Treasury Bonds. So, if we graph the payoff from the put versus the bond price at time  $T$ , it looks like Chart 12. If we translate that into what happens with interest rates, it goes the other way (Chart 13). Now, this roughly offsets your risk of interest rates going up, and it doesn't take away from your gain in the event that interest rates decline. So, if interest rates go down, the put expires worthless, but you still have your gain. You could create a hedge on that end, too, if you wanted to give up some of your gain there and trade it in for a fixed amount of money now instead of gambling on whether you're going to get the gain or not.

You could do that either by using futures, which we're not talking about, or by selling a call. Now, if you sell a call, it's going to have the opposite effect. It's going to have something that looks like Chart 14.

You've hedged on both ends now. The total effect of these three transactions, then, is roughly a straight line (Chart 15), and that's what we mean by saying you've hedged both sides.

CHART 12

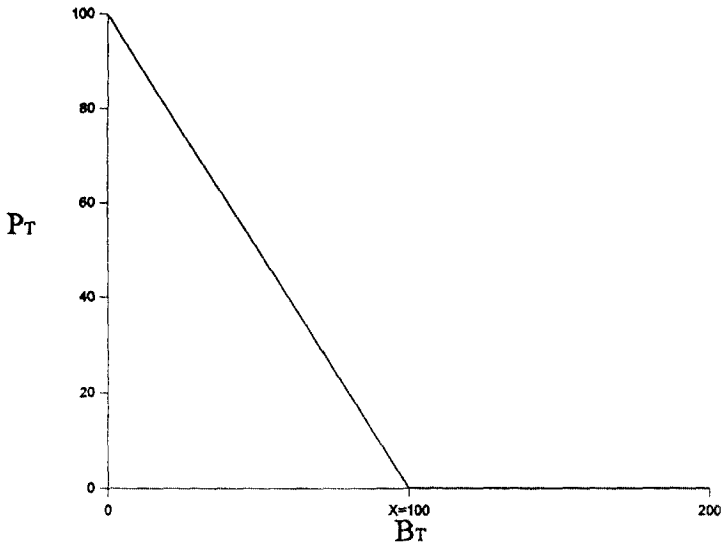


CHART 13

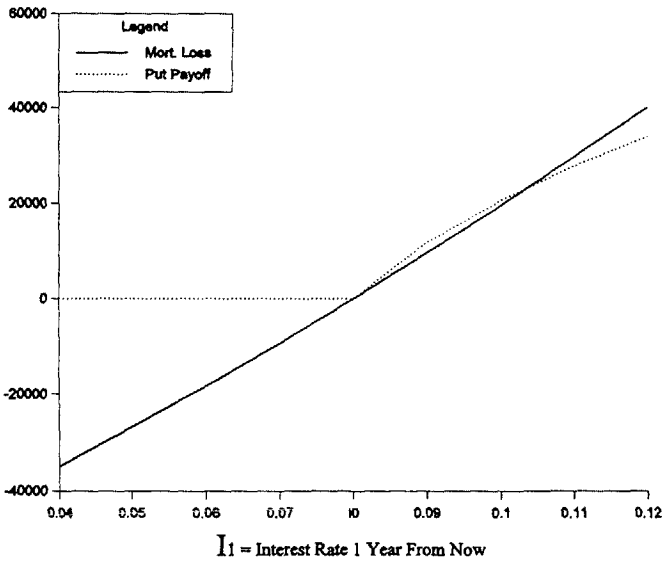


CHART 14

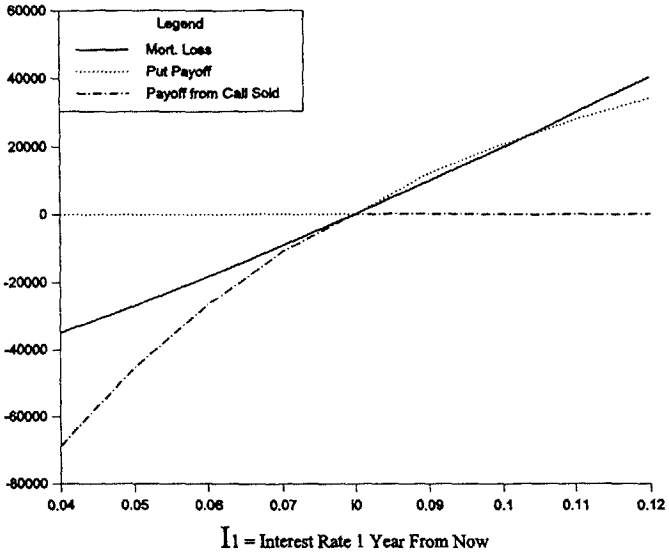
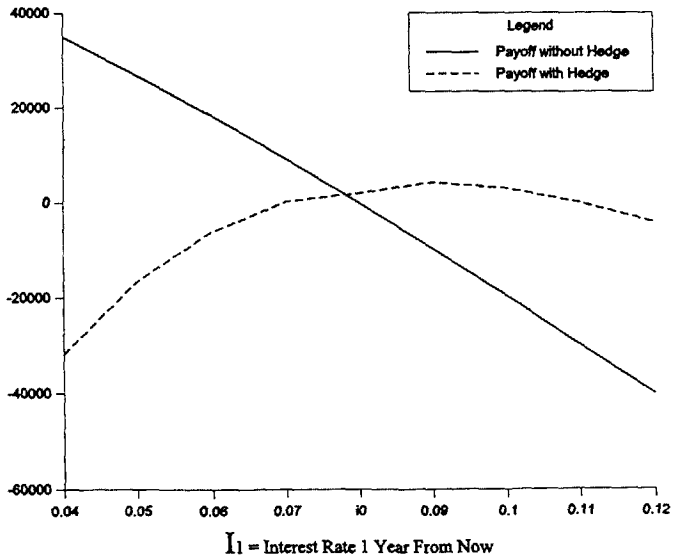


CHART 15



I should point out that there are some risks here that we haven't hedged away. One of them is that mortgage rates may not follow the same path as Treasury interest rates, in which case what looked like a hedge really wasn't. Also, the present value of a mortgage doesn't move the same as the present value of a bond. This explains why the hedged portfolio is not a straight line. It is closer to one than the unhedged portfolio, though.

These risks are called basis risk. You often can't find options that are based on the exact same thing as your risk. You might have a stock portfolio, and you have to buy options on the Standard and Poor's 500 which doesn't exactly match your portfolio. That's basis risk. Another thing I should mention is that there's a cost to establishing this hedge. In this case, it's the cost of buying the put less the amount of money you receive for selling the call, and there are also transaction costs. With an amount as small as what you would buy to hedge the purchase of a house, your transaction costs would be a big percentage of your total cost.

MR. PETER D. TILLEY: Judy, you touched on the regulatory issues, but I wondered how much the study materials really keep up with all the current regulations, like *FAS 115*. These sorts of things are fairly current, but the book that you referred to was published in 1990.

MS. STRACHAN: Unfortunately, McGinn & Tuttle has not kept up with that. When I was talking about RBC, McGinn & Tuttle in the same section is talking about mandatory securities valuation reserve (MSVR). So, the textbooks will not be a good source for the latest on current regulatory issues.

MR. TILLEY: Are there supplementary study note efforts that are being developed to cover those kinds of issues?

MS. STRACHAN: The more specific regulatory issues are covered in different courses, actually. Specific regulatory issues are covered on Course 482 for the Canadians and Course 483 for the U.S. We try to keep up to date with the latest on Financial Accounting Standards and the latest on model regulations. You may want to look at the course material for those courses. You should find most of what you're looking for, and it should be up to date.

MR. REITANO: If I could just add something to that. I think that the most efficient way to deal with that issue is to go right to the source. FASB is happy to distribute versions of *FAS 115*, and the current draft of the model investment law is not difficult to get from the NAIC. I think that the examination process is always behind emerging regulation, and it also takes a certain while for the regulation to firm up. For example, the model investment law is still in a state of flux. If you're interested in knowing what direction regulations are moving before they get finalized, most regulatory bodies and most of the groups that work on these regulations are happy to distribute their information. I would suggest, particularly in the interest of your careers, that you go right to the sources, and keep up with them.

MR. CARL HERMAN ROSENBUSH, JR.: You were talking about the hedge where you buy a stock, you buy a put and sell a call with it; it's this level *X* amount. It

## COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

would seem to me that all investors would do this, and everybody would make a profit off of it without any risk, and that just doesn't seem right.

MR. KLEIN: Well, the profit they make is just equal to the risk-free rate of interest. So, if you buy Treasury Bills, you're making a profit without a risk, too.

MR. ROSENBUSH: It's just an interest profit after all?

MR. KLEIN: Yes, because on the right side of the equation we had a risk-free payoff of  $X$  and we just discounted that back to time  $0$  at the risk-free rate. So, yes, you do make a profit, but it's not in excess of what you would make on it if you put the same amount of money in Treasury Bills. In fact, it's likely to be less with bid-ask spreads and transaction costs.

MR. REITANO: So, you're better off putting your money in Treasury Bills.

Judy and Gordon have a sample exam question on their respective topics; one is on investment policy and one is on options. Then they will review the correct answer which is, of course, what the Exam Committee determined as correct.

MS. STRACHAN: The investment manager of the XYZ pension plan has recommended, as an investment strategy, buying investments in asset sectors where prices are falling and selling investments in sectors where prices are rising. Identify the factors to consider when developing an investment strategy, also outline the advantages and disadvantages of the proposed recommendation. I'll go to the overhead projector and let you tell me what you came up with. (See Appendix A).

What factors should you consider when developing an investment strategy? What would that be? What factors did you think about for an investment strategy for a pension plan?

FROM THE FLOOR: The liability cash flows.

MS. STRACHAN: OK.

FROM THE FLOOR: Your return requirements.

FROM THE FLOOR: Risk intolerance.

MS. STRACHAN: Right. What else?

FROM THE FLOOR: Liquidity.

MS. STRACHAN: I'll jump past tax and regulatory issues. Within those categories what sorts of things did people come up with? What sort of return requirements or risk tolerance do you think a pension plan should have or what should you look at in a pension plan?

FROM THE FLOOR: What's the funding policy of your plan?

RECORD, VOLUME 20

MS. STRACHAN: The funding policy would be important. And you may want to look at the financial strength of the company that is sponsoring the plan. That would be important.

FROM THE FLOOR: You might want to review the type of plan.

MS. STRACHAN: The type of plan would be very important. I think we may have gotten almost full credit for this answer. What do you think, Gordon? Did we get full credit?

MR. KLEIN: I think we got a ten.

MS. STRACHAN: The second half of the question: Outline the advantages and disadvantages of the proposed recommendation.

FROM THE FLOOR: One advantage is simplicity.

MS. STRACHAN: What about some others?

FROM THE FLOOR: It seems to ignore all the things that we just wrote down as an answer to Part A.

MS. STRACHAN: It ignores the issues; that seems like a major disadvantage, doesn't it?

FROM THE FLOOR: What was the investment policy again for those of us that had the other question?

MS. STRACHAN: It was to buy investments in asset sectors where prices are falling, and to sell investments in sectors where prices are rising. So, it's sort of an approach to investing. Any other ideas?

FROM THE FLOOR: It doesn't diversify both sectors. Isn't this investment approach called dollar averaging?

MS. STRACHAN: Yes, it was called dollar averaging. Anything else? I think we have picked out most of the answers. This was a fairly short-answer question. We would have gotten close to full credit for this solution. There's one thing we didn't really mention. The answer says that the strategy does not provide for a permanent shift in the market price of the securities. It assumes that all changes in price are temporary and that you can flow back and forth, but if it's a permanent change, the strategy doesn't take that into account.

FROM THE FLOOR: The investment manager may not have the skills necessary to follow this strategy.

MS. STRACHAN: The investment manager may not have the skills to really know when the market has turned so he might not have the skills to follow the strategy. That would be another issue.

COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

FROM THE FLOOR: The timing would be very critical under this strategy.

MS. STRACHAN: Timing might be very critical. The manager might not have enough information which I think of as being similar to not having the skills.

MR. REITANO: Well, one way that the buy-low/sell-high strategy is implemented is by having fixed allocation ratios between asset classes. Rather than thinking in terms of buying stock and trying to figure out when the market is falling or rising, you simply decide to be 40/60 stock and bonds and think about it from an asset allocation perspective. As long as you maintain those fixed ratios, it forces you into this discipline of selling an asset class when it is relatively high, and buying one that is relatively cheap.

FROM THE FLOOR: But that is just a fixed allocation strategy.

MR. REITANO: That's right.

FROM THE FLOOR: It wasn't explicit in the question.

MR. REITANO: No, it wasn't. I think that when you look at it from the perspective of buying when prices are falling and selling when they're rising, that might seem less prudent to some people. If you articulate it as a strategy to keep fixed allocation ratios, then many people will think that's smart. So, sometimes by looking at the same thing two different ways, you can have different opinions on it.

FROM THE FLOOR: Is having fixed allocation ratios a prudent investment strategy?

MR. REITANO: Yes, because it really does force you to buy cheap and sell high which is fairly fundamental, and it's one of the few strategies I know that forces you to do that.

MS. STRACHAN: I'm going to turn the floor over to Gordon now to handle his question.

MR. KLEIN: The question is, describe the risks to a life insurance company in the following situations and explain how options and futures could be used to hedge these risks. We didn't talk about futures, so, some of these questions might have been tougher than if we had. But, hopefully, you didn't let that get in your way. I'll just read them one at a time, and then we'll talk about the answers, and then go on. Question one deals with a company that enters into a forward commitment to buy a private placement bond six months from now. Any thoughts on that?

FROM THE FLOOR: If interest goes up, the value of the bond becomes less than what you paid for it.

MR. KLEIN: So, your risk is that interest rates go up. One way to hedge that is buying a put on bonds. Although actually what we were thinking about in this question was selling a future which, as I mentioned earlier, is similar to buying a put and selling a call; it accomplishes a similar thing. What you mentioned was sort of hedging the risk, but if you want to sell off your potential gain on the other side, you

can do that by selling a call. And another point on that one is that you've also got basis risk. You can't buy or sell puts or calls on the particular bond for which you entered into the forward commitment. It may not behave in a way parallel to the Treasury Bonds which you'll be buying the options on. There is another answer that didn't make it into the answer key; I think it's not one that you can hedge as much with options. There's also the risk that interest rates will go down, and the other party will back out of the agreement. It definitely is a risk.

MR. REITANO: One comment, Gordon. It also occurs to me that it isn't necessarily the case that when an insurance company enters into a forward commitment that it's taking on a risk. It might have already implicitly hedged that risk by selling a liability, and I think that's common for us guaranteed investment contract (GIC) writers. You sell a GIC, you make a forward commitment, and you're comfortable. If interest rates go up, you've already locked in your funding cost through the GIC. Even though interest rates may go up or go down, and there's an implicit loss or gain on the bond, there's an offsetting gain or loss on the GIC you sold. I didn't notice that consideration in the answer sheet. In practice you always want to think from the perspective of assets and liabilities, and you sometimes are implicitly hedging your asset risk through your liabilities, if you have rate guarantees on these liabilities.

MR. KLEIN: Exactly. And you're really using the options in either the asset or the liability to offset the other options, and that's really what ties this all together.

Question two is about a company that enters into an agreement to accept deposits into a guaranteed investment contract over the next year and credit 7.5% interest for one year on the amounts received. The interest rate currently available on one-year and shorter-duration bonds is sufficient to support the guaranteed crediting rate. You can tell this is kind of an old question. Thoughts on that one?

FROM THE FLOOR: If interest rates fall, they may not support your credited rate. If rates fall and bond prices go up, you want to buy a call for bonds.

MR. KLEIN: So, one of your risks is if interest rates go down, money comes pouring in, and you can't buy bonds that are going to credit that anymore. If you buy calls, then you're hedging that risk somewhat. Any other thoughts on this one?

FROM THE FLOOR: I just had a question. Can you buy options that go out more than one year?

MR. KLEIN: The traded options generally don't go out for more than a year. Some stock options do. There's long-term stock options now that really aren't on bonds. However, insurance companies are often large enough that they can special-order whatever type of derivatives they want from the investment firms. Usually, if you can put together an idea of what you want, somebody will give you a price on it.

FROM THE FLOOR: You generally don't know how many deposits to expect, so you wouldn't know how much to hedge.

MR. KLEIN: That's right, and that's something that ought to be in the answer. You don't know how much could come in. It's kind of a guess, as much as anything. If



## COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

interest rates were 7.5% when you sold, and if they go down to 5%, a great deal of money is going to come in, but you don't really know how much.

FROM THE FLOOR: Is this a qualified plan? If it is a 401(k), you can estimate the maximum that could come in.

MR. KLEIN: If there are transfers from other investments, or if they can transfer all the stock fund into the GIC as soon as interest rates go down, you can at least know how much there is so you can quantify it.

MR. REITANO: I think it's also very common to write GICs with so-called dollar windows that limit your exposure to a given dollar limit. That was something that few companies did in the early GIC days—once burned, twice shy. Most companies use dollar windows on their GICs so that basically, as an upper bound, you know that your exposure can't be more than the dollar window because that's all you're guaranteeing. You then you have to decide how much of that window you want to hedge. Depending on your plan underwriting, a 100% hedge would be prudent for relatively small windows, and less for relatively large windows.

MR. KLEIN: Yes, and I think that was less true when this question was written. It was probably starting to happen because the companies had definitely been burned by the time this question was written. The GIC market has changed since that happened. Another risk is what happens if interest rates go up?

FROM THE FLOOR: People take their money out.

MR. KLEIN: People take their money out, and you're stuck with the capital losses on the borrowing. So, you really have a two-sided risk here. Bob mentioned at the beginning of the session that most insurance companies are in a short straddle position. That's exactly what this question describes. If interest rates go up, you lose. If interest rates go down, you lose. If they stay where they are, you're OK. And so you also might want to purchase a put, as well as a call, or some number of puts, as well as some number of calls, to hedge it in either direction. Again, you may not do that directly. You may do that through features of the liability or through other assets that will have those features.

The last question is, the company wants to lock-in the gain on its IBM stock but wants to defer the sale until next year. So, what's the risk?

FROM THE FLOOR: The risk is a drop in price.

MR. KLEIN: The risk is that the price drops, and so how do you hedge that?

FROM THE FLOOR: Buy a put option.

MR. KLEIN: Exactly. Then, if the price does drop, you can exercise the put option and recover your money. Some people on this also said you could sell a call, similar to what we've talked about already. You could sell off that potential gain for a little bit of extra money.

## RECORD, VOLUME 20

FROM THE FLOOR: That covers the price of the put that you bought.

MR. KLEIN: Yes. Some people said you can sell a future on an IBM stock, but you really can't sell a future on an IBM stock. So, that won't work. They don't have futures on individual stocks. Some people did say you could sell a future on a stock index, and then you'd have basis risk. That is an acceptable answer, too.

### Appendix A

#### Exam V-380 Model Solutions

1. (4 points) The investment manager of the XYZ Pension Plan has recommended the following investment strategy:

Buy investments in assets sectors where prices are falling and sell investments where prices are rising.

- (a) Identify the factors to consider when developing an investment strategy.  
(b) Outline the advantages and disadvantages of the proposed recommendation.

#### Solution

- (a) The most important factors to consider when developing an investment strategy are:

- The investment objectives of the pension plan, including any investment return objective
- The current financial strength of the plan
- The time horizon of the plan, including the age mix of the plan members and the mix between active and retired members
- The short- and long-term liquidity needs of the plan
- The degree of investment risk the plan sponsors, trustees, and members are willing to tolerate
- The current and projected tax situation of the plan
- The legislation and regulations the plan must comply with
- Any constraints the plan sponsors, trustees, or members may put on investment decisions, such as political, social, or environmental

- (b) The two main advantages of this proposal are:

- Empirical studies have shown that a contrarian strategy can outperform the usual investment strategy by a significant margin.
- A contrarian strategy provides liquidity and stability to securities markets by providing cash when the market is full of sellers and providing securities for sale when the market is full of buyers.

COURSE 230: FELLOWSHIP EXAM ON ASSET/LIABILITY MANAGEMENT

The disadvantages of this proposal are:

- This strategy may require significant trading of securities with the associated higher transaction costs.
- The strategy does not provide for a permanent shift in the market price of a security.
- Adherence to the strategy may conflict with fiduciary responsibilities.
- The investment manager may not have the skills to determine changes in market direction and lose credibility with the plan sponsor, trustees, or members.

8. (6 points) Describe the risks to a life insurance company in the following situations and explain how options and futures could be used to hedge these risks.

- (i) The company enters into a forward commitment to buy a private-placement bond six months from now.
- (ii) The company enters into an agreement to accept deposits into a guaranteed investment contract over the next year and credit 7.5% interest for one year on the amounts received. The interest rate currently available on one-year and shorter bonds is sufficient to support the guaranteed crediting rate.
- (iii) The company wants to lock in the gain on its IBM stock but wants to defer the sale until next year.

Solution

- (i) Risk: Interest rates could rise, leaving the company committed to buying this bond at the price fixed today, even though its value will be lower six months from now. The best way to hedge this risk is to sell a six-month future on a similar amount of treasuries with similar duration. Then if interest rates go up, the gain on the future offsets the loss on the private placement. If rates go down, the loss on the future is offset by the gain on the bond. The remaining risk is that the spread between the Treasury and the private placement may widen. This is called basis risk.
- (ii) Here the risk is two-sided. If interest risks go up, deposits will slow down and withdrawals will increase. At the same time, the value of bonds purchased will have decreased. The risk is best hedged by buying puts on Treasury futures. If interest rates increase, the futures price will decrease, so you can sell at the strike price and buy at the market price. This profit will offset the capital loss on your bonds, except for basis risk. If rates decrease, you are only out the price of the put.

The other risk is that rates go down. Then deposits will flood in at the guaranteed rate, but you will not be able to invest at a rate high enough to make a sufficient spread over the guaranteed rate. Purchasing a call on Treasury futures will hedge this risk. If rates decrease,

## RECORD, VOLUME 20

you can still buy at the strike price, which will give you a higher yield. If rates increase, you are only out the cost of the call.

The simultaneous purchase of a put and a call is called a straddle. Since the liability is a short straddle (you lose if rates move very far in either direction), this is the correct hedge.

- (iii) Risk: Price of IBM goes down before the end of the year. Hedge: Buy a put on the stock with a strike price at the current price. If the price goes down, you can still sell at the strike price. If the price goes up, you can keep the gain. Either way, you incur the cost of the option. If you don't want to incur that cost and don't want the upside potential, you can buy the put and also sell a call option at the strike price. Or you could sell futures on an index that moves with IBM stock. But then you would incur basis risk.