THE ORIGIN OF LYONs: A CASE STUDY IN FINANCIAL INNOVATION

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V iewed at a distance and with scholarly detachment, financial innovation is a simple process. Some kind of "shock"— say, a sudden increase in interest rate volatility or a significant regulatory change—is introduced into the economic system. The shock alters the preferences of either investors or issuers in such a way that there then exists no financial instrument capable of satisfying a newly-created demand. Observing the unsatisfied demand, an entrepreneur moves quickly to seize the opportunity by creating a new financial instrument. In the process, the entrepreneur reaps an economic reward for his efforts, investors and issuers are better served, and the entire economic system is improved.

On closer inspection, however, the actual process of financial innovation turns out, like most other human endeavors, to be a lot less tidy than economists' models would have it. In this article, we provide an "up-close" view of the origin and evolution of one financial instrument—the Liquid Yield Option Note (LYON).

The LYON is a highly successful financial product introduced by Merrill Lynch in 1985. Between April 1985 and December 1991, Merrill Lynch served as the underwriter for 43 separate LYON issues, which together raised a total of $11.7 billion for corporate clients. LYON issuers include such well-known firms as American Airlines, Eastman Kodak, Marriott Corporation, and Motorola. In 1989, other underwriters entered the market and have since brought an additional 13 LYON-like issues to market. In the words of a recent *Wall Street Journal* article, the LYON is "one of Wall Street's hottest and most lucrative corporate finance products."[1]

As academics examining a new security, we begin by posing the questions: What does the LYON provide that was not available previously? Does the LYON really increase the welfare of investors and issuers, or is it simply a "neutral mutation"—that is, a now accepted practice that serves no enduring economic purpose, but is sufficiently harmless to avoid being extinguished by competitive forces.[2]

In the spirit of full disclosure, however, we must admit that we are not entirely disinterested observers. Our association with and interest in the LYON is longstanding. When the early LYON issues were being brought to market in April 1985, questions arose about LYON pricing. We were hired by Merrill Lynch to develop a model for analyzing and pricing this new financial instrument. A by-product of this assignment was the opportunity to learn about the train of events that led to the creation of the LYON, and we have since followed the evolution of this market with interest. In the pages that follow, we relate what we have observed, thought, and contributed during the development of this new security.

WHAT IS A LYON?

The LYON is a complex security. It is a *zero coupon, convertible, callable, and puttable* bond. None of these four features is new, it is only their combination that makes the LYON an innovation. These general features of the instrument are perhaps best illustrated by considering a specific issue. Because it was the first one, we consider the LYON issued by Waste Management, Inc. on April 12, 1985.

According to the indenture agreement, each Waste Management LYON has a face value of $1,000

1. Randall Smith, "Tax Status of LYONs, One of Street's Hottest Products, Gets IRS Challenge," Dec. 17, 1991, p. C1.

2. Merton H. Miller introduced this Darwinian metaphor in "Debt and Taxes," *Journal of Finance* (May 1977), p. 273.

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and matures on January 21, 2001. There are, by definition, no coupon interest payments. If the security is not called, converted, or redeemed (i.e., put to the issuer) prior to that date, and if the issuer does not default, the investor will receive $1,000 per bond. If this turns out to be the case, moreover, and based on an initial offering price of $250 per bond, the investor will receive an effective yield-to-maturity of 9%.

The Investor's Conversion Option. At any time prior to maturity (or on the maturity date), the investor may convert the bond into 4.36 shares of Waste Management common stock. Given a stock price of about $52 at the time of issue, this conversion ratio would appear to indicate an initial conversion "premium" of about 10% ($250/4.36 = $57.34). But, because the LYON is a *zero coupon* convertible and thus issued at a large discount from par value, the conversion "premium" is not fixed. That is, as we discuss in more detail later, the minimum share price at which holders would willingly exchange their bonds for 4.36 shares effectively increases throughout most of the life of the bond.

The Investor's Put Option. Although not entirely new, the most unfamiliar feature of the LYON is the right it gives investors to put the bond to Waste Management beginning on June 30, 1988, and on each subsequent anniversary date, at pre-determined exercise prices that increase through time, as shown below:

Date	Put Price	Implied Yield	Date	Put Price	Implied Yield
6/30/88	$301.87	6%	6/30/95	$613.04	9%
6/30/89	333.51	7	6/30/96	669.45	9
6/30/90	375.58	8	6/30/97	731.06	9
6/30/91	431.08	9	6/30/98	798.34	9
6/30/92	470.75	9	6/30/99	871.80	9
6/30/93	514.07	9	6/30/00	952.03	9
6/30/94	561.38	9			

Based on the issue price of $250.00 per bond, this schedule of put exercise prices provides investors with a minimum 6% rate of return at the date of first exercise, rising in three 1% increments to a level of 9% over the next three years.

The Issuer's Call Option. Finally, Waste Management has the right to call the LYON at fixed exercise prices that also increase through time. Although the issuer may call the LYON immediately after issuance, the investor does receive some call protection because Waste Management may not call the bond prior to June 30, 1987 unless the price of the Waste Management common stock rises above $86.01. The schedule of call prices is as shown below:[3]

Date	Call Price	Date	Call Price
Issuance	$272.50	6/30/94	$563.63
6/30/86	297.83	6/30/95	613.04
6/30/87	321.13	6/30/96	669.45
6/30/88	346.77	6/30/97	731.06
6/30/89	374.99	6/30/98	798.34
6/30/90	406.00	6/30/99	871.80
6/30/91	440.08	6/30/00	952.03
6/30/92	477.50	Maturity	1,000.00
6/30/93	518.57		

As in the case of convertibles generally, investors may respond to the call by choosing either to accept redemption payment from the issuer or convert their bonds into stock.

As mentioned earlier, although the LYON is a complex security, it is not entirely new. Callable convertible bonds certainly existed prior to the LYON, as did zero coupon bonds. And so did put and call options on a wide array of common stocks. What demand, then, did the LYON fulfill that was not being adequately met by an already existing financial instrument?

THE SEEDS OF THE IDEA

To address that question, it is useful to trace the history of the LYON. This history begins with Merrill Lynch and Mr. Lee Cole. During the mid-1980s, Merrill Lynch was the largest broker of equity options for retail (that is, non-institutional) investors. During that period, owing to the success of its Cash Management Accounts (CMAs), Merrill Lynch was also the largest manager of individual money market accounts. Individuals had over $200 billion invested in CMAs. CMAs are funds invested essentially in short-term government securities and, for this reason, are subject to little interest rate risk and virtually no default risk.

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3. The imputed interest is computed by increasing the call prices at a rate of 9.0% per year compounded semiannually. If the LYON is called between the dates shown above, the call price is adjusted to reflect the "interest" accrued since the immediately preceding call date shown in the schedule.

During 1983, Lee Cole was Options Marketing Manager at Merrill Lynch. Cole discerned (or, more aptly, divined) a pattern in the transactions of individual retail customers. As Options Marketing Manager, Cole observed that individuals' primary activity in the options market was to buy calls on common stocks. The most active calls had a maximum term to maturity of 90 days and often expired unexercised. Viewed in isolation, this strategy appeared to be very risky.

In reviewing customers consolidated accounts, however, Cole observed that many options customers also maintained large balances in their CMA accounts while making few direct equity investments. From these observations, Cole deduced a portfolio strategy: Individuals (or at least some individuals) were willing to risk a fraction of their funds in highly volatile options as long as the bulk of their funds were largely safe from risk in their CMA accounts. They also avoided direct equity investment. He leaped to the further inference that funds used to buy options came largely from the interest earned on CMA accounts. In short, individuals were willing to risk all or a fraction of the interest income from their CMAs in the options market so long as their principal remained intact in their CMA account.

With these observations and deductions in hand, Cole drafted a memorandum describing in general terms a corporate security that would appeal to this segment of the retail customer market. In drafting his memo, Cole's intent was to design a security that would allow corporations to tap a sector of the retail market whose funds were currently invested in government securities and options. The security described therein eventually turned into the LYON. Because it is convertible into the stock of the issuer, the LYON effectively incorporates the call option component of the portfolio strategy perceived by Cole. Because of the put option, the investor is assured his principal can be recovered by putting the bond back to the issuer at pre-specified exercise prices. The LYON thus approximates the features of the trading strategy as perceived by Cole.

If Cole's theory were correct, the LYON would be a desirable security for individual investors and would give corporation issuers access to an untapped sector of the retail market. As with most theories, however, Cole's rested upon a number of unproven assumptions. The ultimate question, of course, was whether the security would pass the market test.

THE SEARCH FOR THE IDEAL ISSUER

It takes two sides to make a market. And while Cole had identified what he perceived to be a demand by investors, that demand could not be satisfied by every issuer. The ideal issuer would have to satisfy at least two, and perhaps three, criteria: First, because of the put feature and the downside protection desired by investors, issuers would have to have an investment-grade bond rating—and the higher the rating the better. At the same time, however, the issuer's equity would have to exhibit substantial volatility, otherwise the security would not provide the "play" desired by option investors. These two features were critical. Because the initial target market for the security was to be individuals, a third highly desirable characteristic of the issuer would be broad name recognition.

Beginning in mid-1984, the investment banking department of Merrill Lynch began the search for the first LYON issuer. That task turned out not to be a simple one. First, the population of candidates was obviously limited to those firms that needed to raise funds. Second, every issuer, even those issuing already tried and true securities, is anxious about the possibility that an issue might "fail." That anxiety is compounded when a new instrument is proposed—especially one as complex as the LYON. Third, because investment-grade credit ratings tend to be assigned firms with less volatile earnings (and thus, presumably, less volatile stock prices), the subset of companies with investment-grade ratings and volatile stock prices is a fairly small one.

After repeated presentations to a variety of potential issuers and after repeated rejections, Waste Management, Inc. expressed an interest in the security and authorized Chuck Lewis and Thomas Patrick, the Merrill Lynch representatives, to move forward with a proposal. Furthermore, Waste Management exhibited most (perhaps all) of the requisite characteristics of the ideal issuer. Its debt was rated Aa. In terms of volatility, the annual variance of its common stock of 30% placed it in the top half of all NYSE stocks. The only question was whether Waste Management had sufficient name recognition to attract Merrill Lynch's retail customers.

Its stock was traded on the NYSE and it operated in communities throughout the country. It specialized in the disposal of industrial and household waste; but it was not necessarily a well-known consumer product. The Waste Management name

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was by then a familiar one, however, to the extensive Merrill Lynch brokerage network. Over the period 1972 through 1985, Merrill Lynch had managed four separate new equity issues for Waste Management, a number of secondary equity issues, and nine issues of industrial revenue bonds. All of these raised the broker and customer awareness of the company.

Over the same 1972-1985 time period, Merrill Lynch had also arranged a private placement of $50 million in debt for Waste Management and had represented the company in two hostile takeovers. This working relationship may have been the key factor necessary to overcome "first-issuer anxiety."

In any event, Merrill Lynch finally brought the first LYON to market in April 1985, roughly two years after Lee Cole drafted his outline memorandum. The issue sold out quickly and Cole turned out to be at least partly right. In the case of a traditional convertible bond issue, roughly 90% of the issue is typically purchased by institutional investors with only a tiny fraction taken by retail customers. In the case of the first LYON, approximately 40% was purchased by individual investors. Apparently Merrill Lynch had designed a corporate convertible that appealed to an otherwise untapped sector of the market.

And the appeal of the LYON to the retail sector of the market has persisted. For example, Euro Disney raised $965 million with a LYON issue in June 1990. Of that issue, 60% was purchased by individual investors and 40% by institutions. Individuals accounted for over 45,000 separate orders. Over time, the fraction of LYONs purchased by retail customers has varied from issue to issue, but has averaged roughly 50% of the total. Furthermore, the zero coupon, puttable, convertible bond apparently has staying power. Of the total proceeds raised through convertible bonds during 1991, roughly half were zero coupon, puttable convertibles.

Merrill Lynch, moreover, as the entrepreneurial source of this successful innovation, has profited handsomely from the LYON. In the case of the typical convertible bond, the underwriter's spread is about 1.7% of the dollar amount of funds raised. For the earliest LYONs, the spread was 3% and, at the present time, continues to be about 2.5% of the amount of funds raised. Additionally, Merrill Lynch

was able to "corner" the market for almost five years before other investment bankers brought LYON-like securities to market. According to the *Wall Street Journal* article cited earlier, since 1985 Merrill Lynch has earned some $248 million from sale of LYONs.

THE CASE FOR CONVERTIBLES
(Or, Financing Synergies From Combining Debt with Call Options)

But this brings us to the obvious question: What was the source of the gains to issuers and investors from the LYON that would allow Merrill Lynch to earn such large rewards?

Because the LYON is a variant of the convertible, let's begin by revisiting the "case for convertibles" made by Michael Brennan and Eduardo Schwartz in an article published in 1981.[4] The popular argument for convertible bonds is that they provide "cheap debt" (that is, they carry coupon rates below those on straight debt) and allow companies to sell stock "at a premium" relative to the current market price. But, as Brennan and Schwartz demonstrate, this reasoning conceals a logical sleight of hand: It effectively compares convertibles with a debt issue under one set of circumstances (when the firm's stock price doesn't rise and there is no conversion) and with a stock issue under another (the stock price rises and the issue converts). What it fails to point out is that the convertible issuer would have been better off issuing stock in the first set of circumstances and straight debt in the second. In short, convertibles do not provide the average issuer with a financing "bargain."

After exposing this popular fallacy, Brennan and Schwartz go on to argue that the real source of convertibles' effectiveness is that *their value is relatively insensitive to the risk of the issuing company.* Increases in company risk reduce the value of the bond portion of a convertible, but at the same time increase the value of the built-in option (by increasing the volatility of the stock price). Because of this risk-neutralizing effect, convertibles are useful in resolving disagreements (arising from what academics refer to as "information asymmetries") between management and would-be investors about the risk

4. Michael Brennan and Eduardo Schwartz, "The Case for Convertibles," *Chase Financial Quarterly*, Vol. 1 No. 3 (Fall 1981). Reprinted in *Journal of Applied Corporate Finance*, Vol. 1 No. 2 (Summer 1988). This article extends insights about the role of convertibles formulated earlier by Michael C. Jensen and William H.

Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure," *Journal of Financial Economics* (1976), pp. 305-360. See also Clifford W. Smith and Jerold B. Warner, "On Financial Contracting: An Analysis of Bond Covenants," *Journal of Financial Economics*, 7 (1979), pp. 117-161.

of a company's operations. And it is largely for this reason that the use of convertibles tends to be concentrated among relatively smaller, high-growth companies with volatile earnings—the kind of companies, in short, that ordinary fixed-income investors shy away from. Convertibles are also well-suited to such issuers because the lower current interest payments reduce the risk of financial distress, which is likely to be especially disruptive for companies on a high-growth track.

Convertibles are also effective in cases where management has significant opportunity to increase the risk of the firm's activities. When such risk-shifting is a real possibility, the firm will be required to pay an especially high premium to issue straight debt, far more than management believes is warranted given its true intentions for the company. Convertible debt, because it can be exchanged for common stock, provides the bondholder with built-in insurance against such risk-shifting behavior.

But what has all this to do with the LYON—which, after all, is intended for investment-grade companies? To the extent the equity values of LYON issuers are more volatile than those of other investment-grade issuers, LYON issuers also presumably benefit from this risk-neutralizing effect that comes from combining debt with options.

To have succeeded in the manner it has, the LYON must also provide benefits that go well beyond those of conventional convertibles. The success of the LYON, as suggested earlier, has much to do with Merrill Lynch's ability to design a convertible that would appeal to individual investors.

RETAILING CONVERTIBLES
(Or, the Value of the Put Option)

Lee Cole was apparently correct in his assessment that there was a latent demand among retail investors for a convertible-like payoff structure—one combining, in the case of the LYON, a *zero-coupon*, fixed-income component with an equity call option. By offering what amounts to a continuous option position, such a convertible would have the added appeal to investors of potentially large transactions costs savings. Recall that, under the call-option-cum-CMA strategy perceived by Cole, investors were purchasing a series of calls that expire at 90-day (or shorter) intervals, thereby incurring commission costs at least four times a year.[5] By buying and holding a newly issued LYON, the retail investor could maintain continuous ownership of an option position over the life of the bond without paying any brokerage fees.

But, to allow retail investors to take advantage of these long-dated, low-transaction-cost options, Cole realized the new security would have to be designed to overcome retail investors' normal resistance to convertibles. This could be accomplished, in part, by choosing only issuers with investment-grade bond ratings and with "name-recognition." But, to reduce the principal risk to levels acceptable to retail investors, the new security would also have to include a stronger, contractual assurance.

Hence the put option. By giving investors the right to put the notes back to the company after three years (and at one-year intervals thereafter), the Waste Management LYON greatly reduced the exposure of investors' principal to a sharp increase in interest rates as well a drop in the issuer's credit standing. In so doing, it dramatically increased the value of the security. (As we show later, the put option accounted for almost 20% of the value of the Waste Management LYON at the time of issue.)

Of course, granting investors such an option could turn out to be costly to the LYON issuer. A jump in rates or fall in operating cash flows could force the company to retire the bonds at the worst possible time. For this reason, LYONs issuers are likely to "self-select" in the following sense: Among companies with sufficient market volatility to provide LYONs investors with the desired option "play," LYONs issuers will also tend to be those with greatest confidence in the ability of their operations to weather a sharp rate increase, and the need to raise new capital under those conditions.

In short, ideal LYONs issuers are companies for which the benefit of granting the put option (and thereby gaining a retail following) most outweighs the expected cost of having to deliver on that option.

A Retail Clientele Effect?

But this brings us back to the alleged benefits of appealing to a retail clientele. Generally speaking, the "modern theory" of finance has offered little

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5. Traded equity options are available with maturities as long as 270 days, but such options are much less liquid than their 90-day counterparts.

encouragement to explanations of securities designed for specific kinds of investors. But there are notable exceptions. Robert Merton, in his 1987 Presidential Address to the American Finance Association, developed a model of asset pricing in which the size of the firm's investor base is an important determinant of the price of the firm's securities.[6] Starting from the assumption that investors invest only in a limited set of securities about which they have information, Merton's proposed model suggests that securities markets may effectively be "segmented"—that is, companies lacking retail investors may be selling at a sharp "information discount" relative to their retail-owned counterparts. To the extent such segmentation exists—and this is still a matter of sharp contention—management actions that expand the firm's investor base would increase the firm's value.

Moreover, a recent study by Greg Kadlec and John McConnell provides empirical support for the predictions of Merton's model.[7] Their study reports that the prices of stocks newly listed on the NYSE during the 1980s increased in value by 5% to 6% at the time of listing. Also suggestive, this increase in value is significantly correlated with the increase in the *number of investors* in the firm's stock from the year before to the year after listing. In sum, if we extend Merton's argument and this supporting evidence to the case of the LYON, it is plausible that the LYON's extension of convertibles to a previously untapped sector of the market could be providing significant value for issuers.

The Appeal to Institutional Investors

But what about institutional investors? Why would they "pay up" for a convertible with a put option relative to an otherwise identical convertible bond without one? To this question, our answer is again tentative and follows from the form of potential payoffs under the LYON.

During the mid-1980s, portfolio insurance began to flourish as a popular tool for portfolio managers.

The general objective of portfolio insurance is to provide upside potential while limiting downside risk. And that is essentially the payoff pattern presented by the LYON. If the underlying stock price increases, the value of the LYON increases accordingly. If the stock price falls or interest rates increase, the LYON holder is protected by the floor provided by the put exercise price.

To the extent some institutional investors are willing to "pay" for portfolio insurance, then those investors might also be willing to pay a slight premium for the "insurance" provided by the LYON. Over time, however, as more LYON-like securities are brought to market, and as more investment bankers produce competing products, the spread commanded by underwriters should decline. In the meantime, Merrill would have earned its "reward."

ENTER THE MODEL BUILDERS

It was only after the Waste Management LYON had been brought to market successfully that Merrill Lynch asked us to build a model to value the security. Why the need for a model? The answer has as much to do with marketing as with the need of traders and issuers to analyze and price the security. The answer is also reassuring to those like us who view modern finance theory as a powerful, but practical, scientific discipline with important implications for corporate managers and investors.[8]

Following the issuance of the Waste Management LYON, Merrill Lynch intensified its effort to bring additional issues to market, both to increase the liquidity of the market for the security and to demonstrate that the security was not just a passing curiosity.[9] Following the success of the first LYON, other potential issuers showed more interest, but also asked more questions.

Three questions typically came up: First, what was a "fair" price for a specific LYON given the characteristics of the company and security in question?[10] Second, how would the security react under different market conditions? Third, under what

6. See Robert Merton, "A Simple Model of Capital Market Equilibrium with Incomplete Information," *Journal of Finance*, Vol. 42 (July, 1987).

7. Greg Kadlec and John J. McConnell, "The Effect of Market Segmentation and Illiquidity on Asset Prices: Evidence from Exchange Listings," unpublished manuscript, Krannert School of Management, Purdue University (1992).

8. The model can also be used to determine the appropriate LYON hedge ratio.

9. It goes without saying that generating a fee for bringing the security to market was also an important consideration, but to continue generating fees from LYON issues it was necessary to demonstrate the continued viability of the security.

10. Interest in this question was motivated, at least in part, by would-be investment banker competitors who used a crude option pricing model to argue (to potential issuers) that the Waste Management LYON was underpriced by roughly 30%. The likely cause of such underpricing, as this article goes on to explain, was its failure to take account of the interaction of the values of the various components of the LYON.

conditions would investors elect to convert the security to common stock? This last question was asked by managers concerned about the dilutive effect of conversion on the company's EPS.

Pricing the LYON

The model we developed to answer those questions is based on the Brennan-Schwartz (1977) model for analyzing convertible bonds—which is based in turn upon the classic Black-Scholes (1973) option pricing model.[11] Interestingly, with some minor modifications, this model is still used by Merrill Lynch to analyze LYONs today.

Given the similarity between a LYON and an call-option-cum-CMA strategy, the great temptation in developing a model to analyze this security is simply to sum the value of the components: to add the values of the put and call options to that of a zero-coupon (callable) bond issued by the same firm. The problem with such an approach, however, is that it ignores the *interactions* between these values. For example, both the issuer's call option and the investor's conversion rights reduce the value of the put option (by reducing the expected maturity of the put). The value of the conversion option is similarly reduced by the issuer's call option and the put option, both of which reduce the probability of eventual conversion. Because of these interactions, the value of the LYON depends both on the conversion and redemption strategies followed by the investor and the call strategy followed by the issuer.

Our model makes the by-now standard assumptions of the option pricing literature that the investor follows conversion and redemption strategies that maximize the value of the security, while the issuer adheres to a call strategy that minimizes the security's value.[12] These assumptions, coupled with the assumptions that the value of the LYON depends upon the issuer's stock price and that securities are all priced to eliminate arbitrage profits, yield a fairly complicated differential equation for valuing and analyzing the LYON. Despite its complicated appearance, the equation can be solved numerically on a personal computer in a few minutes.

The "intuition" underlying the model is this: The higher the general level of interest rates, the lower the value of the LYON; the higher the volatility and the level of the issuer's stock price, the greater the value of the LYON; the lower the LYON call price and the sooner the call can be exercised, the lower the value of the LYON; the higher the dividend on the issuer's stock, the lower the value of the LYON (since higher dividends imply less stock price appreciation and less chance of conversion); and, of course, the higher the put exercise prices, the higher the value of the LYON.

For purposes of illustration, consider the Waste Management LYON described earlier. The table below presents the basic market characteristics, the characteristics of the firm, and the features of the bond as of the issue date. Given these characteristics, our model predicted that the market value of the bond as of the issue date should be $262.70. In fact, at the close of the first day of trading, the bond's price was $258.75. We tracked the bond over the next 30 days and determined that the model's predicted prices closely tracked the actual closing prices, but were typically slightly above the closing price. Apparently, the model has a slight upward bias in valuing the LYON.

Interest rate of intermediate term bond	11.21%
Stock price	$52.25
Stock price volatility	30.0%
Dividend yield	1.6%
LYON maturity	15 years
Face value	$1,000/bond
Conversion ratio	4.36 shares/bond
Call prices	In text
Put prices	In text

Sensitivity Analysis

In the following table, we show the effects of changes in market conditions, the issuing company, and features of the security on the value of Waste Management's LYON. There are a number of interesting insights from this "sensitivity analysis." The value of the Waste Management LYON is highly

11. For the formulation of the Black-Scholes option pricing model, see Fischer Black and Myron Scholes, "The Pricing Options and Corporate Liabilities," *Journal of Political Economy*, Vol. 81, No. 3 (May-June 1973). For the extension of that model to the valuation of convertible bonds, see Michael Brennan and Eduardo Schwartz, "Convertible Bonds: Valuation and Optimal Strategies for Call and Conversion," *Journal of Finance*, Vol. 32, No. 5 (December 1977).

12. This discussion draws heavily on our article "LYON Taming," *Journal of Finance* (July 1986). Whether investors and issuers follow these strategies is an issue of some contention. For a discussion of this controversy see Michael Brennan and Eduardo Schwartz, "Convertible Securities," *Palgrave Dictionary of Accounting and Finance* (MacMillan, 1992).

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insensitive to interest rate changes (a 200 basis point increase in yields would cause less than a 4% decline in the value of the LYON). But this insensitivity to rates is caused by the put option, which our analysis indicates accounts for almost 20% of the security's value. That is, *without* the put option, the LYON's value would be reduced from roughly $260 to under $215 per bond. At the same time, however, the *issuer's* call option reduces the value of the LYON by roughly $20 per bond (or 8% of its total value). It does so, as mentioned, by reducing both the probability of the investor exercising his conversion rights and the likely length of time that option is allowed to remain outstanding.

	Bond Value	Effect of Change on Bond Value
Basic features	$262.70	
Stock price to $56.00	271.68	+8.98
Stock price volatility to 40.00%	271.89	+9.19
Dividend yield to 3.0%	260.78	-1.92
Interest rate to 13.21%	252.38	-10.32
Without call	283.29	20.59
Without put	215.04	-47.66

The Question of Conversion

As noted, one question of frequent concern to LYON issuers is the stock price at which investors will choose to convert the bond to stock. In deciding whether to convert, the investor weighs the value of dividends forgone by holding the LYON against the downside protection provided by the put. Thus, if the dividend yield is relatively low, the benefits of conversion (to obtain the dividend) are also relatively low. But, even for low-dividend paying stocks, if the stock price rises high enough, it will be so far above the put price that the protection provided by the investor's put option becomes negligible.

Our model assumes the critical conversion stock price is the price at which the investor becomes indifferent between holding the LYON and converting to common stock. As illustrated in the next table, the critical conversion stock price for the Waste

Management LYON changes throughout its life, increasing steadily throughout the first 13 years, and declining sharply thereafter. There are two opposite effects driving these changes—one that is present in all convertibles and one that is unique for the LYON. As in the case of a conventional, current-coupon convertible, the optimal conversion price of the LYON is reduced because the value of the conversion option is shrinking along with the remaining time to maturity. But, unlike conventional convertibles, the conversion price in the case of the LYON is also *increased* through time by the fact that the redemption price increases while the conversion ratio remains constant (4.36 shares per bond)—which, of course, reduces the value of the conversion option. In all but the last two years, the latter effect dominates the former.

Date	Conversion Stock Price	Date	Conversion Stock Price
Issue	$129.50	6/30/93	$273.00
6/30/85	132.00	6/30/94	287.00
6/30/86	145.50	6/30/95	301.50
6/30/87	158.50	6/30/96	316.00
6/30/88	173.50	6/30/97	329.50
6/30/89	194.50	6/30/98	339.00
6/30/90	217.00	6/30/99	340.00
6/30/91	238.50	6/30/00	317.50
6/30/92	257.00	1/21/01	229.36

IN CLOSING

It is difficult to generalize from a single observation—and the Liquid Yield Option Note is just one of many successful financial innovations of the 1980s. The case history of the LYON does illustrate, however, that successful financial innovation requires ingenuity, perseverance, and, perhaps, a measure of good fortune. It also illustrates the potential practical power of modern financial theory in assisting in the development of new financial products and strategies. As practitioners of the science of modern finance, we were fortunate enough to be present at the creation of what now appears to be a successful financial innovation.   .

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