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Pricing, Hedging, AND Trading Exotic Options

UNDERSTAND THE INTRICACIES OF EXOTIC OPTIONS AND HOW TO USE THEM TO MAXIMUM ADVANTAGE

ISRAEL NELKEN

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In memory of Marvin Merrick. Your light has not dimmed for it is carried on by those who loved you and miss you.

CHAPTER 1

Motivation for Using Exotic Options

WHY DEAL WITH EXOTICS?

Before beginning our study of exotic options which are complicated derivatives with bizarre names such as: Lookback, Choosen, Compound, Asian, etc., we need to ask ourselves a question. After all, there have been so many cases of catastrophes and near catastrophes. So why deal with these instruments at all?

Several foreign exchange options desks report that 15 percent of the volume of their foreign exchange options business is done in exotics. Furthermore, that 15 percent generates 50 percent of the profit. Thus, the profit margins on exotic options tend to be much higher than the profit margins on vanilla products.

Consider the following example: If you sell a regular interest rate cap in the U.S., the price competition is 0.1 basis point. Every bank can sell a cap. Even if you sell it, how much profit is in it for you at 0.1 basis point? (In London the profit margins are somewhat better at 0.25 basis point.) Even if you managed to sell the cap you haven't made much money.

However, with exotic options the margins are much larger. Typically, the margins are quite large at the inception of the exotic options market in a particular country. When only one bank can provide a specific type of option, it can charge wide bid-ask spreads. Then, as other banks come in, the spreads gradu-

ally diminish. This happens as other banks learn about these products and begin to offer them. There is a price competition that intensifies as other banks join in.

If you take the barrier options in New York in 1992–1993, the bid-ask spreads were 10 times those of European options. Currently, they are about 1½ to 2 times those of European. The saying is now that "barriers have become vanilla."

Today banks that do not offer exotics find it difficult to succeed. If a company is offered barrier options by five out of the six banks in its banking group, it will also ask the sixth bank to provide them. The sixth bank is almost forced into this market. However, rather than being followers and being forced into the markets, many banks are entering new and untapped markets to become leaders in those markets.

GLOBALIZATION AND DEMOCRATIZATION OF FINANCE

One very important trend in finance is globalization. It means people can do business anywhere in the world. This is markedly different from how it used to be. Fifteen years ago an investor from, say, Iowa would invest in either U.S. stocks or U.S. bonds. That was basically his choice. He didn't even know that Japanese stock existed. Or perhaps our investor was very savvy. He knew of a particular Japanese company, and he wanted to buy some shares. So he wrote the company and requested a copy of its annual report. It took a month before he received the information he asked for. And when he did get it, it was printed in Japanese, so he couldn't comprehend any of it anyway without a translator.

Look at what happens to the same investor today. As long as he has a computer, he can live anywhere. All he has to do is look on the Internet, type the name of the Japanese company, and out comes the latest annual report. And if it comes up in Japanese, he can select the English version and, presto, it is now in English.

The moral of the story—today you have a wide array of investment choices that you didn't have before. You have a lot more opportunities to invest and a lot fewer barriers to investments than ever before. In terms of exotic options, there are special types of structures designed to allow investors in one

country to take advantage of the economy of another—for example, the increased usage of quanto options. These allow you to play a foreign stock market without exposing yourself to currency risks.

The second type of major trend in finance is what has been called democratization. Fifteen years ago, the dealers had major information advantages as compared with their clients. Now, the information advantage has almost disappeared. So, for example, fifteen years ago, a foreign exchange salesperson might have called up a company to tell them what the U.S. dollar–German mark rate had done yesterday. But nowadays the company has the same information on its own screens. Even a retail investor can get access to exactly the same information on a dedicated Internet site.

Think of the following paradigm. Fifteen years ago the client was like a person walking in the desert—superthirsty for information, begging for a drop or two of water. Now, the same client sits beside an on-time screen with live quotes, very much the same screen as the trader watches. In addition, there are thirty-seven e-mail messages, fifty-five voice-mail messages, and a host of faxes and newsletters to read. The client is now like a person drowning in information. He needs a life jacket or, in other words, some way to interpret and make use of all this raw information. As a result of the availability of the raw information, the dealers have started supplying their clients with various tools to interpret the information. For example, the risk management tools such as: RiskMetrics and CorporateMetrics are supplied free (or almost free) to the clients. The dealer makes the client aware of the various risks he is facing and hopes that then the client will then hedge those by purchasing derivatives, which include exotic options, from the same dealer.

SOME DANGERS

The example in Figure 1.1 shows us the difference between a vanilla option mentality and an exotic option mentality. Banks often do deals back-to-back. They sell a structure to a client, and they buy exactly the same type of deal from another bank.

At the beginning of 1997 J. P. Morgan sold an option to the Bank of China. J. P. Morgan bought the exact same option from a counterparty back-to-back. It had been doing back-to-back deals

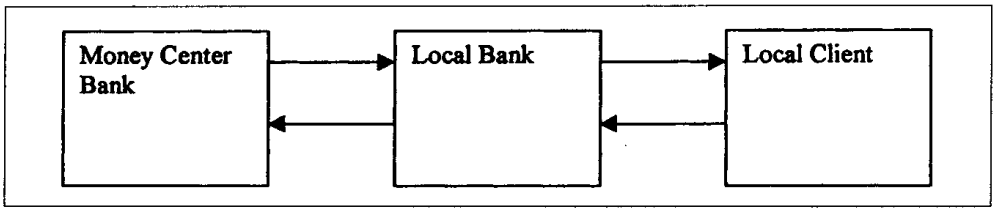

Figure 1.1 A typical back-to-back deal: A local bank puts on a trade with a client and, at the same time, places a mirror trade with another counterparty.

for many years; it had never had a problem doing options before. This option was to mature on May 1, 1997. In this case, it was a barrier option on the U.S. dollar–Japanese yen, with a strike of 123 and a barrier of 127.30. The notional amount was 800 million U.S. dollars. J. P. Morgan then bought exactly the same option with exactly the same underlying, exactly the same strike, exactly the same barrier. Everything was the same. On May 1 when the option expired, the U.S. dollar–Japanese yen was at 127.10. The option owned by the Bank of China was deep in the money. So J. P. Morgan had to pay the bank an amount close to $20 million.

Then J. P. Morgan came to cash its offsetting option. Here comes the hitch. The one it sold to the Bank of China was set to expire at Tokyo time. It was the Tokyo market, and so the "cut" was to be determined using Tokyo standards. However, the offset option was purchased in New York, and so the cut for the offset was to be determined using New York standards.

There is a six-hour difference between the "cut" time of Tokyo and New York. What can happen in a six-hour time period if you had a back-to-back trade in European options? Not very much. A six-hour time difference on a five-month option is a pretty good cover. You have to pay somebody $20 million and you receive $19.9 million.

But now look what happened in our case. At the Tokyo cut time, the rate was 127.10. Then, within the next six hours the dollar climbed just a little bit, past 127.30 (see Figure 1.2). By the time J. P. Morgan came to exercise its offsetting option in New York, it was totally knocked out. J. P. Morgan received nothing, and there was a big loss. This story illustrates the differences between exotic options and European (vanilla) options. The back-

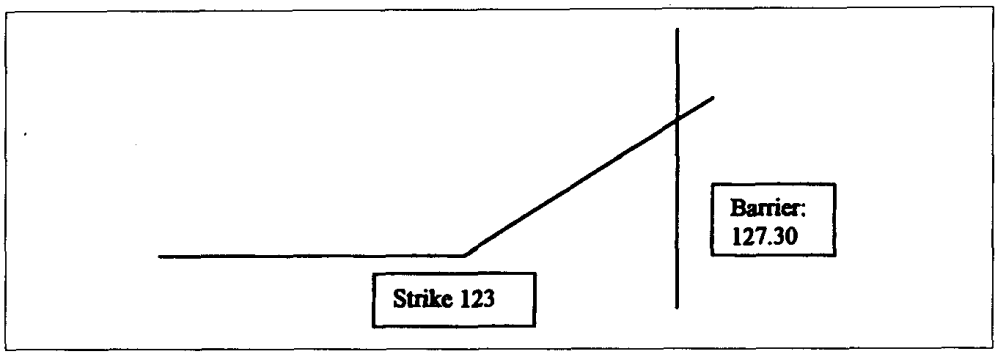

Figure 1.2 The J.P. Morgan–Bank of China barrier option.

to-back strategy has been working for a long time; many banks have done hundreds of such deals. Since the back-to-back strategy works so well, why not do it with barrier options? In fact, many a time back-to-back deals are also done with barrier options. This works fine also. Most of the time, the underlying is not very close to the barrier at expiration.

The very nature of exotic options, and the nonlinear characteristics of them, makes them difficult to deal with. However, difficult is not impossible. Many market makers are earning a very good living with exotics.

CHARACTERISTICS OF THE MARKET

- First of all, we see complicated risk profiles—the nonlinear nature of these options makes them difficult to understand, monitor, price, and hedge. For example, in a European call option the delta is between zero and 1 and goes up nicely. But in an exotic it can go up and then go sharply down. You can get these huge gamma swings. The delta can be very positive at one moment and very negative at the next moment. We will see examples where the delta might reach 1,000 percent. An option that was sold with a notional of $10 million might require a delta hedge of $100 million in the spot market, as compared with about $5 million for a European. Obviously, a hedge of $100 million is not reasonable, but a hedge of $5 million is.

- Then we have difficulties in pricing, hedging, and replication. Take the J. P. Morgan back-to-back deal, for example. Everyone thought it was perfectly replicated, and everybody approved it. Just the same, the loss totaled about $20 million.
- The exotic option, because it is a structured type of deal, usually has low volumes of trading. It is not an exchange-traded product that has huge amounts of volume on it. That means that if you are a client and you bought such a structure, it can be very difficult for you to sell it in the secondary market. You can't always readily get out. Typically, the market maker who sold you the product will stand behind it. So the market maker may buy it back from you, but at what price?
- Exotic options are over-the-counter products and are a special design, not generic. They are not something that you go to the exchange and buy at the money call for a month. For an exotic option, you have to specify where you will put the strike and where you will put the barrier. You have to know how long the maturity is, what the average is, when the averaging period begins, etc. All these extra parameters make this into a very specially designed product for a limited range of customers. So, for example, a sales team can go and argue that every company needs an 8 percent cap, and it will sell as many of them as it can. But not every company needs an Asian option with a knockout. Because the exotic option is designed specifically to target the customer, there is a lack of liquidity.
- In the exotic options market, most investors are long on the option. This is different from an exchange-traded market. For example, suppose you are standing in Chicago in the pit. Some people are buying, and some people are selling. At more or less every moment of the day you have a balanced book. It is not perfectly balanced because people trade all the time. But about half are long and half are short. In an exotic options market you are just selling options to clients. No companies want to sell

you a chooser option. They are only interested in purchasing chooser options. So your book becomes naturally short. Running a one-sided book poses special challenges that we will have to address later.

USER GROUPS

Who are the users of exotic options?

- Investors and asset managers
- Derivatives dealers
- Nondealer financial institutions
- Nonfinancial institutions (e.g., corporations)

Each of these groups uses exotic options in special ways.

Investors and Asset Managers

These people are on the buy side. We can further divide the buy side into asset managers, or investment managers, who are close to the market, and retail investors, who are somewhat removed from the market. The investment managers sit by their Reuters screen all day, and they are connected to the market. They know what is going on every day. Retail clients have a much more passive interest in the market. They may read the evening paper and glance at quotes of stocks that they own. In terms of products, we can differentiate between *active* products and *passive* products. Active products demand participation by the client. Passive products (after they are sold) do not require active participation. Active products are more suited to asset managers and cannot be sold to retail investors.

Derivatives Dealers

Derivatives dealers are interested in option premiums. The premiums for exotic options are much larger than those for vanilla options. Many banks find that they do 15 percent of their volume in the foreign exchange options business in exotics, and yet the exotics generate 50 percent of the profits. Of course, the premiums tend to diminish as the products become more common.

Consider the dealers. They have big problems contending with the democratization of finance. It is not enough for them to give the client some raw information. The client needs advice on how to use that information. The dealers have developed insight into and understanding of risk measurement and management, proprietary trading, etc. They can pass on the knowledge to the client and thus build the relationship. The dealers also understand volatility and correlation better than others, and this is another place where they can assist the client.

The dealers are interested in the option premiums and the large bid-ask spreads. In order to earn these, the dealer establishes an exotic options desk. It is the desk's responsibility to price the options correctly and also to adequately hedge the resulting exposures. Bear in mind that this process is very complicated, and sometimes, even the most sophisticated dealers can get hurt. Even a highly regarded company such as J. P. Morgan lost $20 million on a barrier option trade. Hence, dealers who are selling exotic options must do so very carefully and pay special attention to issues of pricing, hedging, and overall risk management. However, getting things right, while difficult, is not impossible.

Example: Limited-Payout Cap

As noted above, the premiums tend to diminish as the products become more commonplace. Here is an example from a corporate treasurer's point of view. Let's suppose that the treasurer wants to buy an interest rate cap. Of course, the treasurer can consider buying a standard interest rate cap. Since this is a five-year cap with quarterly resets, the cap is composed of twenty caplets. The corporate treasurer then calls up the six or so banks in his banking group and obtains quotes that are within 0.1 basis point of each other. So he is assured that these prices represent fair value.

An exotic options dealer approaches the same corporate treasurer and offers him a chance to buy a *limited-payout cap.* This is also a five-year structure, and it is still reset quarterly, but there are only ten caplets (rather than twenty in the original cap). At the beginning of each quarter, the client will call the dealer and choose whether to activate the cap or not. However, the client may only activate the cap for ten out of the twenty

quarters. This is similar to a rifle with half the cartridges, although you get to choose when you want to shoot.

To compensate for the smaller number of caplets, the dealer offers to sell the option to the corporate treasurer at a 15 to 20 percent discount compared with the cost of the standard cap. The client considers the past five years when he purchased a standard interest rate cap. A lot of times the cap expired out of the money. During many periods, protection wasn't required at all. Further, during some quarters, interest rates were so low that the client was almost certain at the beginning of the periods that he wouldn't need the protection for that period. For example, during the life of the five-year cap there were three years that interest rates were so low that there was no way that this cap would be in the money any time soon. The point is that the client didn't really need all of the twenty caplets. He only needed seven or eight of them. Here is a chance to buy one with ten.

The corporate treasurer has to make a decision:

- If he buys the standard cap, he knows the price is correct up to a 0.1 basis points. Everyone gave him the same pricing.
- If he buys the limited-payout cap, his company gets a 15 percent discount on the price. But he can only get a quote on this product from this one bank that offered it because no other bank knows how to do the price or hedge it yet.

The limited-payout cap looks very interesting from the corporate treasurer's point of view. But he doesn't know how to judge whether the price is fair, and he certainly doesn't have a computational model that can price such a structure. Is this a fair value? Is a 15 percent discount enough? How should the treasurer determine whether he is giving away the farm by accepting the 15 percent discount? The treasurer cannot know. And, of course, the premiums tend to diminish as the products become more common. For example, assume that the real value is a 25 percent discount. Well, if there is a lot more competition, the price is going to drop very close to its fair value.

Note that there are several different types of limited-payout-cap structures. In one type you can choose at the beginning of the

five years the specific quarters at which you want the caps placed. In the other type (the one we've just described), you get to choose every three months if you want to activate the cap. Other caps automatically exercise the first ten caplets that are in the money.

Nondealer Financial Institutions

Commercial banks or insurance companies frequently have needs that have to do with asset liability mismatches. These can be handled quite well with exotics.

The nondealer financial institutions typically have yield curve risks. A commercial bank takes money from clients and places the funds in demand accounts. It credits its depositors with the interest on short-term deposits. Meanwhile the bank invests the same funds in long-term products. The bank receives proceeds based on the long end of the yield curve. This strategy is called "riding the yield curve." The bank borrows short and invests long. As long as the yield curve is upward sloping, things are going OK. What if it flattens a little or even inverts? Then the bank will suffer losses. Exotic options may be used to hedge these risks. For example, an insurance company has assets and liability gaps. Money from premiums comes in, and the company has these potential liabilities later on. For instance, it has to pay out when someone passes away. The insurance company has to perform asset and liability management. Can it generate potentially high-yielding assets?

The differences between insurance products and derivatives are eroding. What is the difference between default insurance offered by a monoline insurer and a credit derivative offered by a dealer? What is the difference between hurricane insurance and a catastrophe-linked bond? In essence, the answer is none. So the distinctions are rapidly blurring.

Corporations

Corporations use exotic options for two primary purposes:

- To generate cost-effective funding
- To create complex hedge structures to match underlying exposures

Cost-Effective Funding

The bond originator sells structured notes to the public. When an investor buys the security, the investor is selling an option to the originator. The price of the option is usually very much reduced. The bond originator then strips the embedded options (usually in collaboration with the underwriter). The options will be sold at fair value in the secondary market. The difference between what was paid for the options and what was received for them represents extra cash inflow to the issuer. This in turn equates with sub-Libor funding. Many times these structures are done as medium-term notes.

Imagine you sell someone a bond. Within that bond you paid $5 for an option, but you immediately turn around and sell that option for $20. That is cash in your hand, and that translates into sub-Libor funding or very low-cost funding. We'll examine a few examples of those. In 1996 several U.S. federal agencies such as the Federal Home Loan Bank (FHLB) issued one-year step-up callable bonds (see Figure 1.3). These were bought by investors. They liked the short maturity of these bonds and their excellent credit rating. However, it turns out that the investors were not able to evaluate these bonds properly. Very short-term bonds need to be modeled with the entire Libor curve taken into account. However, there is no popular bond portfolio management system that adequately handles very short-term bonds as well as long-term

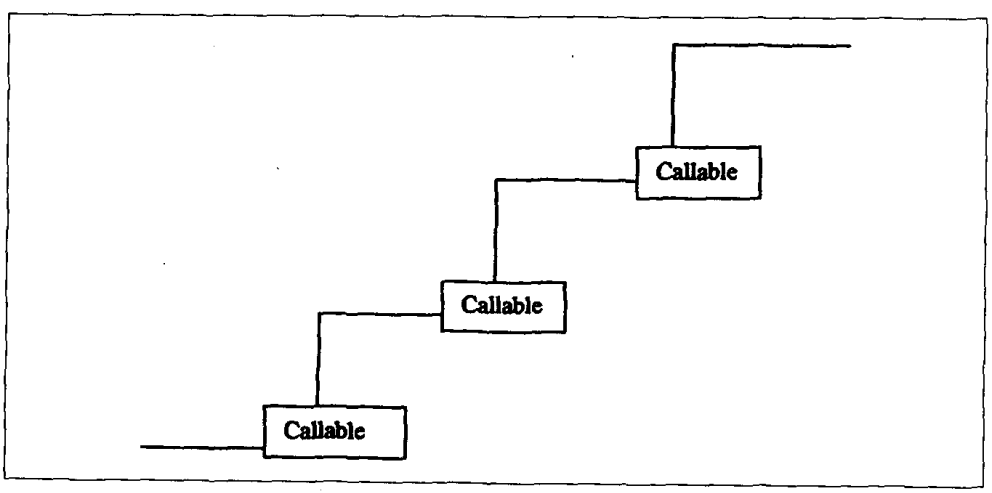

Figure 1.3 A step-up coupon bond callable every three months with a final maturity of one year.