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Financial Economics: With Applications to Investments, Insurance, and Pensions

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Summary: The Society of Actuaries (SOA) Foundation and Lincoln National Corporation have sponsored the publication of a new textbook for actuaries entitled. Financial Economics: With Investment, Insurance and Pension Applications.

Mr. Harry H. Panjer: This is a teaching session, and along with Hal Pedersen, I hope to explain some of the key ideas in the financial economics area. Financial economics are becoming very important. That's the reason why there are so many sessions at this meeting involving financial economics in one way or another. This session centers around a book project that is funded by the SOA Foundation, along with the cooperation of the Lincoln National Corporation. The title of the book is *Financial Economics: With Applications to Investments, Insurance, and Pensions*. This book is in progress now; it's nearly complete. Our purpose is to report on the book, describe the rationale for the book, and also to give some practical applications of financial economics in an insurance or annuities context.

I'm going to provide a brief overview of the rationale for the book and the lay out of the book, on a chapter by chapter basis.

This book will be made free of charge to all members of the SOA, compliments of the Lincoln National Corporation. Of the ten chapters in the book, eight are in the final editing stage, one is close to final editing and should be finished in the next few weeks, and one chapter will be finished in three or four weeks. So, the book is very close to being completed. There are a lot of publication details to be worked out, but we're working hard on those.

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Editor's Note: Mr. Pedersen discussed some examples in this session from the book which has since been published and distributed to the membership; therefore, a complete transcript of this session is not available.

I'm going to briefly go through the chapters and tell you a little bit about what's going to be in the book. By the way, some of you who are here have been reviewers for the book, and have provided extensive detailed comments on the various drafts to date. We appreciate this very much, and have gone through every one of your comments and discussed each one in detail. Many, if not most, of your comments are reflected in the book. Joe Fairchild is one of the best reviewers. He's provided us with hundreds of comments and pointed out errors and various oversights and so on, and we've tried to reflect many of his comments.

The first two chapters deal with the basic framework of financial markets. We describe how stock markets, transactions, money market securities and bond markets operate. Then we move on directly into some discussion of interest rate calculations, which are very standard for actuaries. So, Chapters One and Two are background material, and introduce most of the basic ideas in the book. If someone was to read Chapters One and Two, they would capture many of the ideas that are in the remainder of the book. The Markowitz model, which is used in portfolio selection, is discussed briefly here, but there's an entire chapter of close to 100 pages devoted to this subject later in the book. We've tried to, in addition to the standard material that comes from the finance literature, incorporate insurance, pensions, and annuity examples throughout the book. This is what really makes this book different from most books that are available on finance. They don't spend much time considering insurance, although insurance is becoming a more important topic in the finance area.

Chapter Two moves directly into derivative securities. Here we consider forwards, futures, options and other derivative markets. We describe how, in fact, yields are calculated. This continues the introductory material. We introduce basic notions of options and swaps. We describe things like put-call parity, which to an actuary are easily understood, even graphically, and we have a small section on options with a Black-Scholes option pricing model and explain it's background. We don't do any derivations. The level in this book is similar to what a corporate finance book might be. We think this is appropriate for relatively early actuarial examinations, although we're not designing this specifically for actuarial examinations, we are thinking of it from an educational point of view, in general. The decision to put it on an examination will be up to the appropriate exam committees. In this chapter we even discuss securitization of assets and liabilities briefly. As we near the end of each chapter you'll see applications in insurance or pensions or annuity.

Chapter Three deals with a topic that actuaries already know a lot about, management of interest rate risk. The material in this chapter has been presented at SOA meetings for many years by experts, including people like Elias Shiu, who is one of our authors. He has given many, many talks in this subject area to the Society. The work, of course, goes right back to Macaulay in the late 1930s and Redington in the early 1950s. You will recognize most of these topics.

Chapter Four gets into the issue of pricing under uncertainty.

Chapter Five relates to no-arbitrage pricing theory. In arbitrage-pricing theory one assumes there is a set of prices in the market and one works with that set of prices as a reference. In Chapter Four this provides one paradigm for how a market gets to a set of prices. Equilibrium pricing is the subject of chapter four. This is done in quite a lot of detail. At the end we get to factual option pricing formula from an equilibrium approach. You will notice the capital asset pricing model is here. It will appear again in other chapters as will Black-Scholes and related option pricing.

Chapter Five deals with asset valuation and arbitrage conditions. This is a very difficult chapter to deal with because it can be dealt with technically on many different levels. We try to produce all the ideas in a single period framework, but using them in algebra only. In a multiple period framework will provide a more complicated treatment based on measure, theory, probability, filtrations and so on, which are one way of getting the results in a level period framework. So, all of the ideas of markets being complete or incomplete are discussed and explained. We go through things like fundamental theory of investment pricing. These are all basic concepts. This is going to be a relatively, technically heavy chapter. It's the first chapter that is going to be a real challenge, but it needs to be here because it provides the theoretical underpinnings of this whole general area of asset valuation. The same model, and some discussion of evaluation of European options are included in this chapter. These topics are discussed later on, as well. So, this is going to be a technical chapter. The first cut of this chapter was about 100 pages, so there's a lot of material and a lot of theorems and proofs. What we're trying to do is put some of the heavy material in appendices, but we're trying to add a lot of text to explain the intuition behind many of the key ideas. That's also our challenge right now; to turn something that can be treated very technically into a level that would be appropriate for practicing actuaries.

In Chapter 6, options and other derivatives are presented. We spent a lot of time looking at options with certain complexities associated with them in terms of pricing and methods of pricing. There's extensive treatment of exotic options here. The problem with pricing American type options, which have early exercise provisions, is itself an area of study, and time is spent on American options. Now, we don't spend large amounts of space in the book dealing with the numerical methods. What we do is try to give a framework for the numerical methods, but we do not provide numerical methods for each and every type of option or specialized numerical methods that might be better for certain types of options. What we try to do is provide a framework for numerical methods. The models based on recombining the lattices are the lessons based on redefining lattices, the typical framework for pricing options when cash flows become cost dependent. When things become a bit more complicated, you can resort to some kind of approximation or simulation method. There are specialized simulation methods that have been developed particularly for these kinds of applications. So, what we try to do is discuss the framework for those.

Chapter Seven deals with term structure models. Constructing arbitrage pricing models and the valuation of interest rate derivatives. This is a very, very nice chapter. This chapter was largely written by Stan Pliska, who himself has published another book recently in the same general area. Stan is not an actuary, but is the editor of *Journal of Mathematical Finance* and very well known in this field. He has proved many of the key theorems in the financial economic area.

Someone has asked if mathematical finance is synonymous with financial economics? It overlaps, but certainly not synonymous.

Mr. Hal Pedersen: Mathematical finance tends to focus more on some of the technical results that make the theory complete, not always emphasizing more the practical aspects of the subject. A good example is mean variance analysis, which is perhaps border line mathematical finance, but a lot of the intuition that goes with it would be considered more in the realm of financial economics. That's probably the essential difference. If you pick up the journal, *Mathematical Finance*, you would immediately find yourself requiring a Ph.D. in mathematics to understand it.

Mr. Panjer: In this chapter we do end with single premium deferred annuities (SPDAs), which are familiar to actuaries.

Chapter Eight moves on to the whole area of portfolio selection, starting with the Markowitz model and focusing largely on pension applications. So, there are some examples of pensions. In one example, you will notice that the investor is a Swiss investor. One of our key officers is Swiss and this is an international book. There are a number of examples which focus on assets in various countries. There are exchange rate risk and so on considered. Dealing with assets in different countries is particularly pertinent to Europe. It's not as pertinent to the U.S., but it's pertinent to most countries in the world other than the U.S. It's very pertinent in Canada, for instance, in terms of pension fund investment. So, the key is on the basic Markowitz framework. Our group of authors is international. At the moment, I know that we've had a number of requests from groups in Switzerland to buy the book already, and it's not available yet. So, there seems to be a lot of interest in this. There have been a number of courses already given, and some more coming up in Europe based on the book by some sub-sets of authors. We're doing a similar session in Australia.

Many of the chapters have an appendix, which is pertinent to the material in the chapter.

Chapter Nine moves on to another topic that actuaries are familiar with, and this is a whole area of investment return models that is useful in long term projections. One of the key markets that's well known to actuaries worldwide is the Wilkie model, which was developed through the 1980s and continues to be used in the U.K. We, specifically, have a section on the working model. But, we also deal with other models that appear in economic metric literature. We don't do everything, but we provide a good introduction, I think, to those models, so that people will be able to go to the economic literature and

spend time dealing with various types of economic metric models that are used. We have a nice piece on the working model, and show how it's constructed as a cascading model. And, spend some time on applications. The applications include the insurance and pension areas, portfolio insurance, evaluation in general, maturity guarantees, and minimum death benefits.

That's the main body. Chapter Ten is the final big chapter, dealing with option pricing and U.S. time. This chapter really builds a bridge between continuous process modeling, which actuaries are comfortable with, but people in finance generally aren't. It also deals with U.S. time and option pricing. There have been a large number of papers in literature recently, largely in actuarial literature, mainly driven by Hans Gerber and Elias Shiu. Their work is reflected in this chapter. This work is currently gaining a lot of attention in the finance literature. The people in finance are realizing that there are significant contributions that actuaries can make to this area that are different in approach from the traditional approach in finance, using a Brownian framework. So, a large number of specialized options are considered in this framework.

That provides, essentially, an overview. There is a large appendix which deals with probability, theory, which supports all this information, which can be read or can be avoided. It's there for completeness. What we've tried to do is make this book as complete as possible. We've selected a level of rigor in the text that is higher than the average MBA textbook in finance, but is lower than the mathematical finance books, which also exist. We've tried to provide some of the key probability background that actuaries may not have in their basic education system in an appendix, and this is a big appendix. So, people can read this. People who teach this material in university programs might rely on this material. People who read it on their own would probably ignore this material and focus on the basic conceptual ideas throughout the book. So, that's my introduction to the content of the book, and what I'd like to do is turn it over to Hal now for the remainder of this session to talk about Shiu applications.

From the Floor: I've heard one of the comments made in terms of actuarial and financial areas that we tend to use somewhat different language from some of the financial community. Are we going to have anything that brings the language together? Where does this book stand on that?

Mr. Panjer: I think that's all here. I think this is largely in the language of finance, but the text is written with an actuarial audience in mind. I think the language connection is there.

And, as I said earlier, what we're trying to do is operate at a slightly lower level and do this in the continuous time framework. There is some material in the appendix on continuous time; originally we had thought we would have several chapters in continuous time, as well, where we parallel these results. What we've decided is that we're already at more than 700 pages of text, and we thought to do a proper treatment of continuous time would require another 400 or 500 pages, so we thought we'd leave this to either a second edition or second volume. We decided from a pragmatic point of view that we could've done

that, and that was in our original framework, we expected to do it, but we decided it was really too big. We needed to get this done. We could do it, but it would take another year to do a good job in that area.