WILEY Trading

OPTIONS MATH FOR TRADERS

How to Pick the Best Option Strategies for Your Market Outlook

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SCOTT NATIONS

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John Wiley & Sons, Inc.

Cover image:© emily2k /iStockphoto
Cover design: Michael Rutkowski

Published by John Wiley & Sons, Inc., Hoboken, New Jersey

Published simultaneously in Canada

Library of Congress Cataloging-in-Publication Data:

Nations, Scott.
Options math for traders : how to pick the best option strategies for your market outlook /
Scott Nations.
p. cm.– (Wiley trading series)
Includes index.
ISBN 978-1-118-16437-2 (cloth); 978-1-118-23940-7 (ebk); 978-1-118-26416-4 (ebk);
978-1-118-22621-6 (ebk)
1. Options (Finance)–Mathematics. 2. Investments–Mathematics. I. Title.
HG6024.A3N35 2012
332.64’530151–dc23

2012022697

For Wendi

Preface

The goal of option trading is to make money. It's a fascinating endeavor—it will make you a better investor, will help you learn something, and will teach you something about yourself. But the goal is to make money, please don't forget that. Too often people start to trade options because it seems interesting. It is and it can be lucrative, but it's the lucrative part that matters.

Option theory relies on certain concepts and formulas but is ultimately used by humans. In order for the extraordinary complex financial world to be distilled to formulas that are actually usable, those concepts and formulas have to make certain assumptions; those assumptions aren't always consistent with the way the world really works. Once humans start using those concepts and formulas, they use them in such a way that attempts to correct for some of those flawed assumptions. The result is that there are certain naturally occurring phenomena in the option world that we can use to our advantage and that will help us make money.

Some of these phenomena are the result of human behavior. Some are a function of the way markets work. Some are a result of the over-idealized world of option pricing models, but all are robust and persistent. They may not exist at each and every moment but they're generally at work, and even if some market force has temporarily overshadowed one of them we can be confident it will return.

This book is not intended for the absolute beginner. We'll define our terms but if you're still unsure of the difference between a call and a put, then there are other works you should read first. Rather, this book is intended for the novice, meaning someone who knows a little about options and understands most of the concepts. The ideal reader doesn't need to know about option pricing models and the arcane variables they throw off; this book explains certain structural phenomena that exist in the option world and how an option trader can take advantage of them to reduce risk and/or increase return. In using these phenomena we put the math of option trading to work for us. Short-term bad luck is always a possibility, but understanding and using these phenomena is a little like putting yourself in the shoes of the casino rather than the gambler.

THE PHENOMENA

Some of the phenomena that we'll discuss have to do with option math and the nature of risk. For example, the passage of time affects investment returns in one way and affects the volatility of those returns in a very different way. Since options are all about volatility and the passage of time, this is a difference we can use to our benefit.

Some have to do with the fact that, in order to understand and generate prices for options, we've come up with idealized versions of the investment universe and then called these idealized worlds *option pricing models*. Certain assumptions have been made in these option pricing models so that the models remain manageable. If option models didn't hold some elements static, the sheer number of possible outcomes for any set of facts and set of potential future facts would be so large that the model couldn't render a result; even if it could manage to generate a result that result would be useless. The option trading world isn't idealized, and thus it has responded to these assumptions in ways that seem contradictory or nonsensical. Taken alone, the results are indeed nonsensical. Once we understand that the real-world contradiction is intended to make up for the real-world failings of our idealized-world option pricing models, then we understand that some of these accommodations can be used to our advantage.

So some of the phenomena are a result of math, and some are the result of the models we use. Some are also the result of failures of the humans who use options, option math, and the models. The math tells us that buying a lottery ticket doesn't make much sense, yet millions do it every day. This is a failure of people rather than math (for the record, I've bought plenty of lottery tickets in my life). These people know that buying a lottery ticket is an extremely long shot and most know that what you get (the expected value of that lottery ticket) is less than what you give (the cost of that lottery ticket). Those who recognize this don't care that the math is working against them; they buy the ticket and without realizing it write off the difference between what they get and what they give as entertainment. In fact, millions of us buying lottery tickets contribute to a giant victory of math for the state selling the tickets. You really have to have the math on your side if you can repeatedly give away $250 million or more while constantly producing a profit.

The gambling analogy is problematic because gambling has no purpose other than enjoyment. The risk in gambling is fabricated by the shuffle of the cards, the tumble of the dice, or the bounce of the ball in the roulette wheel. This gambling risk is without redeeming value. This isn't a moral judgment as long as we recognize that gambling should be entertainment (by the way, I've also spent a little time and money in casinos).

Investing and option trading, on the other hand, should be enjoyable, but both have a redeeming goal. The risk in the capital markets serves a purpose. It allows entrepreneurs to raise money. It allows investors to deploy their money. It allows those investors to use vehicles and strategies to increase their return or reduce their risk. It allows corporations to hedge risk. It creates wealth for investors. That said, who would you rather be, the gambler or the casino?

While we should be leery of introducing the gambling analogy, it's only because we don't want option trading or investing or risk hedging to be unfairly tarnished by association with the frivolous nature of gambling. Nonetheless, the analogy can be instructive and often serves to illustrate a point or concept. Since 1944, when John von Neumann published *The Theory of Games and Economic Behavior*, we've been making the comparison. I'll continue to do so occasionally.

THE GOAL

The goal of this book is to describe some of the structural phenomena that persist in the option world, and to describe whether they exist because of option math, the failure of an option model, the failure of people, or a combination of all three. I'll also describe the magnitude of some of them.

In Part Three of this book we'll discuss certain option strategies that can take advantage of these phenomena. We'll revisit the relevant phenomena and discuss how each impacts our trade. We'll discuss when the trade will work and when it won't, and the risk and reward in both cases. Occasionally we'll also discuss how and when you might make a subsequent trade to change, adjust, or close your initial trade, and how to do so without destroying the mathematical edge we got initially, if that's possible. We'll discuss what to do next because one of the most important takeaways for a trader of any sort is to remember that you always have the right to make a better informed decision as new information comes out. Don't think, just because you've put an option trade on, that you have to let it go to expiration. You always have the right to do the right thing.

THE STRATEGIES

We won't discuss every option strategy or trade type, so you won't see a laundry list of option spreads with intriguing names. We'll discuss vertical spreads, calendar spreads, put selling, and some other strategies, but you won't see Christmas trees, condors, or iron butterflies discussed here. It's not that the phenomena don't apply to those structures; it's simply that they're not the best expression of the phenomena we're trying to capture. The structures we don't discuss can still be valuable structures because a good trader is flexible and imaginative, folding new concepts and lessons into an existing foundation.

I often use real-world examples, and I don't hide the name of the underlying stock, index, or asset. Why, given that fabricating an example might actually be easier? Because many of the phenomena we'll discuss manifest differently from one asset to another. For example, option skew (Chapter 6) is completely different in the Standard & Poor's (S&P) 500 Index than it is in crude oil. We can take advantage of it in both markets, but it's important to understand that some of these phenomena exist differently across assets and they may express themselves to different extremes. If I hid or changed the name of the underlying asset, then it would be easy to misapprehend how and when some of these phenomena exist. Occasionally I'll use a generic example. This usually means the theory or phenomenon is robust but might be observable only after removing a bunch of market-induced noise that obscures our vision.

One strategy that you won't see discussed at all, even though logically extending some of the phenomena might make one think it would be a profitable strategy, is naked call selling. Please don't do it, even if your broker will let you. Little good and much regret can come of it. I'll explain naked put selling, which some might say is being hypocritical, but even when we discuss selling naked puts they're not really naked. You'll have the cash segregated in your account ready to buy the stock if you have it put to you. We'll always treat naked put selling as another form of a limit buy order for the stock, even if we don't explicitly say so in every instance. On the other hand, it's impossible to set aside enough cash to cover the risk from selling naked calls.

Don't expect this book to offer the keys to the kingdom by divulging the "best" option strategy. It won't. Rather, we'll discuss several "good" option strategies, and I'll describe why they're good, when they're great, and when they're only fair. Just because a strategy or structure isn't discussed here doesn't mean it's bad or that you should avoid it—although that's a pretty reasonable bet. For example, I can't imagine a situation when buying a straddle makes sense for a directional trader, so we won't discuss it.

Option trading ultimately becomes a pretty personalized endeavor. Experienced traders tend to have their own styles, which they develop over time.

They have strategies that they like and that fit their personality. They develop the ability to recognize the patterns in prices and circumstances that repeat. Because these traders have seen the patterns before they understand the situations that are likely to result in profitable trades. But don't ignore the other strategies we discuss, or even the ones we don't discuss, just because you've found one that you really like and that works for you. Really advanced traders will recognize that the *reason* a certain trade structure works can be co-opted to make another strategy that they like work even better. We can use that phenomenon to spin out of the first trade (e.g., selling a put) we've had on for some time and into a different structure (e.g., long a put calendar spread) when the option math for the first structure can be improved with the second structure.

THE TAKEAWAYS

Each chapter ends with a section called "Takeaways." These takeaways comprise general themes that tend to exist in the context of the phenomena or trade structures we'll discuss. The phenomena won't always occur at a constant level. For example, the volatility risk premium (Chapter 5), the first phenomenon we'll discuss, tends to be very high in times of turmoil and is generally lower when markets are calm. It ebbs and flows. The general themes tend to be the fundamental, robust "problems" concerning either the math or the models, and sometimes with the people who use them. These are problems we can take advantage of. They're not ironclad or bulletproof solutions—you have to use them judiciously—but they provide a way to get the option math working for you.

Finally, there's never been a better time to be a directional or retail option trader. Electronic brokers can do a great job of execution, even on complex spreads. They've reduced the cost of trading substantially. Option exchanges have embraced technology, meaning that markets are more democratic than ever before and also that the sometimes-hidden costs of option trading (e.g., the bid/ask spread, which we discuss in Chapter 8) have plummeted.

Professional option traders operate in a world filled with advanced math and exotic language. They talk about concepts like *gamma* and *theta* and how they affect their iron fly or condor. Many retail and directional traders, on the other hand, treat options as a proxy for the stock. They think a stock is going higher so they buy some call options. This book is intended to bridge the gap between the two. We'll look at directional strategies and consider as well the issues confronted by the professional trader, and then look at how those issues can inform our directional strategies.

JUST ONE EQUATION

In *A Brief History of Time*, Stephen Hawking famously tells of an editor's warning that for each equation he included he'd lose half of his audience. As a result, Dr. Hawking included just one equation. I think this book faces a similar problem, so there will be just one equation as well. It's the Black-Scholes option pricing model. There are many option pricing models in use now, since Black-Scholes is intended for a pretty narrow set of circumstances, but Black-Scholes is where it all started and throws into sharp focus some of the problems inherent, to one degree or another, in all option pricing models. We'll discuss Black-Scholes in Chapter 4. It's the only equation in the book until the Appendix, I promise. In certain sections we'll use an option pricing model to generate an apples-to-apples comparison of how expensive an option is. In doing so we might use an option pricing model other than Black-Scholes, but the precise equation isn't important, it's the concepts that are important.

ABOUT THE WEBSITE

Because the option math is so important to our analysis and to understanding the phenomena that we're seeking to exploit, we've developed a website at www.wiley.com/go/optionsmath that provides option pricing models and option analysis. Feel free to use it. It can help you calculate the theoretical value of an option as well as the sensitivities of the option to changes in the price of the underlying asset, or the passage of time as well as the expected daily price erosion of the option. Volatility is a vital concept in option trading, and www.wiley.com/go/optionsmath will also calculate the volatility of the underlying asset that is implied by the option prices that we actually see trading.

The website can be a valuable tool in quantifying some of the phenomena. For example, the amount by which the price of an option is expected to erode changes over time. You can use the site to see how this erosion changes, and I imagine you'll be surprised by what you learn.

Different options might also say different things about how much the underlying asset is expected move. This can seem odd: The underlying can only have a single path, but ten options might say it's going to have ten different paths. This is a phenomenon we can take advantage of and the option model at the website can help you understand and quantify this.

When we refer to an option pricing model you're welcome to use www.wiley.com/go/optionsmath but you're also free to use any model that you're comfortable with.

GETTING STARTED IN OPTION TRADING

Finally, I'd like to say a word about getting started in trading. All professional traders, at the beginning of their careers, had to make their very first trade (I still remember mine). It was probably a very small trade (mine was). The traders were almost certainly nervous (I was). Once they got over the hurdle of actually executing that first trade they were able to grow and learn (I'd like to think I did). If you've never made an option trade, then don't try to find the perfect one to be your first. Find a good one that takes advantage of the issues we discuss. Focus on underlying instruments that boast options with good liquidity and a small bid/ask spread. Make the structure one that defines your risk, such as a vertical spread. Then enter the order. Welcome.

Acknowledgments

Thank you to everyone at Live Vol. They've been great partners and I look forward to doing more interesting things with them in the near future. They were also the source of all the actual option prices we've used.

Thanks also to Kevin Commins, Meg Freeborn, and Stacey Fischkelta at John Wiley & Sons. They've provided a great platform for works that help people become better at the things that are important to them.

Thanks also to everyone who's helped me learn about options over the years. Spending so many years in the option pits in Chicago provided a unique education; unfortunately it's a lifestyle that is fading as trading becomes increasingly electronic. That simply means there are different opportunities, not fewer opportunities.

Thanks to Melissa Lee, Max Meyers, Dan Nathan, and Mike Khouw of CNBC's *Options Action*. Helping viewers learn a little more about options would always be fun but it's a tremendous delight to do it with these talented people.

And again, thanks to Wendi.

PART ONE

The Basics

CHAPTER 1

The Basics

The word *option* has come to mean many things beyond a financial instrument. The meaning includes the concept of choices or alternatives. In our context that's appropriate because at the heart of an option is the fact that owners of options have a clear choice. They have the right to do something, but no obligation to do anything, once they've paid for the option. It's this freedom, this choice, and this luxury of waiting that result in the unusual risk/reward profile for an option. The most that option owners can lose is the cost of the option. The amount that option owners can make is literally infinite in the case of a call option. On the other hand, the seller of an option has no choices other than the choice to reenter the market and repurchase the option, paying whatever the market demands.

Add to this element of choice the impact of an option being a wasting asset, since it will expire at some point, and we are left with a wonderfully nuanced instrument. All of these factors and others, such as the date of expiration as well as the price we'd pay or receive for the underlying asset, go into the calculus of considerations that is option trading.

OPTION SPECIFICS

A *call option*, often just referred to as a *call*, gives its owner the right to buy something. A *put* option, often referred to simply as a *put*, gives its owner the right to sell something. It's an oversimplification in the extreme but instructive to say that if you think the price of something is going higher, you'd buy a call option on that something. If you think the price of something is going lower, you'd buy a put option on that something.

The "something" in our simple example is the *underlying asset* (often simply referred to as the *underlying*). It is the asset or instrument that the owner of the call option has the right to buy. It is the asset or instrument that the owner of the put option has the right to sell. It's fixed for the term of the option although its price or value might well change during that term. That potential for change in price is one of the reasons we use options.

For an option, the price you'd pay or receive for the underlying asset is predetermined and standardized. This predetermined price, the price that you'd pay for the underlying asset if exercising a call option or that you'd receive for selling the underlying asset if exercising a put option, is the *strike price*, sometimes referred to as the *exercise price*.

Each option has an expiration date. Technically, the expiration date is usually the Saturday after the third Friday of the expiration month, that third Friday being the last trading day. Effectively, that last trading day is the last day for you to determine whether or not you're going to exercise your option.

Some will recognize that the occasional option will have a final trading day that is other than the third Friday of the month. For example, weekly options are listed that trade for one week and then expire on Friday. The result is a series of expirations each and every Friday. Quarterly options expire on the last business day of the quarter regardless of what day of the week that is. Some index options, such as options on the Standard & Poors (S&P) 500 Index (i.e., SPX options), expire on the open of trading on that third Friday. Options on the Chicago Board Options Exchange Volatility Index (VIX) settle on Wednesday. But the vast majority of individual equity and exchange traded fund (ETF) options follow the normal pattern; the last trading day is the third Friday. And why did the exchanges pick a convoluted day like the third Friday of the month as the typical final trading day rather than something simple like the last day of the month? Because they pored over the calendar and determined the third Friday would have the fewest conflicts with holidays and such. In option trading there is a reason or mathematical basis for everything even if it's not readily apparent. This includes the selection of the day for expiration.

DESCRIBING AN OPTION

We can fully describe any specific option using just these details:

- Underlying asset
- Put or call
- Expiration date
- Strike price

For example, describing an option as the "SPY March 150 call" tells us all we need to know. We have fully described the option and there is no confusion about the specific option we're discussing. The underlying is the S&P 500 Index

ETF (SPY). It's a call option so it's an option to buy SPY. The last trading day of this option is the third Friday in March (if we don't mention a specific year then it's assumed to be March of this year or March of next year if the third Friday in March of this year has already passed) and it expires the next day. Finally, the strike price is 150. If owners of the option choose to exercise it, then they'll buy SPY at $150 a share regardless of where SPY is at the time.

By convention for equities and ETFs, each option controls 100 shares of the underlying. A single SPY March 150 call option gives the owner of the option the right, but not the obligation, to pay $150 for each of 100 shares of SPY on or before the third Friday in March.

Most options allow the owner to exercise the option on or before the last trading day. However, some options only allow the owner to exercise the option on the last trading day. These options are rare when talking about options on individual equities, almost every one of which has the freedom to be exercised at any time. These options that provide the freedom to be exercised at any time are American-style options (think American-style for more freedom). The options that can only be exercised on the last trading day are European-style options. As you might imagine, European-style options (which can only be exercised on the last trading day) are more common in Europe. A few European-style options trade in the United States, and SPX options (when referring to SPX options we're always referring to options on the S&P Index, not on SPX Corporation) are easily the most popular European-style option in the United States.

OPTION COST AND VALUE

The price of an option is determined by the marketplace. Potential buyers and sellers will meet, generally electronically, and determine what an option is worth, with supply and demand being the invisible hand that results in a price acceptable to buyer and seller. For an option, this price is referred to as the *premium*. The option buyer pays the premium to the option seller, and the seller gets to keep this premium regardless of what happens in the future. Sellers may end up sustaining a loss when they pay more than they initially received in order to buy back the option they had sold, but they keep the initial premium they received. Option premium is quoted in dollars per underlying share of stock. Since the standard option contract covers 100 shares, the total an option buyer would be out of pocket if they paid $2.25 in premium for a call option would be $225.

That premium has two elements. The first element is the *inherent* or *intrinsic* *value*. The second, the value of being able to wait to make a decision and to get more information as time passes, is the *time value*.

Inherent Value

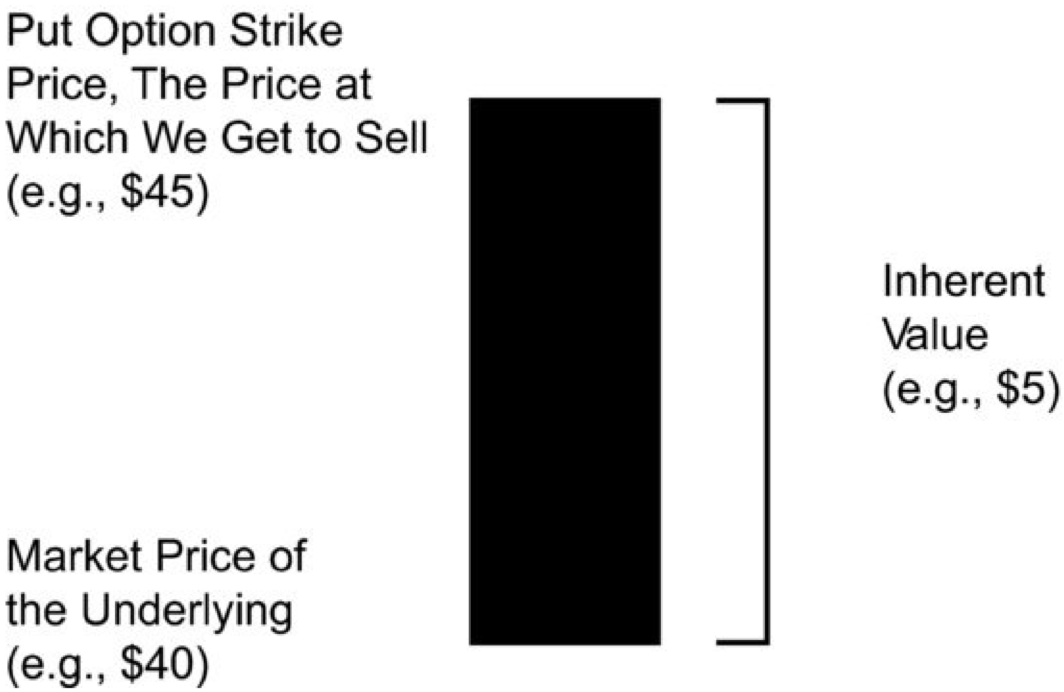
The inherent or intrinsic value is how much you'd get immediately if you exercised your option and then immediately closed your stock position by selling or buying your stock. For a call option the inherent value is the amount by which the strike price of the call option is below the market price of the underlying, as you can see in Figure 1.1.

FIGURE 1.1 Call Option Inherent Value

If the underlying is at $40 then the 30 call is inherently worth $10.

Inherent value for a put option is the amount by which the strike price of a put option is above the market price of the underlying, as you can see in Figure 1.2.

FIGURE 1.2 Put Option Inherent Value



If the underlying is at $40 the 45 put is inherently worth $5.

It's entirely possible for an option to have zero inherent value. If the strike price of a call option is above the current market price for the underlying asset, then the call has no inherent value and its entire price is derived from the luxury of having time on your side.

If the strike price of a put option is below the current market price of the stock, then the put has no inherent value.

Time Value

The time value of an option is the portion of the option price that you're willing to pay for the luxury of waiting to make a decision or to see what happens in the future. It is an option's entire price exclusive of the inherent value.

It's entirely possible for an option to have zero time value. If the strike price of our call option is hugely above the current price of the underlying and our option expires very soon, then the option will have no time value. The likelihood of the option being profitable is so infinitesimal that no one is willing to pay anything for it; there's no point in waiting for something that's never going to happen. No one would be willing to buy this call option because it provides no luxury of waiting.

Likewise, it's possible for a put option to have zero time value. If the strike price of a put, the price as which the put owner would get to sell the underlying asset, is so far below the current market price for the asset that there's essentially zero chance that the underlying will drop that low, then no one would be willing to pay anything for that option, particularly if it's due to expire soon.

An option's price is always the sum of its inherent value and its time value, as you can see in Figure 1.3, which shows that the combination of inherent value and time value equals the total value of a call option.

FIGURE 1.3 Call Option Price, Time Value, and Inherent Value

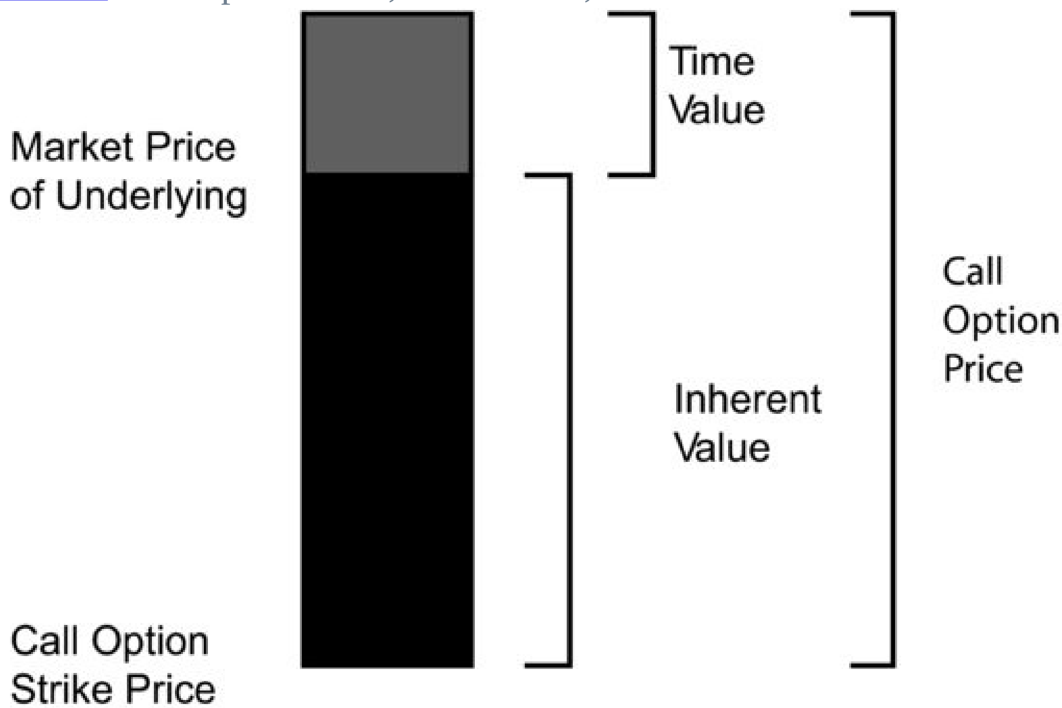
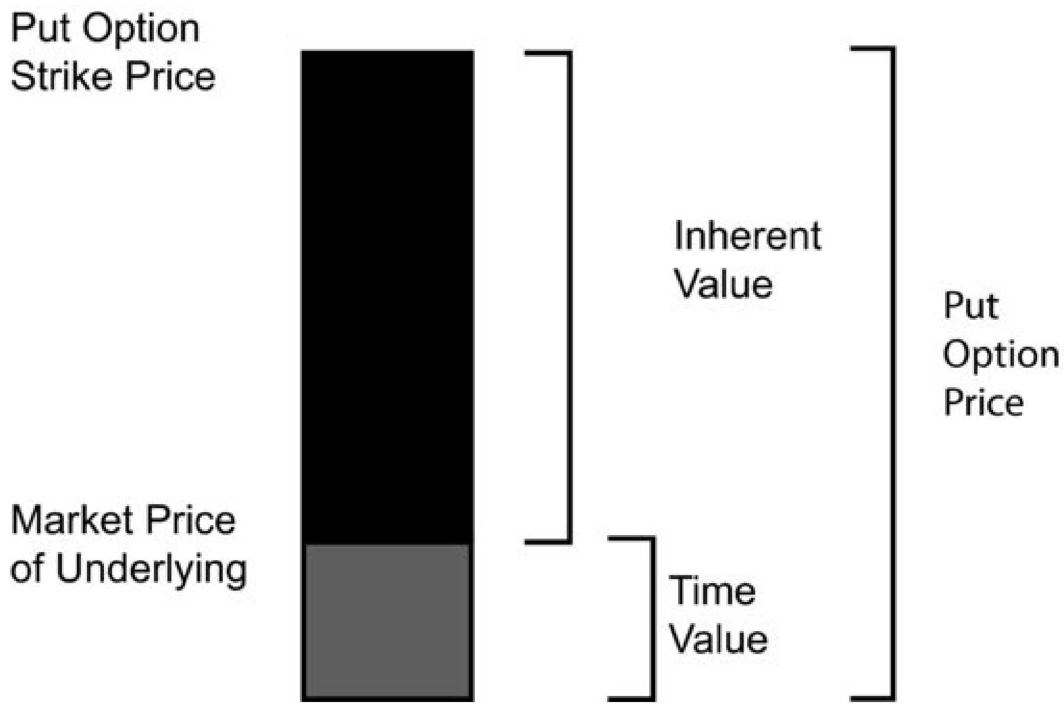


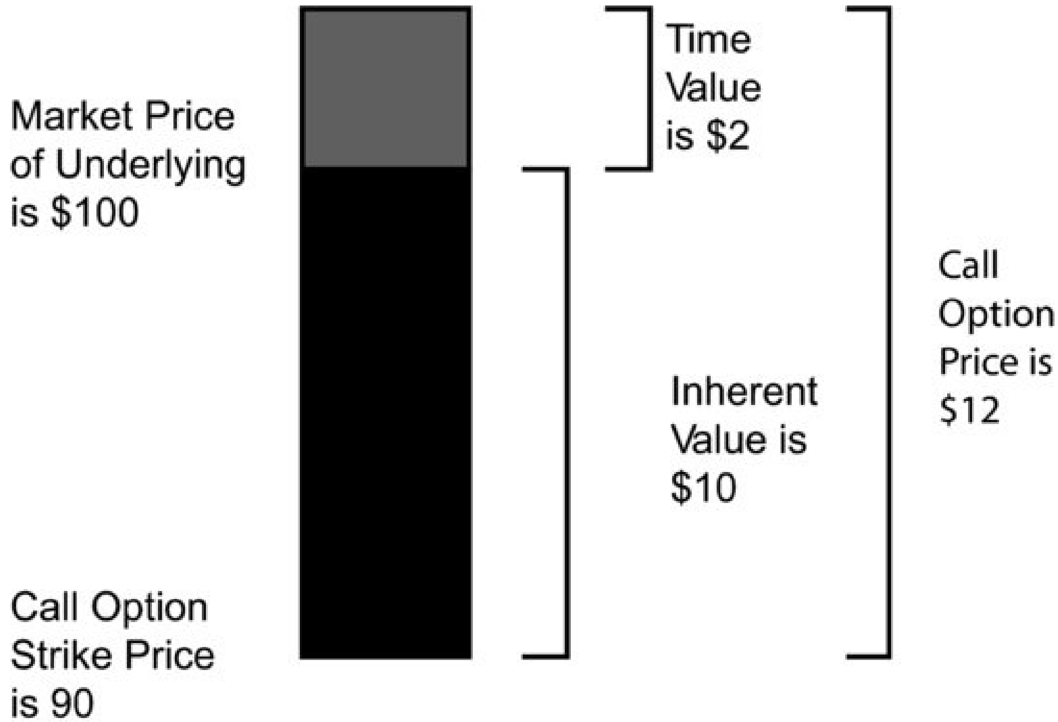
Figure 1.4 shows that the combination of inherent value and time value equals the total value of a put option.

FIGURE 1.4 Put Option Price, Time Value, and Inherent Value



If a stock is trading at $100, then how much is the 90 call option worth? Assuming you could exercise the option immediately, it's worth at least $10 because that's the inherent value of the option. But would you also be willing to pay a little bit more for the luxury of waiting a little longer in order to make a better informed decision? Would you be willing to pay an extra $2 to see if the stock goes up while only risking the cost of your option rather than paying $100 for the stock and risking that entire $100? Figure 1.5 shows this combination of inherent and time value.

FIGURE 1.5 Call Option Price Components Example



If we paid $12 for the 90 call with the stock at $100, then we'd be buying an option with $10 of inherent value and $2 of time value. Why would we do that versus just buying the stock at $100? Just buying the stock saves us the $2 in time value. But that might be an expensive $2. If the stock rallies to $150 at expiration, then we'll exercise our 90 call. We'd pay $90 (the exercise price of our call option) for the stock. We paid $12 for our option. Our total outlay is $102. We have a profit of $48. If we'd just bought the stock at $100 then our total outlay would be just the $100 we paid for our stock. Our profit would be $50. We're $2 ahead by just buying the stock.

But what if the stock drops to $50? With the option we get the luxury of choosing, and we choose not to buy the stock at $90 (our exercise price). Our option expires worthless and we've lost the $12 we paid. But if we'd tried to save that $2 in time value by buying the stock? Then we've lost $50, $38 more than the option trade, all to save $2.

Let's look at another hypothetical stock and some options on that stock to learn a little more about inherent value and time value. The hypothetical option is a call option with a strike price of 100.

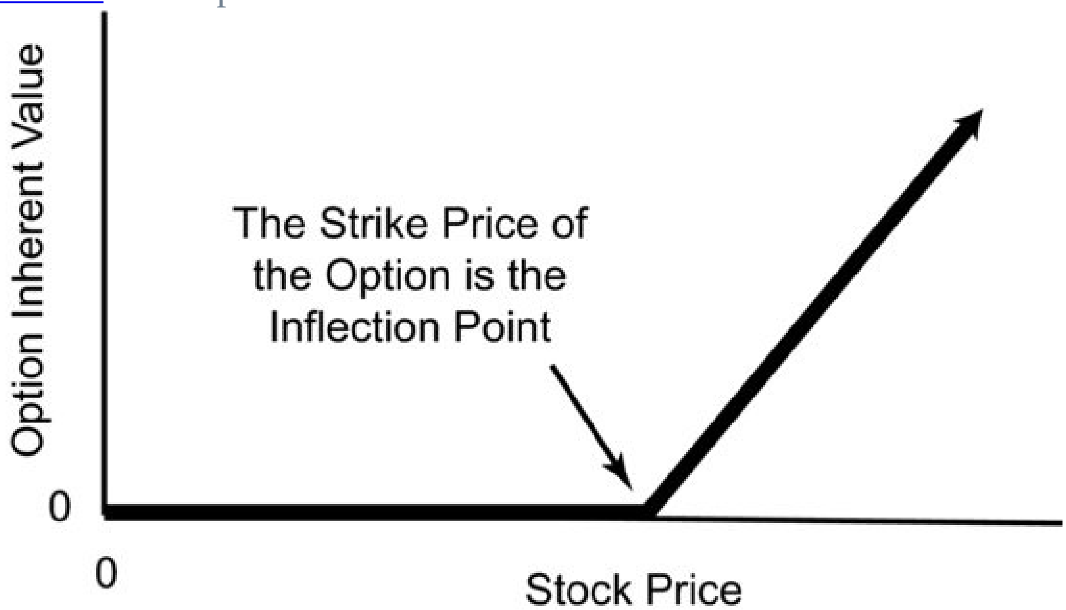
As we see from Table 1.1, the price of each option is the sum of inherent value and time value. Also, inherent value is zero for call options unless the stock price is above the strike price. Once that happens the inherent value becomes linear; it increases in lockstep with the underlying.

Table 1.1 Option Price Components

Stock Price	100 Call Option Price	100 Call Option Inherent Value	100 Call Option Time Value
25	0.00	0.00	0.00
50	0.50	0.00	0.50
75	1.00	0.00	1.00
100	10.00	0.00	10.00
125	26.00	25.00	1.00
150	50.50	50.00	0.50
175	75.00	75.00	0.00

If the stock price is below the strike price the inherent value is zero. Inherent value can never be less than zero. Figure 1.6 shows that inherent value is zero for a call option until the market price of the underlying rises above the strike price.

FIGURE 1.6 Call Option Inherent Value Line

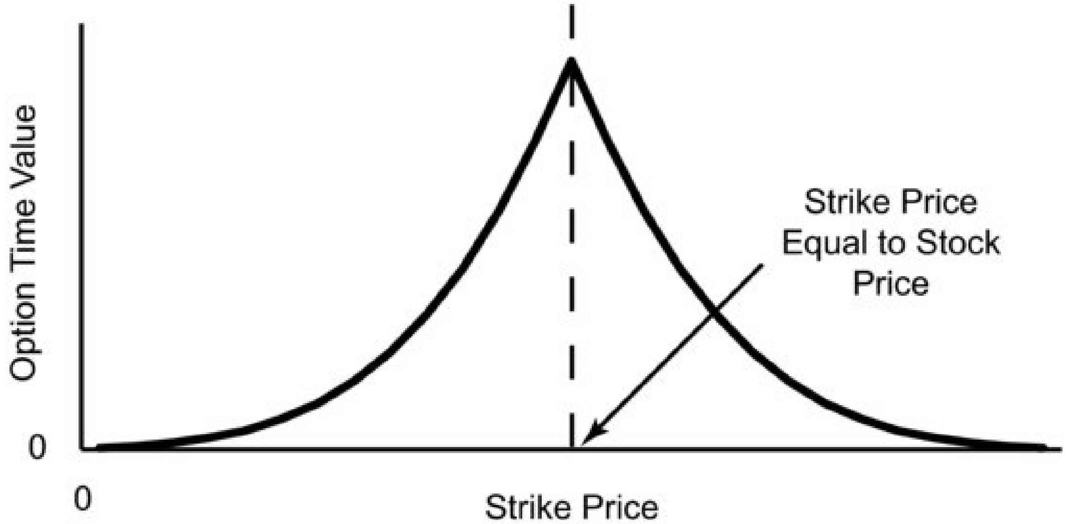


HOW TIME VALUE CHANGES

As we see in Table 1.1, with the stock price equal to the strike price there is no inherent value and all of the option's value comes purely from the luxury of being able to wait to make a decision. The time value tails off in both directions as the strike price moves further away from the market price of the underlying. That makes sense. There's not much luxury in being able to wait for a stock currently at $100 to move to $150 because the likelihood of that move is pretty remote. A move from $100 down to $50 is pretty remote as well, so there's not much luxury in waiting to see if our stock drops that much.

The result is that time value is greatest for the strike price that is equal to the current market price, and then time value trails off more or less symmetrically in both directions, as seen in Figure 1.7. In practice, the curve of time value will not be strictly symmetrical as hedging activity changes its shape. We'll discuss this phenomenon more fully in Chapter 6.

FIGURE 1.7 How Time Value Changes by Strike Price

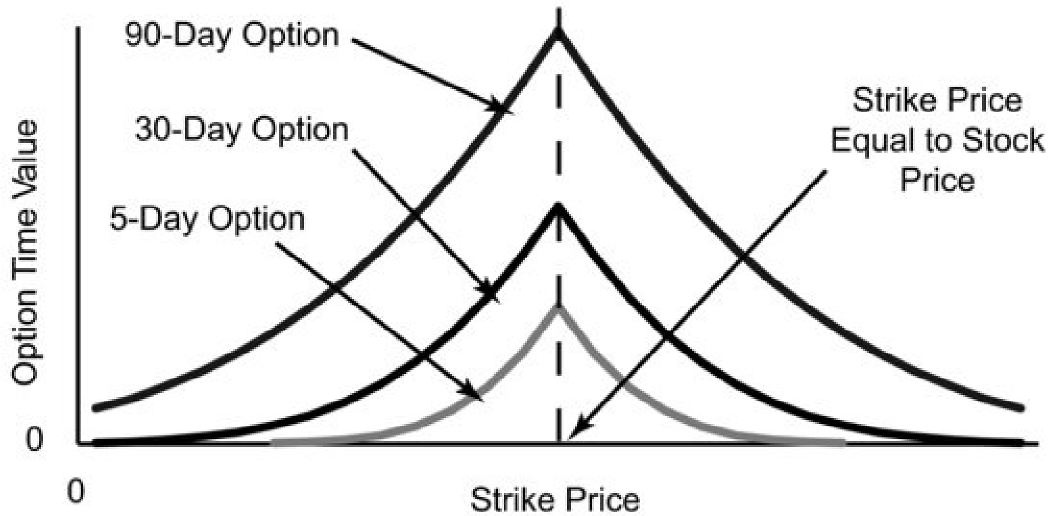


The height of the peak, the time value for the option with a strike price equal to the price of the underlying asset, will move up and down depending on how much the market demands for those options, but this general shape will hold for all options.

Now we know how time value changes with strike price. How does time value change with expiration date? Having more time, more luxury of being able to wait and to get more information—even if it's just the information telling us what the stock price is at the end of the month—is obviously more valuable than having less time, but the value of this time isn't always equal. If you have to make a decision in the next five minutes then the value of an extra day might be very high. On the other hand, if you have to make a decision in the next 10 years, then there's probably not much value to an extra day.

Figure 1.8 shows how time value changes by time to expiration. For each expiration date, the general shape we saw in Figure 1.7 applies; time value is greatest for the at-the-money option. However, now the curves have different shapes. The shorter-dated curve is more bowed because one extra day is pretty valuable if you only have five to go—but only if the strike price of our option is close enough to the stock price, that is, if it's close enough to at-the-money. If our stock is at $100 and our 100 strike price call option only has 5 days to expiration then each day is pretty valuable. But if our stock is at $100, then an additional day for the 50 strike price put option isn't worth very much with only five days to expiration.

FIGURE 1.8 How Time Value Changes by Expiration



Those 5-day options are moving rapidly to match their inherent value (which may be zero) as time value erodes away. The longer-dated option line is less bowed. An extra day isn't worth as much if you have 90 days left anyway, but there's still some value in seeing if our stock currently at $100 might fall to $50 sometime in the next 90 days.

Observant readers will notice that the 30-day option isn't 6 times more expensive than the 5-day option, that the 90-day option isn't 3 times more expensive than the 30-day option, and that the 90-day option isn't 18 times more expensive than the 5-day option. We'll discuss this phenomenon in Chapter 7 when we discuss time decay.

DOING THE SAME FOR PUTS

Too often books on options focus on calls because they're considered easier to understand, but this is intellectually lazy and a disservice to readers as well, because the result is that new traders focus on calls to the exclusion of puts.

Don't fall into this trap of ignoring puts because you think they're backward. Many phenomena that we'll discuss manifest themselves most acutely in put options. *Skew,* which we'll discuss in Chapter 6, is a perfect example of an option phenomenon that is most obvious in put options and that is incredibly powerful.

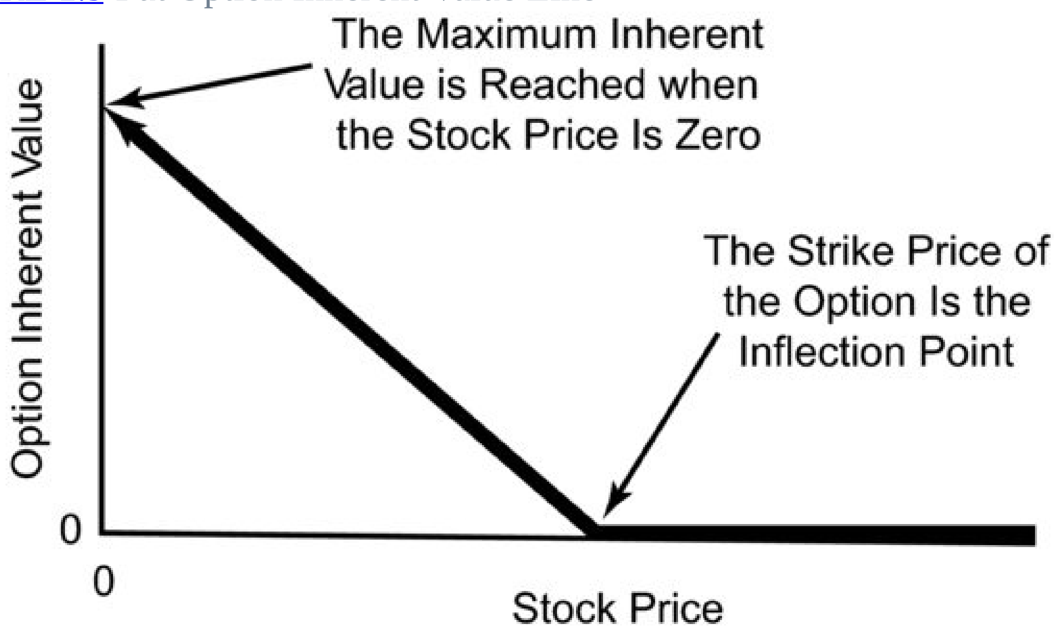
To make sure we don't fall into this trap, let's look at the same hypothetical stock but look at its put options this time in order to learn a little more about inherent value and time value and about the symmetry of call and put options. The hypothetical option is a put option this time, but it still has a strike price of $100.

As we see from Table 1.2, the inherent value for a put option is zero unless the stock price is below the strike price. Once that happens the inherent value becomes linear until the stock price falls to zero, at which point the inherent value has reached its maximum value, as we see in Figure 1.9. This makes sense because the price of the underlying stock can't fall below zero, as we also see in Figure 1.9.

Table 1.2 Put Option Price Components

Stock Price	100 Put Option Price	100 Put Option Inherent Value	100 Put Option Time Value
25	75.00	75.00	0.00
50	50.50	50.00	0.50
75	26.00	25.00	1.00
100	10.00	0.00	10.00
125	1.00	0.00	1.00
150	0.50	0.00	0.50
175	0.00	0.00	0.00

FIGURE 1.9 Put Option Inherent Value Line



The same relationships hold for the puts and the calls, and the time value for the 75 calls ($1.00) equals the time value for the same strike puts (the 75 strike put's time value is $1.00). The time value for the 150 puts ($0.50) equals the time value for the call with the same strike (150 strike call option time value is

$0.50). This symmetry between puts and calls with the same strike and same expiration date will always hold for American-style options. If you think you've found a situation where it doesn't hold, then the effect of dividends or the cost of money, or both, is at work.

MONEYNESS

Earlier we discussed the 90 call when the underlying stock was at $100. We also discussed 75 calls and 125 puts with the theoretical stock price at $100. All of these options would have inherent value. As such, option traders will say they are *in-the-money*. This simply means they have inherent value.

We also mentioned the 100 call with stock at $100. Option traders refer to this option as *at-the-money* because the strike price is equal to the price of the underlying.

If an option is not in-the-money or at-the-money, it is *out-of-the-money*. If a call's strike price, the price at which the call owner can purchase the underlying asset, is above the current price of the underlying asset, the call option is said to be out-of-the-money. Likewise, if a put's strike price, the price at which the put owner can sell the underlying asset, is below the current price of the underlying asset, the put option is said to be out-of-the-money. At-the-money and out-of-the-money options have no inherent value. All of their value is derived from time, from the luxury of being able to wait.

The strike price doesn't have to be precisely equal to the price of the underlying for an option to be at-the-money, close is usually good enough. Since it's rare for an underlying price to be precisely equal to a strike price, most professionals consider the out-of-the-money call option with the lowest strike price to be the at-the-money call option. They likewise consider the out-of-the-money put option with the highest strike price to be the at-the-money put option.

This relationship between underlying price and strike price is called *moneyness*. Figure 1.10 describes moneyness for all call and put options.

FIGURE 1.10 Moneyness

The Relationship of the Strike Price to the Underlying Asset

	Call Options	Put Options
In-the-Money Option	The strike price is below the price of the underlying	The strike price is above the price of the underlying
At-the-Money Option	The strike price is equal to (or very nearly so) the price of the underlying	The strike price is equal to (or very nearly so) the price of the underlying
Out-of-the-Money Option	The strike price is above the price of the underlying	The strike price is below the price of the underlying

TAKEAWAYS

- An option can be fully described with just four details:
  1. the underlying asset (or security)
  2. the type (is it a put or a call)
  3. the expiration date
  4. the strike price.
- Most individual equity and exchange traded fund (ETF) options are American-style, meaning they can be exercised at any time. Some index options are European-style, meaning they can only be exercised on the last trading day. Assuming an option is one or the other and being wrong about it isn't usually a tragedy unless the options are deep in-the-money. If you're not sure, ask.
- Time value is what an option is all about. It's the price an option buyer pays for being able to make a better informed decision later.
- Time value changes. It declines as expiration approaches, but the decline isn't linear; smart option traders will use this to their advantage.
- Moneyness describes the relationship between the strike price of the option and the market price of the underlying stock. If the strike price of a put option is above the market price of the underlying, the put option is said to be in-the-money. If the strike price of a call option is below the market price of the underlying the call option is in-the-money.

CHAPTER 2

Direction, Magnitude, and Time

Many of the option strategies that we'll discuss expect the underlying to move in a particular direction and actually need that move to occur in order to be profitable. From that point of view option traders might be no different than stock traders. Buyers of a stock expect the stock to move higher, in fact they require the stock to move higher if they're going to make a profit (ignoring dividends). If the stock moves higher from their purchase price, then they've got a profit even if the profit is unrealized (meaning they haven't sold their stock yet to lock in or "realize" that profit). Likewise, if traders sell a stock short, then they expect the stock to move lower and need it to do so if they're going to make a profit.

For example, if XYZ is at $50 and we think it's going to rally, we might buy 100 shares of the stock. If we buy the stock and XYZ moves to $60 we've made a $10 profit. It's not quite that straightforward for traders using options. If we think XYZ is going to rally, we might buy a 60 call. Like stock traders, we need XYZ to appreciate in order to make money. If XYZ falls, then the stock traders will have lost money. For option traders, if XYZ falls and our option expires worthless, then we've lost money—we'll have lost the amount we paid for our call option.

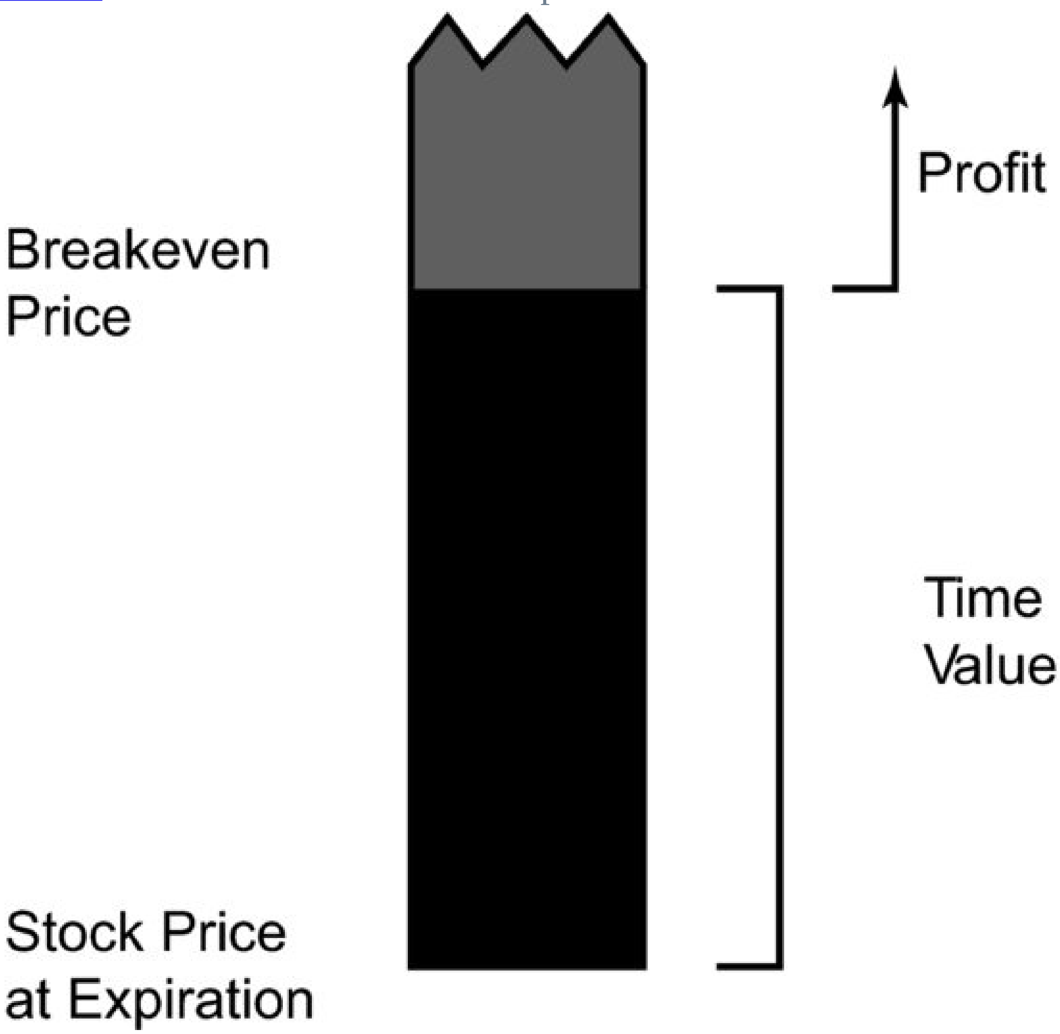
What if the price of XYZ doesn't change? This is where the outcomes diverge for stock traders and option traders. Stock traders experience no loss, other than an opportunity cost, if the price of XYZ doesn't change (we might say the price of XYZ has moved sideways) while call option buyers do experience a loss if the price of XYZ doesn't change. As time passes the value of the call option bought will erode to zero; call buyers will have lost the amount they paid for their call option. In this case call option buyers have one way to make money (the price of XYZ increases) and two ways to lose money (XYZ falls or doesn't change). Stock traders have one way to make money (the price of XYZ increases), one way to lose money (the price of XYZ decreases), and one way to break even (the price of XYZ doesn't change). Call option buyers need to really be right, more right than stock traders, in order to make money.

For stock traders who thought XYZ might head higher, the choice was binary.

They could buy XYZ stock or not.

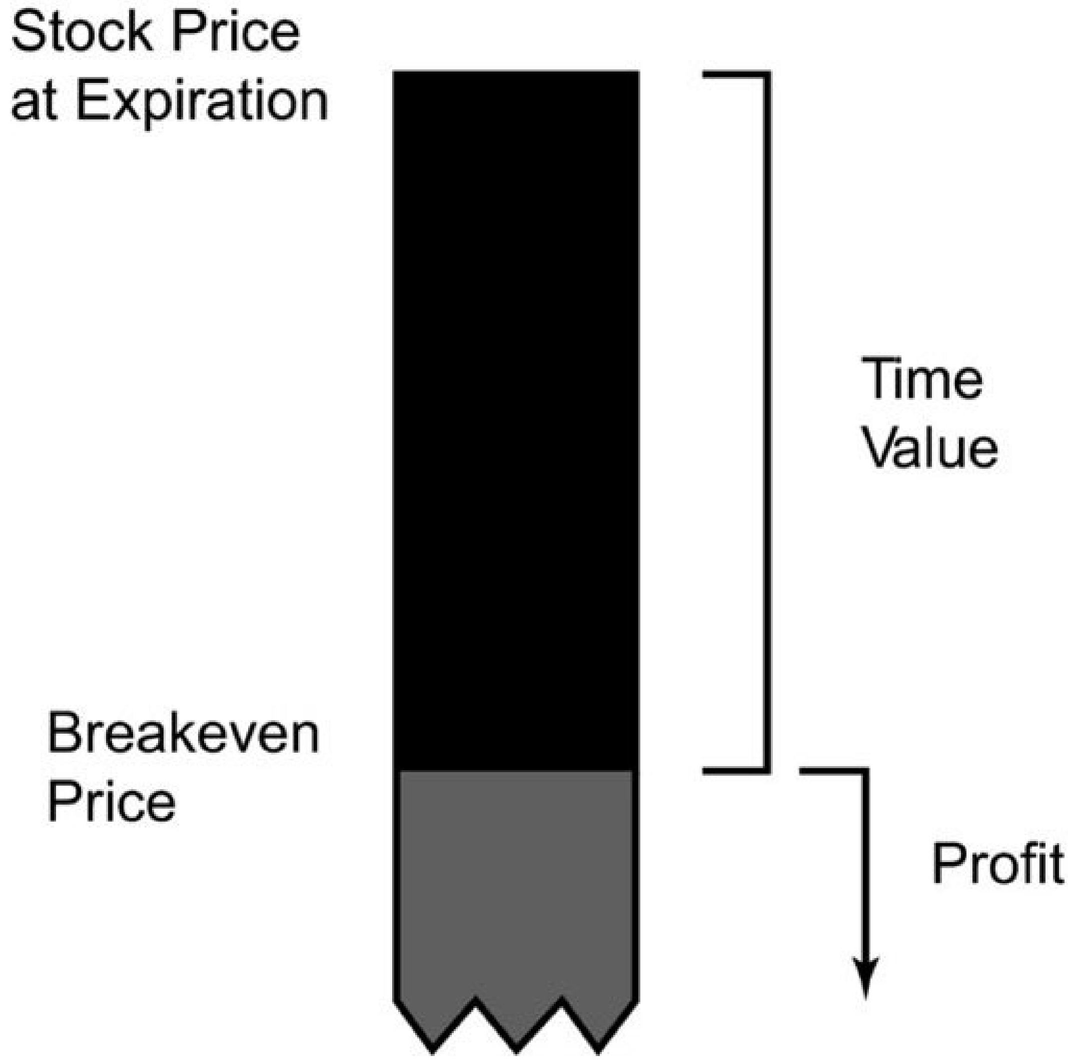
For call option buyers the choice isn't simply whether to buy a call option or not. If we want to buy a call option, then which strike price do we buy? The call option trader might buy the 50 strike call option. But what if that option costs $10? In the case of buying a call option, we need the price of the underlying to appreciate to a point that is over the strike price by the amount of premium paid in order to get to the breakeven point. We need the price of the underlying to appreciate above that breakeven level in order to make any profit. In the case of buying the 50 strike call option for $10 and having XYZ rally to $60, the stock rallied but it didn't rally enough for us to make a profit. The magnitude of the move wasn't great enough, as Figure 2.1 shows.

FIGURE 2.1 Breakeven Level for Call Options



In the case of buying a put option we need the price of the underlying to fall to a point that is below the strike price by the amount of premium paid in order to reach the breakeven point, as Figure 2.2 shows.

FIGURE 2.2 Breakeven Level for Put Options



The final consideration that doesn't concern stock traders but that is vital to option traders is time. If stock traders believe that XYZ is going to appreciate to $60 sometime, then they can buy XYZ and wait for the price to increase. Call option buyers on the other hand have to worry about when the move occurs. What happens to call option buyers if they're able to buy the 50 call for $5 but XYZ doesn't move to $60 until after the option has expired? They've lost money.

Obviously from our hypothetical examples, option traders have at least three factors to consider. The first is direction. If option buyers are wrong in their estimation of the direction in which the underlying stock will move, then our simple option trade example is going to lose money.

The second consideration is magnitude. It's entirely possible for call option buyers to be correct as to direction—they see the stock price move higher—but they can still lose money if the price doesn't move enough. The stock has to move above the strike price by enough to pay for the time value of the option. In this example the worst has happened. Our call buyer has been right as to direction and still lost money.

Another consideration that stock traders don't have to consider is time. It's entirely possible for call buyers to be correct as to direction and to even be correct as to the size of the move, but to lose money because the stock didn't move by the time their option expired.

MAGNITUDE AND TIME ARE RELATED

Magnitude and time are related. Think about it this way. If we'd bought that 50 call for $10 and the very next day the stock rallied from $50 to $60, then we would have a profit. The call option would inherently be worth $10 and it would have some time value as well—we'd have an unrealized profit because our option would be worth more than the $10 we paid. The excess is the time value others are willing to pay in order to have the luxury of waiting. We might never realize our profit because that would require selling our call option.

If XYZ didn't budge from $60 for the further life of our option then the time value would erode away, but immediately after the underlying rallied our call option would be worth more than we'd paid. We'd have a potential profit because of the speed with which XYZ moved even though it moved by the same magnitude (from $50 to $60) as our earlier example.

A stock trader cares about direction; an option trader, at least as we're going to discuss options here, cares about direction, magnitude, and the speed with which the stock moves. As we've seen, we can have the direction right but the magnitude and/or speed wrong, and if the speed or magnitude we assume is so wrong that it overwhelms the direction, we're still going to lose money. It's also possible to have speed right but direction wrong and lose money.

UP AND DOWN AREN'T THE ONLY POSSIBILITIES

Many of the options strategies we'll discuss expect the underlying stock to *not* move in a particular direction and would lose money if it did move in that particular direction. It's important to note that thinking ABC *isn't* going to move lower isn't the same as thinking it *is* going to head higher.

For example, if ABC is at $25 and our stock traders think it's not going to move lower, that is, they think it's either going to move sideways or head higher, then they only have two alternatives. They can buy the stock, wherein they need it to go higher in order to make money, or they can do nothing, wherein it's impossible for them to make money. If ABC rallies to $30 then our stock traders may or may not have made any money depending entirely on whether they chose to initiate their trades. Alternatively, our stock traders might have bought ABC stock only to see it move sideways. In this situation our stock traders haven't lost any money, but they've experienced an opportunity cost by not putting their money into something that did go up.

Option traders have more tools available. Our option traders might want to buy a call option, but then the same problems we discussed previously present themselves. Which strike price do we buy? Which expiration do we buy? What happens if ABC moves sideways? We might buy the 30 call but then we again need ABC to rally quickly, before our call option can lose too much time value. We might buy the 25 call, but ABC might never get high enough to pay for the call option and generate a profit. We're still at the mercy of time, magnitude, and direction.

Since thinking a stock isn't going to fall isn't the same as thinking it's going to rise, we have another alternative. We could sell a put option. We still have to consider strike price and expiration date, but now we have two directions that should be profitable, up and sideways. If we think that ABC isn't going to fall below $25, we could sell the 25 put option and the option buyer pays us the premium for selling the option. Let's say we receive $2 for selling this put. Now what happens if ABC indeed doesn't move for the life of our option? The option we sold expires worthless, our potential obligation to buy the stock at $25 expires as well, and we have $2 we didn't have before. Time was the factor and we've come out ahead. But speed was also a factor. The speed of ABC movement was zero. Magnitude of the move was zero as well.

This leads to a question: If options are so much about speed, then how do we measure speed? Fast and slow isn't going to do it because those are tough to quantify, and fast for one stock might be slow for another. And speed over what time frame? A day? A month? The life of our option? The time frame is an important question because nothing moves in a straight line, either up, down, or sideways over any of those time periods. Even if a stock has a huge move higher over one month, it won't have been higher with every trade that occurred. It will whipsaw a little. How does this whipsawing, this zigzag movement, factor into our measure of speed?

Another question: How do we measure the magnitude of any price changes? Big and small aren't very descriptive, and both terms lead to the question of timeframe. A move that's huge in the context of one day isn't going to mean much in the course of a year.

It is safe to say that not only are we worried about where the stock is going, how quickly it gets there, and the magnitude of the move, but also about how bumpy the path is. You say you're not worried about how bumpy the path to the final price is? Well you may not be but the market is, and the market is going to discount the price of a stock that has a particularly bumpy path.

THE PATH MATTERS

Assume you're thinking about investing in two companies for a period of 10 years. Both companies are in the same industry, make similar products, and share similar growth prospects. Company A shows earnings, meaning net profit, of $1 million each and every year for the last 10 years. Company B shows earnings that are a little bumpier. Company B's earnings over the last 10 years are:

Year 1	$2 million profit
Year 2	$3 million loss
Year 3	$3 million profit
Year 4	$5 million profit
Year 5	$4 million loss
Year 6	$1 million profit
Year 7	$3 million profit
Year 8	$2 million loss
Year 9	$4 million profit
Year 10	$1 million profit

Both companies show total profit of $10 million over the last ten years. They both made the same amount of money, $1 million, last year. Which company would you prefer to invest in if the terms of the investment were the same for each company? Most investors would rather invest in Company A because the bumpiness of the earnings path matters. Disagree? Then look at it this way. Which company would you rather loan money to if you weren't due to be paid back for ten years?

Let's look at Company A and Company B again in the context of volatility of earnings. If you could invest in either company at identical terms, you'd probably choose to invest in Company A. But what if buying a call option instead of stock was an alternative? If that were the case, then you might very well choose to buy a call option on Company B rather than buying stock in Company B. Why? If you buy a call option you have the luxury of time and of being able to wait to make a decision as to whether or not to invest. This volatility of earnings means that it's possible for Company B to string some great years together and end up with a stock price substantially higher than Company A. It's also possible that Company B could string some horrible years together and go bankrupt.

In either case, a great string of hugely profitable years or a terrible string of giant losses ending in bankruptcy, the value of waiting to make a decision would be extremely high. For this reason, if Companies A and B were the only companies in our universe then many potential investors in Company B might choose to buy a call option instead of stock. They would be happy to pay for the luxury of waiting to see how Company B performs rather than risking much more money by buying the stock. Ultimately this buying interest for call options, this demand, would cause the price of those Company B call options to rise. Company B call options are now more expensive than Company A call options, and the only difference between the two companies is the volatility of their earnings.

This leads to yet another question: If options are so much about volatility, then how do we determine what an option is worth? It can't merely, as some would say, be the amount by which the option is in-the-money at expiration. That doesn't account for speed, magnitude, or bumpiness at all.

The combination of direction, speed, magnitude, and bumpiness that we've been discussing can be distilled into a single measure. That measure is volatility.

VOLATILITY COMBINES THESE ISSUES

Volatility is the one concept that combines speed, magnitude, bumpiness, and direction. It's also the true measure of the value of an option. If we think that a stock is going to be very volatile during the life of our option then that option has real value to us; even though when we buy the option we don't know if it will have any inherent value at expiration. Thus, just the belief that a stock price will be volatile means it has some value to us. But what should that value be?

How does the volatility of the underlying asset provide value to the option owner? Suppose DEF Corporation is trading at $100 and we think that DEF will move around some but that it will be back at $100 when the 100 strike call options expire. Since we think our call option is not going to be in-the-money at expiration, we think it's going to be worthless at expiration. But is it worthless now? Would we ever be willing to pay $10 for such an option even though at expiration it would probably be worthless? Let's see.

We think that DEF is going to move around some (almost all stocks move around a little) but will be close to $100 at expiration. What are the speed and magnitude of the moves and the bumpiness of the path going to look like? If we bought that call option for $10 and the next day we saw DEF rally to $150, then the speed and magnitude of the move have been huge. How do we take advantage of this? We could sell 100 shares of DEF short for $150 each. We're long the call and short 100 shares of DEF. The two positions offset each other. What if the following day DEF plummets to $50 per share? Wow, the speed and magnitude of the moves are really impressive and the path is pretty bumpy. How do we take advantage of it? We can buy back the DEF shares we sold short at $150, but now we're paying $50 for them. We've pocketed $100 (shorted at $150, bought back at $50) and now we can sit back and watch DEF do whatever it will, including potentially rallying back to $100, where it sits while our call option expires worthless.

Our net profit is $90 (the $100 we make scalping DEF stock minus the $10 we paid for the call option). We were right. DEF was back at $100 when our option expired and our option expired worthless, but owning it wasn't worthless to us. The value of our option at expiration had nothing to do with the ultimate value of the option to us. It was only because we owned that option that we were able to sell DEF shares at $150; if we hadn't owned the call option we would probably have been too scared to short DEF there. Without being short DEF at $150, we might not have been willing to buy it at $50.

The value of the option was the ability to take advantage of speed, magnitude, and bumpiness in a way we might not have been able to if not for our option. We might not have been willing to face a huge (actually unlimited) potential loss by shorting DEF stock at $150. With DEF at $50, we might not have had the courage, or the cash, to buy it unless we'd already been short.

Our option expired worthless but we were happy to pay $10 for it.

TAKEAWAYS

- Stock trading is more or less about direction. Option trading is about direction, magnitude, and time.
- Magnitude of the move and time are related. For the option trader it’s possible to get the direction and magnitude right but be wrong on the timing and lose money as a result. Getting any of the three wrong can result in a loss, which is why getting the option math working in your favor is important. It can mitigate the risk in some of these issues.
- Up and down aren’t the only possible outcomes, and options are the vehicle that allow a trader to take advantage of the third possibility, sideways.
- For option traders it’s not just the price of the underlying at expiration; the path to that price matters as well. The bumpier the path, the riskier the asset. The riskier the asset the more valuable and expensive options are going to be.
- Volatility is the concept that combines direction, magnitude, time, and the price path. Volatility is everything to an option trader. It’s no accident that many professional option traders actually consider themselves volatility traders.

CHAPTER 3

Volatility

As we've seen, the volatility of earnings for a company impacts the value of that company. Everything else being the same, the greater the volatility of earnings, the less valuable the company is. We've also seen that the volatility of a company affects the value of options. Everything else being the same, the greater the volatility of stock price, the more valuable the options on that company. Why? Because volatility equals risk.

Some will say that it's bunk to equate volatility and risk. They'll say that their risk is equal to their maximum potential loss; if they have invested $1,000 then their risk is $1,000. That may very well be true if they put the $1,000 into an Internet startup long before its initial public offering (pre-IPO). The potential for losing all of the $1,000 is very high. But what if they'd put the $1,000 into U.S. government bonds? The likelihood of losing $1,000 if it's invested in U.S. government bonds is exceedingly small. It's almost infinitesimal, but it's not zero. The maximum potential loss is still $1,000. If we gauge risk by maximum potential loss, then we'd say U.S. government bonds are just as risky as a pre-IPO Internet startup. That doesn't make much sense. We can do better.

RISK IS VOLATILITY

The concept of risk also has to factor in direction, time, magnitude, and speed. Even if we removed the potential of a U.S. government default from the example above—that is, if we were absolutely, metaphysically guaranteed that we'd receive the face value of that U.S. Treasury bond at maturity—then we still have some directional risk. The value of that bond will change with variations in interest rates and if the market price of our bond fell below face value (very likely if market interest rates rise above the interest rate the bond's coupon pays), then the only way to get face value is to hold the bond to maturity. What if it was a 30-year bond and we needed to sell it to raise cash with 29 years left? We'd be at the mercy of the market for that bond meaning we'd have directional risk. The bond could be worth more than we paid for it or it could be worth less than we paid for it. We'd also be at risk with 28 years left. What about with 10 years left? We might indeed experience a loss. We're concerned with the directional risk at many points in time, actually at every point in time, over the entire life of the bond, not just the risk 29 or 30 years from now.

Our measure of risk also has to take magnitude into account. If we have to sell our T-bond before maturity, then we're not just worried about whether the market value is above or below the face value; we also have to be concerned with how much it's above or below face value. This is the magnitude of our potential gain or loss. Is the magnitude of the potential deviation very large, so large that the loss would bankrupt us, or small—in which case it might be effectively meaningless?

Finally, our measure of risk also has to take speed into account. If the market price of our bond moves very quickly, then we might not be able to realize what we expect to realize or hope to realize if we have to sell before maturity.

The volatility of an asset is essentially a measure of the speed and magnitude with which it will bounce around before maturity, so it's a measure of the likelihood that the price will be below our purchase price at any given point in time. It's also a measure of how quickly it might move to below our purchase price. It's also a measure of how much it might be below our purchase price at any given point in time.

This obviously doesn't mean that volatility is the only measure of risk we should consider. For one thing, as we'll discuss, volatility can change over time meaning that risk has changed. Looking back at Company B, if they made a management change by firing their CEO, Swing-for-the-Fences Freddy, and replaced him with Steady Eddie, the CEO of Company A, then we'd expect the volatility of both companies' earnings to change. Also, over a specific period we can probably find data that gives nonsensical results. There will probably be periods where assets that we understand to be very risky saw stable prices for some short period while assets that we understand to be very stable saw big price swings. If we pick too short a time period for the price data we're looking at, then the data will fool us.

For example, if it's Year 7 and we only look back to Year 6 to determine how risky our hypothetical companies are, then we'd see they both made $1 million in the previous 12 months, and we'd think the volatility of their earnings was identical.

INVESTORS DEMAND A RISK

PREMIUM, REDUCING THE PRICE OF RISKY ASSETS

The result of this volatility, this risk, on the price of an asset is that investors require a lower stock price to generate potentially greater returns for a riskier asset versus a less risky asset, everything else being equal. This makes sense. Assume that you got hired by a circus. You could get paid minimum wage to sweep up after the show or you could choose to fill in for the lion tamer. Would you take that lion tamer job for minimum wage? No, you'd demand a premium to compensate for the extra risk.

But if a stock is riskier (i.e., has higher volatility), then wouldn't the ability to put off making a decision have greater value? Wouldn't the luxury of time, of being able to wait to make a decision, be more valuable for a stock that is very likely to drop or rally by 50 percent than for a stock that's unlikely to drop or rally by 50 percent? Yes it would be. This means the volatility of a stock is related to the value of options on that stock. The higher the volatility of the stock, the more valuable the option.

Volatility is risk, but it's also the opportunity for reward. Let's look back at Company A and Company B again. What would you expect the stock charts of these two companies to look like? We've already said that the price of Company B stock should be lower than the price of Company A stock in order to compensate holders of Company B for the additional risk, but how should the stock prices look over time? The price of Company A stock would likely be very stable since Company A's earnings are very stable. Company A stock is really more like a bond or an annuity. It makes $1 million year in and year out. You'd expect very little volatility in the price of Company A stock.

What about Company B? You'd expect the stock price of Company B to be all over the road since Company B earnings, as indicated in Chapter 2, are all over the road. At the end of Year 1 investors are likely to be impressed with Company B's earnings of $2 million so they'd bid up the stock. The same is likely to be the case at the end of Year 4 after the $5 million profit and at the end of Year 9 with a $4 million profit. On the other hand, at the end of Year 2, investors are likely to be intensely worried by the $3 million loss and are likely to be selling their stock. In fact, some speculators might be selling Company B stock short. The same would probably happen at the end of Year 5 with the $4 million loss and at the end of Year 8 with a $2 million loss.

By looking at the DEF Corporation, also discussed in Chapter 2, you've probably figured out how the volatility in Company B's earnings can offer a similar opportunity. How would traders have done if they'd bought Company B stock at the start of Year 1, sold at the start of Year 2, bought at the start of Year 3, sold at the start of Year 5, and so on, buying at the start of a good year and selling at the start of a bad year? Figure 3.1 shows they would have likely done pretty well.

FIGURE 3.1 Company B Stock Price

This volatility in the stock price of Company B is an opportunity to buy low and sell high. That being the case, the options would be more valuable than the options on Company A. The luxury of time, of waiting to make a decision whether to buy or sell company B stock, could be very valuable. It's going to be much more valuable for Company B than for Company A.

We know from Chapter 2 that volatility is a combination of direction, speed, time, and magnitude. In looking at Company B we might describe it as "choppiness." From the discussion in Chapter 2, this discussion of Company B, and your own experience you probably know volatility when you see it, but can we describe volatility in a way that allows us to objectively compare it across time or from one instrument to another?

VOLATILITY IS THE STANDARD DEVIATION OF RETURNS

Option traders define *volatility* as standard deviation of returns. Standard deviation is the variation that we'd expect from a central value, usually the average of all observations.

Standard deviation is a statistical measure that describes how diverse outcomes are. If outcomes are not diverse then the standard deviation of those outcomes is very small. For Company A the outcomes were not diverse at all, they were all precisely equal. Thus, the standard deviation of earnings for Company A for the years we looked at would be zero. We wouldn't expect the earnings for a random year in the sample to deviate from $1 million at all, and none do.

Company B on the other hand saw its earnings deviate tremendously. While the average of earnings was $1 million, the same as the average for Company A, the deviation from that average was as much as $5 million in Year 5 when there was a $4 million loss. The standard deviation of earnings for Company B is $3.055 million. The formula for calculating standard deviation for any set of numbers can be found in the Appendix and any computerized spreadsheet can perform the calculation.

Standard deviation doesn't describe the absolute range from top to bottom, from the highest result to the lowest result. If that were the case then the number we got wouldn't deliver much information, because an extreme result would have much more influence on our thinking about the variability of a sample than it should. That would be a little like saying the risk in buying that U.S. government bond and the risk of investing in an Internet startup are equal, despite the fact that actually losing that $1,000 by investing in a U.S. government bond is stupefyingly remote.

We'd expect most observations in a population to fall inside the range defined by the standard deviation, but we wouldn't expect every instance or observation to fall inside the range of standard deviation. That's why it's the standard deviation, not the absolute deviation.

For Company B there are 3 years of the 10 when earnings fell outside that range of plus or minus a standard deviation. They were Year 4 with a $5 million profit, Year 5 with a $4 million loss and Year 9 with a $4 million profit. So when we say that we'd expect most of the results to fall inside that range of plus or minus a standard deviation, what do we mean by *most*?

STANDARD DEVIATION TELLS US WHAT RANGE OF OUTCOMES TO

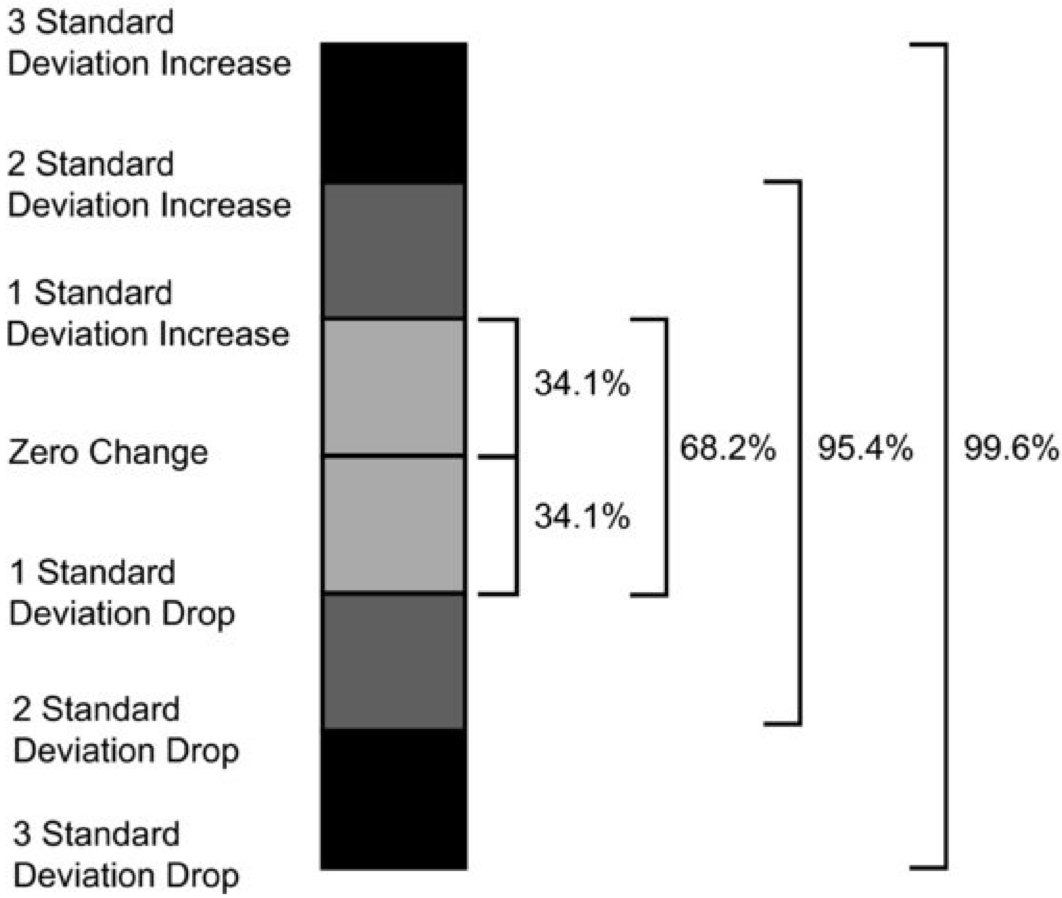
EXPECT

The math can be pretty daunting and it's not important to our use of options, but we'd expect 68 percent of observations to fall inside this range. We'd always expect 68 percent of observations to fall inside the range of plus or minus one standard deviation. That 68 percent is purely a function of the standard deviation calculation. It holds for every population and every standard deviation of a population.

How does this expectation that 68 percent of observations will fall inside that range of positive $3.055 million to negative $3.055 million compare to the actual results for Company B? Sure enough, 70 percent of the annual results fall inside that range of plus or minus one standard deviation of $3.055 million. Given that our sample size was only 10, 70 percent is as close as we can get to 68 percent.

What if we wanted a little more confidence as to potential outcomes? What if we wanted more than 68 percent confidence? What is the likelihood that an observation would fall within a range of plus or minus two times the standard deviation (within two standard deviations)? In the case of Company B, that would mean within a range of a $6.11 million profit and a $6.11 million loss. The likelihood of seeing an outcome fall inside of that range would be 95 percent. Again, the precise derivation of these percentages is a function of standard deviation and isn't vital to our using them to understand standard deviation and volatility. Given that 95-percent likelihood, it's not surprising that Company B didn't have any years outside that range. And if we wanted even more assurance? The likelihood of any observation falling inside of three standard deviations is over 99 percent. Figure 3.2 shows the probability of any outcome falling within these standard deviation ranges.

FIGURE 3.2 Expected Outcome Ranges for Standard Deviation



It's important to note that these likelihoods, 68 percent, 95 percent, and 99 percent, are valid for any standard deviation but that the standard deviation might change over time, meaning that the range we'd expect 68 percent of all outcomes to fall into would also change. If Company B fired Swing-for-the-Fences Freddy as CEO and replaced him with Steady Eddie, formerly the CEO of Company A, then we would expect the future outcomes for Company B to change. A company's fortunes rarely change that drastically, however, so it's generally fair analysis to expect the past to repeat itself to a certain degree.

STANDARD DEVIATION OF RETURNS IS VOLATILITY

In the context of options and their underlying assets, volatility is simply the annualized standard deviation of daily percentage changes in the price of the underlying. Just as with the earnings for Companies A and B, if the price of a stock changes very little over time, then that stock price displays a low standard deviation of percentage daily changes and low volatility. If the price of a stock changes a great deal from day to day, then that stock price displays a high standard deviation of daily price changes and a high volatility.

Since volatility in finance is in annualized terms, the volatility of any stock or underlying is the range of annual price changes we'd expect to see 68 percent of the time. If a stock had a volatility of 20 percent then in about two of every three years (actually 68 percent of all years) we'd expect the stock to have risen less than 20 percent or to have fallen by less than 20 percent. It doesn't mean it couldn't move more than 20 percent, it just means that we'd expect that sort of outsized movement only 32 percent of the time.

It's important to remember that the standard deviation that we use as volatility in option trading is the annualized standard deviation of the daily percentage price changes of the underlying and not the standard deviation of the absolute price or the absolute price change. This is an important difference. Let's look at two new companies, Company C and Company D, selling at the prices shown in Table 3.1.

Table 3.1 Daily Stock Prices for Company C and Company D

Day	Company C	Company D
IPO Price	100.00	25.00
1	101.00	25.25
2	100.50	25.50
3	99.75	24.75
4	100.25	25.25
5	100.00	25.00

Both of the companies saw their stock prices end up just where they started. But how volatile were the prices? The stock price of Company C changed by as much as $1.00 while the price of Company D changed by a maximum of only $0.75, but this isn't the best measure of volatility.

The standard deviation of the change in price of Company C stock after the IPO is $0.73. We'd expect that 68 percent of observations of the daily net change would fall inside a range of a $0.73 gain and a $0.73 loss.

The standard deviation of the change in price of Company D stock after the IPO is $0.50. We'd expect that 68 percent of observations of the daily net change would fall inside a range of a $0.50 gain and a $0.50 loss.

Does this mean that Company D is less volatile (i.e., less risky) than Company C? No. In this case the net change isn't the right measure. Take this to its logical extreme. What if Company C saw the same percentage changes but the stock had issued at $10,000 per share solely because Company C had executed a 1 for 100 stock split prior to the IPO? Nothing has changed except the number of shares outstanding and subsequently the price per share. The company, the prospects, and the employees are all unchanged with an IPO price of $10,000 per share. The daily net change in dollar terms would be huge; if we did that calculation the standard deviation of the daily net change in stock price would be $72.89. Would we really say that Company C became 100 times more risky just because of a stock split? Certainly not, because in this situation real risk isn't equal to the maximum potential loss any more than it is for our U.S. government bond. The better measure is the standard deviation of percentage changes for each day.

Given the difference in absolute stock prices, the percentage of the price change is obviously more informative; a $1.00 change in a $100 stock is small compared to a $0.75 change in a $25 stock. The volatility that we'll discuss is the standard deviation of the daily *percentage* price changes.

The standard deviation of the percentage daily change, then, is the best measure of volatility and risk. For Company C it's 0.727 percent. For Company D it's 1.981 percent. That makes more sense; Company D is certainly more volatile and riskier than Company C from a subjective point of view. On any given day the distance in percentage terms that Company D is from its IPO price is likely to be greater than for Company C.

A final note about the standard deviations of companies C and D: They don't define the volatility of the stocks (as we'll discuss them in the context of options) only because the volatility in the context of options is the annual volatility. We can calculate an annual volatility from these daily numbers, and the formula for that is in the Appendix. If we did that option math we'd find that the annualized volatility of Company C is 11.74 percent. The annualized volatility of Company D is 31.99 percent.

TYPES OF VOLATILITY

We've been using the volatility of historical prices for our hypothetical companies. Thus, we've been talking about the historical volatility or the volatility realized by these stock prices during these hypothetical historical periods. We can only determine this historical or realized volatility in hindsight. Only by looking at the actual results and then doing the calculation can we find what the volatility actually was.

The fact that the annualized volatility of Company D over those few days was 31.99 percent doesn't mean that it will be 31.99 percent for the entire year or even that it will stay at 31.99 percent for the rest of the month. The fact that a company's volatility was 20 percent last year doesn't mean that we know what it will be for the coming year any more than a stock being up 10 percent last year tells us anything about what it's going to do next year. In order to know the actual volatility that's realized during the coming year we'd have to know what the underlying prices were going to be for that year. That's obviously not possible. This sort of historical volatility is only knowable in hindsight.

We've seen that the real value of an option is driven by the volatility of the stock price. This means that if we use the historical volatility of the stock we would know what an option with a term covering that same time period should have been worth. That doesn't help us today if we're trying to figure out what an option will be worth in the future. In order to know what that option will be worth, we have to know what the volatility of the underlying stock will be over that term. We need to forecast what the volatility will be.

Forecast Volatility

It makes sense to look at the past to help us figure out the future. A good place to start might be to look at the historical volatility of the stock or underlying asset and then make some adjustments based on events that have already occurred or that will occur. We might think that a stock will be more volatile than the long-run average because of an upcoming earnings announcement. Maybe there's a new product launch that's expected. We might think a stock will be less volatile than the long-run average because it now has solid management after years of turmoil.

The forecast volatility that we seek is the volatility over the period from now, or from when we initiate our option position, until the expiration of that option.

Future Volatility

The future volatility is what the actual distribution of observed prices will be in the future. Just as the historical prices can be used to calculate the historical standard deviation of returns, if we knew future prices we could calculate what the actual future volatility of the underlying stock is. This is certainly impossible. But just as we can use historical volatility to find out precisely what an option would have been worth over that historical time frame, if we have the future volatility then we could precisely determine what an option would be worth over that future period.

In our previous example, we bought an option that we thought was going to expire worthless yet we managed to make it pay off. How does that work? The future volatility of that stock was tremendous. It rallied from $100 to $150 in one day and fell back to $50 the next. This future volatility meant that the call option we bought was worth significantly more than we paid for it. We would have been willing to pay up to $99 dollars for it since it allowed us to short DEF stock at $150 (we probably couldn’t have stomached shorting the stock without owning the call option and our broker probably wouldn’t have let us short it after that rally) and to subsequently buy it back at $50.

TAKEAWAYS

- Risk isn’t defined by the amount invested. If it were then $1,000 invested in a Treasury bill would be just as risky as $1,000 invested in the highest of high-flying venture capital investments.
- Risk is volatility and volatility is risk because volatility increases the likelihood of an investment being unprofitable at any particular point in time. This is because volatility takes direction, magnitude, and speed into account.
- Volatility will change over time, sometimes for reasons we expect and sometimes for reasons we don’t expect. As companies grow, die, expand, divest, fail, and merge the volatility of their results and stock prices will ebb and flow.
- Risky assets will be cheaper than nonrisky assets because investors demand extra return for taking additional risk. The extra return is generated from a discounted stock price. The risk also increases the value of options because it increases the value of being able to wait and make a better informed decision.
- Volatility is calculated as the standard deviation of price returns. It measures how diverse outcomes are. Wildly diverse outcomes show a high standard deviation of returns. Standard deviation tells us what range of outcomes to expect.
- Risk and volatility are not necessarily bad. They’re tools, and like any other tool they can help or hurt. The Colt .45 helped to tame the West; some settlers also managed to shoot themselves in the foot with it.

CHAPTER 4

Option Pricing Models and Implied Volatility

There are a nearly infinite number of variables we could analyze in trying to determine what an option is worth. We would look at the exercise price and whether it's a call or a put. We'd certainly consider the expiration date, but we could also examine the fundamentals of the underlying stock, including its competitive position in its industry. We could examine its balance sheet, including cash on hand and accounts receivable. We could look at the stock's chart over time to find important technical levels. We could look at the medical history of the CEO to try and divine if he's likely to drop dead of a heart attack soon. Even if we could figure the odds of such a heart attack, we'd then have to figure out whether such a change in leadership would be a good thing (Swing-for-the-Fences Freddy from Company B) or a bad thing (Steady Eddie from Company A). The result would be so much analysis that we'd experience paralysis.

Instead of looking at everything, we might look at fewer inputs, just enough inputs to help us make some decisions. And since all the fundamental, technical, and even medical information is supposed to help us understand and measure risk, we could use a single proxy for risk. As we discussed in the Chapter 3, that risk measure is volatility.

IT'S AN OPTION PRICING MODEL, NOT AN EQUATION FOR OPTION VALUES

What do we have when we reduce the size and scope of a problem so that solving it becomes manageable? We have a model. Models, whether mathematical ones to help us understand options or plastic ones created by an architect to help us visualize a new building, necessarily eliminate certain considerations in an effort to isolate and emphasize the most meaningful considerations. The result is that a model can help us make certain decisions but can't make those decisions for us.

The original option pricing model was created by Fischer Black and Myron Scholes and is still the best-known model today. The Black-Scholes model was so vital to the growth of listed option trading and so completely highlights the important inputs in option trading that it's the only equation we'll discuss outside of the Appendix.

The Black-Scholes price for a call option is:

$$Call\ Price = (S^{*}N\,(d1)) - (SK^{*}\,e^{(-rt)}\,{}^{*}N(d2))$$

Where:

$$d1 = \frac{\left(\ln\left(\frac{S}{SK}\right)\right) + \left(\left(r + \left(\frac{Vol^2}{2}\right)\right) {}^{*}\, t\right)}{Vol^{*}\sqrt{t}}$$

$$d2 = d1 - \left(Vol^{*}\sqrt{t}\right)$$

And where:

S is the price of the underlying stock

SK is the strike price of the call option

r is the annual risk-free interest rate

Vol is the volatility or the annualized standard deviation of underlying stock returns

t is the time to expiration (in annual terms such that 6 months is 0.5)

e is the base of the natural log and is equal to 2.7183

ln is the natural logarithm

N represents the cumulative standard normal distribution. This cumulative distribution describes the probability of a random variable falling within a certain interval. The cumulative distribution value for any number can be found in online tables or can be calculated using a spreadsheet.

The Black-Scholes equation for the price of a put option is similar but slightly different. That equation can be found in the Appendix.

A BLACK-SCHOLES EXAMPLE

Let's assume:

Stock price is $48.60

Strike price is 50

Risk-free interest rate is 1 percent

Volatility is 20 percent

Time to expiration is 60 days (or 0.1644 years)

How much would this call option be worth?

$$d1 = \frac{\left(\ln\left(\frac{48.60}{50}\right)\right) + \left(\left(0.01 + \left(\frac{0.20^2}{2}\right)\right) * 0.1644\right)}{0.20 * \sqrt{0.1644}}$$

$$d1 = -0.28939$$

$$d2 = -0.28939 - (0.20 * \sqrt{0.1644})$$

$$d2 = -0.37048$$

$$Call\ Price = (48.60 * N(-0.28939)) - (50 * 2.7183^{(-0.01 * 0.1644)} * N(-0.37048))$$

$$Call\ Price = 1.02$$

THE ASSUMPTIONS

Since all models are simplified versions of real-world situations, they have to make assumptions about how the world works. For the Black-Scholes model the assumptions about how our little world works include:

- The underlying stock pays no dividends during the term of the option. This obviously makes it tough to use Black-Scholes if the underlying we're interested in does indeed pay a dividend, but the assumption eliminates the need to account for changes in option prices resulting from payment of a dividend. It also eliminates concerns about the time value of money as it applies to the timing of the dividend.
- The option can only be exercised on the expiration date. As we've learned, that means these are European-style options while most options on stocks and ETFs are actually American-style, meaning they can be exercised at any time. The extra freedom associated with early exercise means that American-style options are slightly more valuable than European-style options. The difference is usually pretty small because it's rarely advantageous to exercise earlier than we have to (early exercise to capture a dividend that's about to be paid is theoretically the only situation in which early exercise would be advantageous), but eliminating the complexity of the potential for early exercise was necessary for the first option pricing model because the ability to early exercise really means we have an infinite number of very short-term options.
- Underlying markets are efficient. This means that direction can't be predicted consistently.
- No commissions are charged.
- Risk-free interest rates are known and remain constant over the life of the

option, and we're freely able to borrow and lend at this risk-free rate. While interest rates are known when we price our option it's likely that they're going to change over the life of our option. The impact of changes in interest rates on option prices is usually pretty small, but this assumption explains why a simplified model of the option world was necessary. There are an infinite number of paths that interest rates could take over the life of our option. To account for each of those infinite paths would be an incredibly involved undertaking. It's just easier to eliminate that consideration.

- Volatility is constant. This is the most significant assumption. The thought that the volatility of the underlying asset is fixed for the term of our option is obviously at odds with the real world. Stocks get incredibly volatile just before and just after earnings are announced and when major economic news is released. Stocks tend to be much less volatile in the weeks after earnings come out. However, as there are infinite paths that interest rates can take during the term of our option, there are infinite paths that the volatility of the underlying can take during the life of our option.
- It is always possible to buy or sell any amount of stock, even fractional shares, and stock prices are continuous, meaning there are no jumps or gaps. This is the assumption that many traders believe is most divorced from the real world. Clearly, it's not possible to trade fractional shares, and stocks clearly experience gaps and jumps. In the real world faced with jumps and gaps, option traders have introduced so-called fudge factors to option pricing. One of the most important fudge factors is skew, discussed in Chapter 6.
- Underlying asset prices are lognormally distributed. A lognormal distribution has a longer right tail, representing prices increasing, and a shorter left tail, representing prices decreasing, than a normal, bell-shaped distribution. The lognormal distribution acknowledges that stock prices will exist between zero, since stock prices can't be negative, and infinity, and acknowledges as well that stocks have an upward bias, since companies should be creating value over time. Thus, the lognormal distribution also acknowledges that stock prices can drop by 100 percent but can increase by more than 100 percent. In reality, stock price distributions are often not lognormal. They tend to have faster, larger drops than expected.

The fact that these assumptions don't comport with the real world results in some unusual phenomena that we'll discuss in Part Two. Savvy option traders can use these phenomena to their advantage.

INPUTS TO THE BLACK-SCHOLES OPTION PRICING MODEL

Almost all of the inputs to the Black-Scholes model are easily knowable: Strike price, put or call, and expiration are absolutely knowable. We know what the risk-free interest rate is (most traders use the 1-month or 3-month Treasury bill rate). The only input that might give us a little pause is volatility. Even with that one we might think that if we just figure out how volatile this stock was in the past, then we'll know how volatile it will be for the life of our option. This would be the historical volatility we discussed in Chapter 3. However, as we've already discussed, the volatility of a stock can change over time: Remember when our hypothetical Company B decided to fire Swing-for-the-Fences Freddy and replace him with Steady Eddie? If we used the historical volatility of Company B then we'd be using a volatility input that was higher than the actual volatility of Company B would be for the life of our option. We'd end up thinking options on Company B were worth more than they ultimately would be. If we relied on historical volatility as our input, we would constantly be a buyer of Company B options and we would constantly be disappointed because they would end up being worth less than we paid.

In our example of Black-Scholes we originally used a volatility input of 20 percent. This was a guess of what the volatility would be for the 60-day term of our option because it was the historical volatility for the underlying stock for the previous 60 days.

The result of using historical volatility is to calculate how much an option would have been worth if its life had matched the timeframe for the historical price data we have. We ended up figuring out what this option would have been worth 60 days ago. Knowing how much such an option would have been worth won't do us much good in trying to figure out how much our option is worth right now.

Black-Scholes is a model that we can use to help us make sense of the world; in our case it's the world of options on our underlying. But there's a reason we call it a model and not an equation even though there's an equals sign in there. Black-Scholes does not tell us what an option will be worth. It tells us what an option would be worth if the volatility input we chose ended up being precisely equal to the realized volatility for the term of our option, and if all those assumptions held.

IMPLIED VOLATILITY

We can look online and see option prices; someone obviously manages to come up with a price because options trade. Since we can see the option prices and since all the inputs to Black-Scholes, except volatility, are known, can't we reverse engineer the volatility the market is using? In our example we used a volatility of 20 percent to come up with a call option value of 1.02. We calculated our estimate of the value of the call option as follows:

Underlying price: $48.60

Strike price of call option: 50

Risk-free rate: 1 percent

Volatility estimate: 20 percent

Time to expiration: 60 days

This way we generate a call value of 1.02.

What if we see that the price of that call option in the market is actually 1.25? We could work backward, relying only on those variables that are either directly certain (e.g., strike price, time to expiration) or observable (e.g., underlying price, risk-free rate, observed value of the option) and do the option math like this:

Underlying price: $48.60

Strike price of call option: 50

Risk-free rate: 1 percent

Time to expiration: 60 days

Observed value of call: 1.25

This way we generate a volatility input implied by the observed option price of 23 percent.

The previous forms of volatility that we've discussed—historical and forecast —relate to the underlying and to changes in the underlying prices. Implied volatility relates to the option. It's the reverse-engineered volatility that is implied by observed option prices.

THE SENSITIVITY OF OPTION PRICES TO CHANGES IN THE INPUTS

What would happen to an option price if we changed one of the inputs? The inputs that could change during the life of our option include the underlying stock price, time to expiration (not only could this change, it has to change), the risk-free interest rate, and implied volatility. They wouldn't be in the option pricing model if they weren't important, but do they impact an option's price? We can use that same Black-Scholes option pricing model to determine how sensitive our option price would be to changes in these inputs.

Together, these sensitivities, along with some others that are incredibly technical, are referred to as the Greeks because we use Greek letters and glyphs as shorthand references to each. *Delta*, an option's sensitivity to changes in the price of the underlying, is the most important sensitivity measure for directional traders. *Theta* refers to an option price's sensitivity to changes in time to expiration. It's really an option price's change (decrease) due to the passage of a single trading day. *Gamma* is a measure of how quickly delta, an option's directionality, changes, and *Vega* is the measure of an option's sensitivity to changes in implied volatility.

Delta

An option's value obviously changes as the price of the underlying stock changes, but by how much will it change? That measure is known as *delta* and it's easily the most important of the Greeks for the directional, nonprofessional option trader.

If our underlying stock is trading at $1 and we have a 100 strike call option expiring soon, then a small change in the stock price is going to have almost zero impact on the value of our call option. The underlying stock is so far away from our strike price, and is so unlikely to ever get to our strike price given that it expires soon, that even a doubling of the stock price from $1 to $2 would have exceedingly little impact.

On the other hand, if our underlying stock is trading at $1,000 and we have a 100 strike call option, then even a small change in the stock price is going to have an equal change in the price of our call option; our call option has become a proxy for the underlying stock since the likelihood of our option being in-the-money at expiration is huge. If the stock price rose to $1,001 then the value of our option would also increase by $1 (our option would move in price from $900 to $901 since there would be zero time value for such an option).

Delta, the sensitivity of an option price to changes in the price of the underlying, is tiny for a very out-of-the-money option and is huge for a very in-the-money option. What about for the sort of options we generally encounter, an option that’s at-the-money, or nearly so?

One way to think about delta is to consider it the likelihood that an option will expire in the money. In our first example with the stock at $1 and a 100 strike price, that was very unlikely, and so that option had a minuscule delta. In our second example, with the stock at $1000 and a 100 strike price, it was almost certain that our option would expire in-the-money, so that option had a very large delta. What is the likelihood that a 100 strike call will expire in-the-money if the underlying stock is trading at $100? In this situation it’s nearly a coin flip because over a short period we don’t really know in which direction a stock is going to move. The odds of any particular outcome of a coin flip, say heads, is 50 percent. If our option is precisely at-the-money, then the odds of any particular outcome at expiration (in-the-money or out-of-the-money, since precisely at-the-money is a little like expecting a flipped coin to land on its edge), is also 50 percent. The sensitivity of our at-the-money option to any change in the underlying would be 50 percent of that change so the delta for this option would be 50. If our 100 strike call was trading at $5.00 with the underlying stock at $100, and the underlying stock rose by $0.80 to $100.80, we’d expect our call option price to increase by 50 percent of that $0.80. We’d expect our call option to now be worth $5.40.

In our implied volatility example (with volatility at 23 percent) the delta is 40, meaning that if the underlying stock moved from $48.60 to $49.60 we’d expect the price of the call option to change by 0.40, from 1.25 to 1.65.

Theta

Theta is the sensitivity of an option price to changes in time to expiration. It’s the change we’d expect to see in an option price—since we’re only getting closer to expiration it’s the decrease we’d expect to see due to the passage of time. Since options are a wasting asset, theta is where the rubber meets the road. In our example with an implied volatility of 23 percent we’d expect the price of our call option to decrease in value by 0.015 today. Observant readers will note that 0.015 multiplied by 60 days doesn’t get us our observed option price of 1.25. Theta increases as expiration nears, and we’ll discuss that more in Chapter 7 because we can use that increase to our advantage.

Gamma

When discussing delta we saw that the delta for our deep out-of-the-money option was zero. The delta of the at-the-money option was 50. The delta of the deep in-the-money option was 100. Delta obviously changes as the underlying price changes. Gamma describes this rate of change. For the professional trader who's stripping the directionality from their option position by taking an offsetting position in the underlying and using the delta to determine what the size of that offsetting position should be, gamma is their risk or reward.

In our example with an implied volatility of 23 percent, the gamma of our call option is 0.085. This means that for each 1-point change in stock price we'd expect the delta of our option to change by 0.085. If the stock rallied we'd expect the delta to increase, and if the price of our stock fell we'd expect delta to decrease. If our stock rallied by 1 point to $49.60 we'd expect the delta to be 48.5(40 plus 8.5). That makes sense because with the stock price just below the strike price of our option, and with 60 days left to expiration, the odds of our call option expiring in-the-money are nearly 50/50.

Vega

Volatility is the most important input to any option pricing model and, as we've said, it's impossible to know what the correct input is until after the option has expired. If the market's estimation of what volatility will be changes, then traders will manifest this by changing option prices. The impact of the change in implied volatility on an option's price is *vega*. Vega assumes implied volatility changes by 1 percent (say from 23 percent to 24 percent in our example) and reflects the sensitivity of the option price to that 1 percent change in implied volatility.

In our example with implied volatility at 23 percent, the vega was 0.076, meaning that a change in implied volatility from 23 percent to 24 percent would increase the price of our call option by $0.076, from $1.25 to $1.33.

Rho

Delta, theta, gamma and vega are the most important Greeks but an option's price is sensitive to other changes as well. One example is interest rates. Despite the assumption inherent in the Black-Scholes model, interest rates are likely to change during the term of options. *Rho* is a measure of the impact of the change in interest rates, specifically the interest rate we've used in our pricing model, on the price of an option. It's not possible to generalize on the impact of changes in interest rates on option prices. Rho depends on issues like the type of option

(American-style or European-style) and the type of underlying asset, as well as others. The formulas for all these sensitivities can be found in the Appendix.

These sensitivities can be overwhelmed by each other. The passage of time (theta) might take more out of an option's value than a mildly increasing implied volatility (vega) can add. Likewise, a call option may become less valuable despite a rising underlying if implied volatility is falling enough or due to the passage of time. Similarly, implied volatility can increase so much that an option is worth more than it was the previous day despite time decay. In this situation, time didn't run backward, the erosion occurred but it was overwhelmed by the increase in implied volatility. Figure 4.1 shows the general response to option prices due to changes in the price of the underlying, changes in implied volatility, and as well to the passage of time.

FIGURE 4.1 Option Sensitivities

	Call Options	**Put Options**
If the Price of the Underlying Asset Increases…	Call Option Values Will Increase	Put Option Values Will Decrease
If the Price of the Underlying Asset Decreases…	Call Option Values Will Decrease	Put Option Values Will Increase
If Volatility Increases…	Call Option Values Will Increase	Put Option Values Will Increase
If Volatility Decreases…	Call Option Values Will Decrease	Put Option Values Will Decrease
As Time Passes…	Call Option Values Will Decrease	Put Option Values Will Decrease

These sensitivities are rules of thumb, not immutable laws of nature, but they can be used over time to inform our trading decisions. We'll learn how to do that in Part Three.

TAKEAWAYS

- Lots of variables can be used in determining an option's value. We'll focus on a few quantifiable variables.
- An option pricing model, even though it's a mathematical calculation, is not a magic equation that tells you how much an option is worth now or how much it's going to be worth at expiration. Use the tools at OptionMath.com but remember that these tools should be used as a map, not an autopilot.
- Option pricing models make many assumptions: Some relate to dividends, others to how the underlying market functions, how interest rates will change, what volatility will be, what sort of distribution of returns the underlying will display, and so forth.
- None of these assumptions are valid in the real world. All are contrary to the way the world really works.
- We can still use assumptions. In fact, the way the market responds to these assumptions can be used to our advantage. We'll learn how to do that in Part Three.
- Implied volatility is the volatility of the underlying asset, for the term of the option, implied by the observed option price. Think of using the Black-Scholes model, inserting the observed option price and solving backward for the volatility input.
- Changes in the underlying price, time to expiration, and implied volatility will change option prices. The Greeks quantify these sensitivities.

PART TWO

The Phenomena

CHAPTER 5

The Volatility Risk Premium

Over the long run, options cost more than they are worth. Period. Academics have studied the *how much* and the *when* to death, but the *what* is pretty much a given. Options, as measured by implied volatility, cost more than they are ultimately worth, as measured by realized volatility. The difference is the *volatility risk premium*.

Intuitively, this makes tremendous sense in part because option payoffs are hugely asymmetrical. Option buyers have a relatively small risk, the price paid for the option, and have a theoretically gigantic potential return; if they've bought a call option then the potential return is essentially infinite. On the other hand, option sellers have a relatively small potential return, the amount received for selling the option, and a theoretically gigantic potential risk; if they've sold a call option then the potential risk is essentially infinite. We'd expect the option sellers to make some profit to compensate for this asymmetry, and most people wouldn't begrudge them a reasonable one. But what is a reasonable profit? Why don't some who are willing to reap a smaller profit sell down option prices? Why does this volatility risk premium continue to exist, and is there an empirical reason that it is what it is?

VOLATILITY RISK PREMIUM, THE *WHAT*

For option buyers, implied volatility is what they pay. For option buyers the realized volatility is what they actually get. The volatility risk premium is the difference between the two—the volatility risk premium is generally considered to be implied volatility minus realized volatility.

As we've seen, the real value of an option isn't how much it's in-the-money at expiration, it's how bumpy the path to expiration was. Even if we think an option will expire worthless, we can use the bumpiness of the path the underlying takes to get to the expiration date. The result is that we can "extract" the realized volatility of the underlying through this trading.

If the path ends up being very bumpy then option buyers have gotten a lot from their option. Professional traders or market maker have gotten a lot because they were able to extract money through this bumpiness by trading the underlying against their position. What if you're not a professional? Even if we don't take advantage of that bumpiness by trading the underlying, then we've gotten lots of value from our option. Maybe we've gotten a lot because we had the luxury of waiting, the luxury of being able to make a more informed decision. We didn't have to confront every meteoric rise and sickening gap in the underlying price. Maybe it was simply being able to stand aside confidently, knowing that we had protected the value of our underlying thanks to owning a put option. Maybe it was simply knowing that we had bought time, that we could wait to make a decision on expiration day. As we've discussed, all those sound like things that someone would be willing to pay extra for.

Figure 5.1 shows just how much extra option buyers have been willing to pay for SPX options over time. The darker line represents implied volatility, which is the cost, for the first out-of-the-money, 30-day-to-expiration call option. The lighter line shows the realized volatility, which is the value of that option, for the S&P 500 over the same periods.

FIGURE 5.1 SPX Implied and Realized Volatility

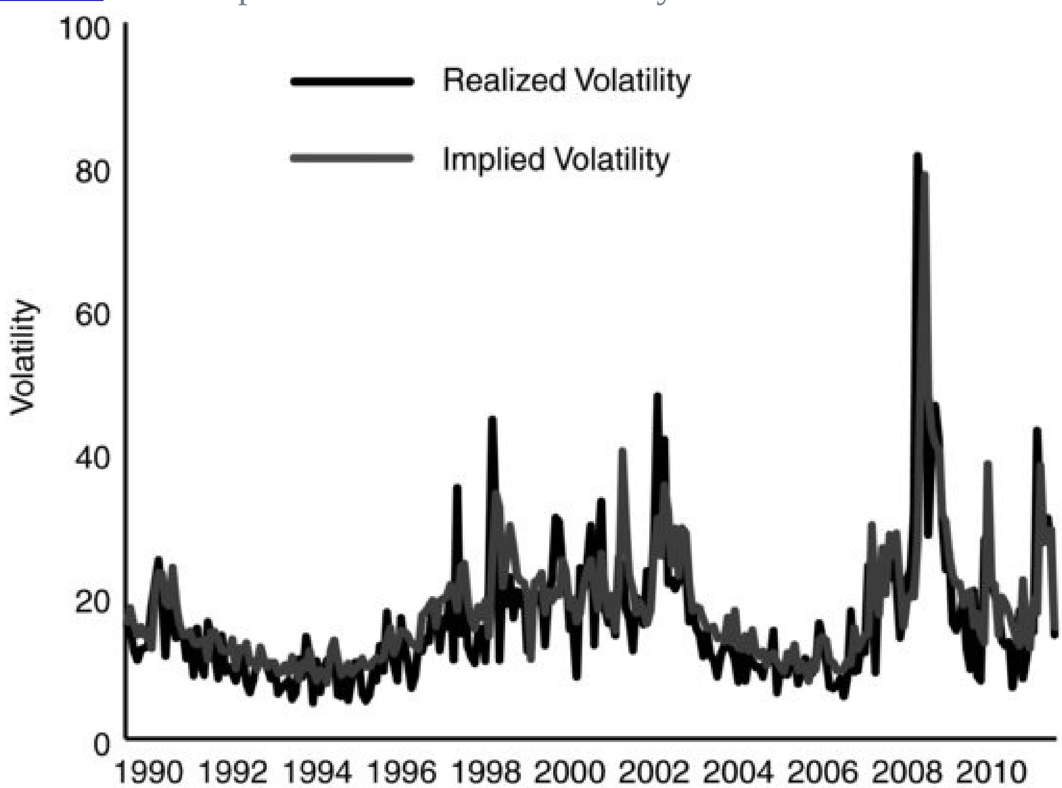
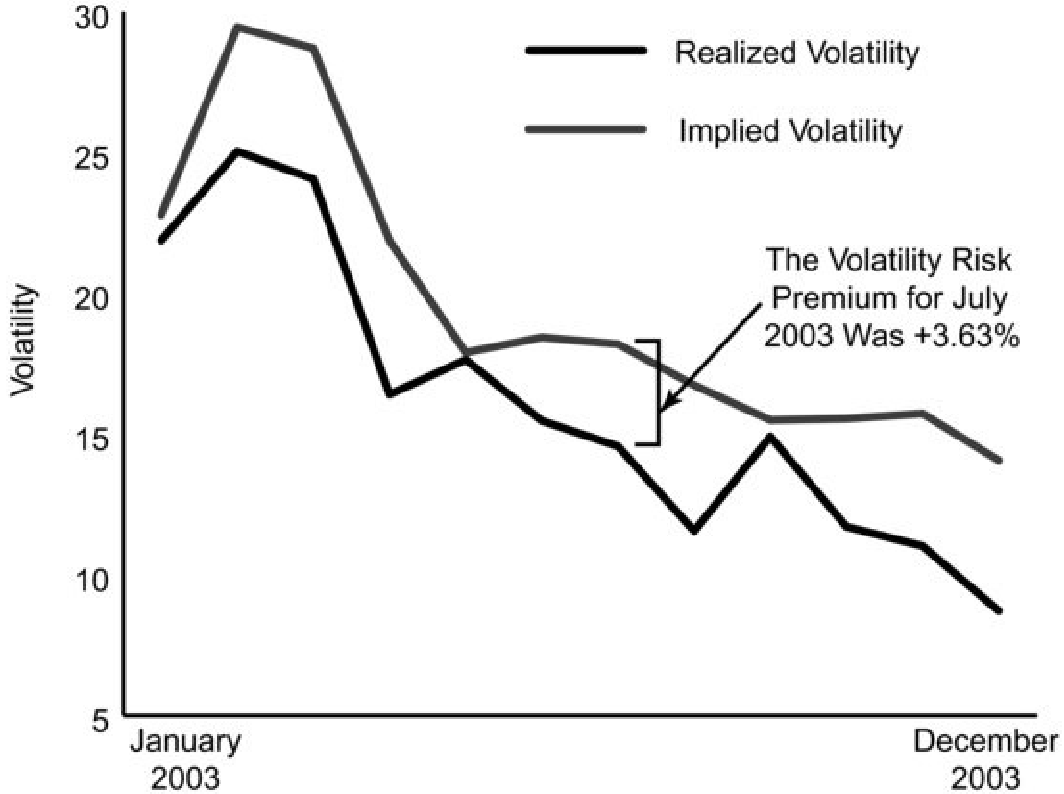


Figure 5.2 shows the same information, the implied volatility and realized volatility, for just 2003. In Figure 5.2 it's easier to recognize the difference between the two volatilities.

FIGURE 5.2 SPX Implied and Realized Volatility for 2003

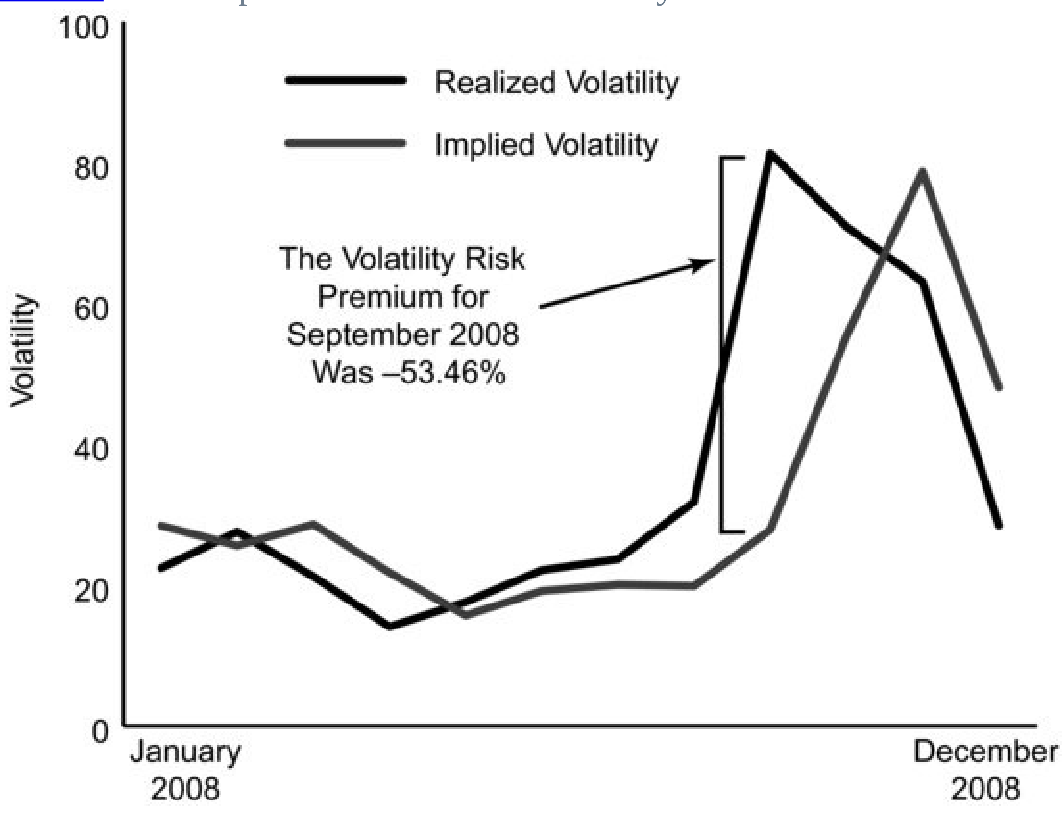


In Figure 5.2 you can see that implied volatility was consistently higher than the ultimate realized volatility. This difference was the volatility risk premium and it would have compensated option sellers for the asymmetry in their risk and reward. For example, in July 2003, the 30-day at-the-money SPX call option had an implied volatility of 18.21 percent. Over the next 30 days the realized volatility of the S&P 500 Index was just 14.58 percent, a volatility risk premium of 3.63 percent.

If implied volatility, an option's price, is generally higher than the ultimate realized volatility, an option's value, why wouldn't a steely-eyed option professional say, "I don't care about peace of mind, much like a casino executive doesn't care about someone winning an occasional big jackpot at the slot machines. I'm willing to forgo peace of mind for money if I know that over time I'm selling something for more than it's worth." The result would be selling down the implied volatility so that it's just fractionally above realized volatility. Think of a Walmart for options. A systematic option seller could extract the realized volatility by trading the underlying and pocket the very small difference over time and grow wealthy. The realized volatility can't be over the implied volatility by very much, can it? Don't they tend to track each other?

One answer is that realized volatility, the ultimate value of the option, can be over implied volatility, the cost of the option, by a *huge* amount. That huge amount can be staggering, physically and financially, for the trader who blindly and constantly sells options. The volatility risk premium is something to be used carefully. If we look at the same underlying (SPX) in 2008 we see in Figure 5.3 that in September of that year the realized volatility was 81.39 percent while the implied volatility had been only 27.93 percent at the start of the period. The realized volatility ended up being at least 5,346 basis points higher than expected. We might have expected it to correct the next month because option sellers might have dramatically increased the price they demanded for options. In fact, they did just that. In October they demanded an implied volatility of 55.44 percent, almost double the previous month's price. It still wasn't enough. Realized volatility that period ended up being 70.97 percent. A volatility seller for either of those two periods would have been punished by the volatility risk premium.

FIGURE 5.3 SPX Implied and Realized Volatility for 2008



THE ASSUMPTIONS, THE *WHY* OF THE VOLATILITY RISK PREMIUM

A skeptic has to ask—and every good trader needs to be a little skeptical, whether it's being skeptical of conventional wisdom or of the opinion of the crowd—is implied volatility really higher than realized volatility? We calculate the implied volatility of an option by plugging the option price and other specifics (expiration, strike price, etc.) into a model that generates an implied volatility. It's easy to forget while doing the option math the following caveat: Implied volatility is subject to all the assumptions inherent in that particular option model.

Several of the phenomena that we discuss in this book (and which option traders can take advantage of, including the volatility risk premium), exist partly because the assumptions inherent in theoretical option pricing models simply don't hold in the real world. Option models make these assumptions because the problem of pricing an option would simply be unmanageable otherwise.

One of the assumptions is that the prices of the underlying are continuous, meaning that there are no jumps or gaps and there is no bid/ask spread in the stock price. This assumption exists because option pricing models assume volatility can be captured through hedging. Just as there are an infinite number of paths for volatility and interest rates, there are an infinite number of paths for the underlying. Instead of saying the stock price is unchanged (like we assume for volatility and interest rates) defeating the need for options at all, by saying that the stock prices are continuous (meaning constantly tradable at every price, in any quantity, even as prices change), hedging in microscopic amounts at each and every price is possible; we have eliminated one variable and are now able to construct our model.

However, anyone who's watched the real-time prices of a stock immediately after an earnings report knows that this assumption is fundamentally at odds with the real world. The price often jumps several percent without trading even once. Then it's likely to bounce about in a wide range with significant gaps in trading.

This is the actual course of the first five trades in one U.S. stock immediately after an earnings announcement (data from NationsShares).

100 shares @ $30.27

200 shares @ $30.10

1,000 shares @ $30.00

200 shares @ $29.87

100 shares @ $29.85

This market is clearly not continuous, and the assumption that it is continuous is flawed.

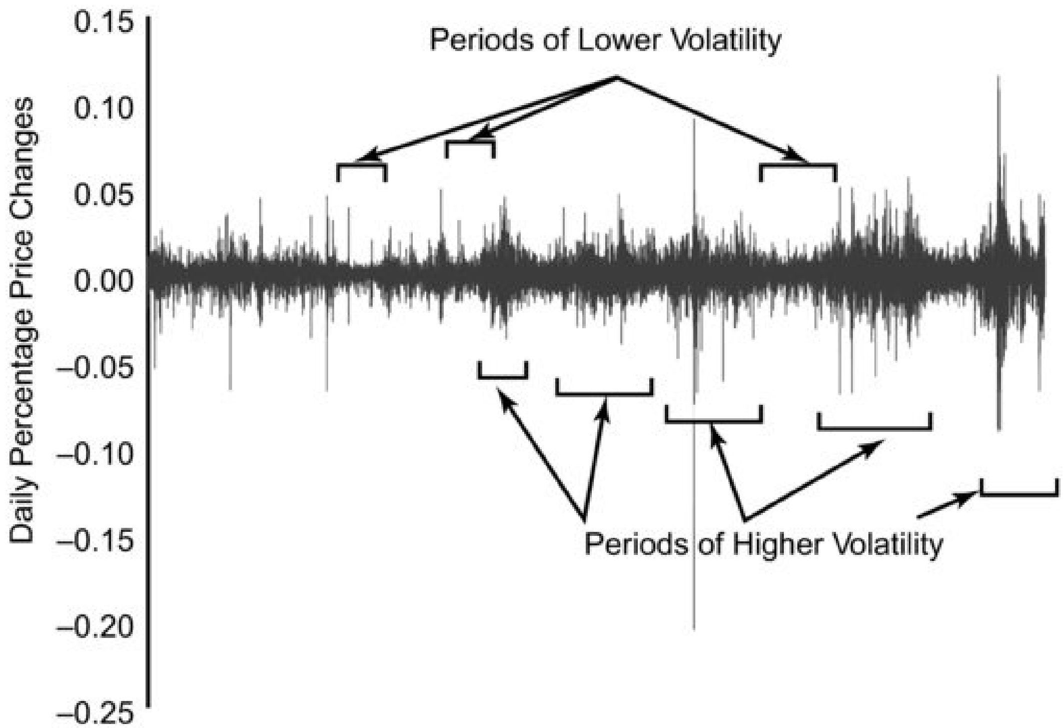
Black-Scholes, in fact all option pricing models, would have assumed that a trader trying to capture realized volatility would have been able to offset his option position by selling a little of this stock at $30.27, then a little more at $30.26, and a little more at $30.25, selling a little at each price all the way down to $29.85. Oh, if it were only that easy.

Hence, even for the smartest, best-equipped professional, it isn't possible to capture the realized volatility by trading in the underlying to the degree imagined by the model.

The volatility risk premium acknowledges this real-world inability to capture the realized volatility.

Another related and commonly violated assumption is that volatility is constant for the life of an option. This is simply not so. Volatility is lumpy (the technical term is *heteroskedastic*) meaning that periods of higher than average volatility, such as the period immediately following an earnings announcement or a period of geopolitical turmoil for stock indexes, are followed by periods of lower than average volatility. These periods may last days or weeks. Figure 5.4 shows realized volatility for the S&P 500 from 1955 to 2011. It's clear that there are clumps representing periods when realized volatility was high, and there are troughs representing periods when realized volatility was low.

FIGURE 5.4 Heteroskedasticity



The violation of these assumptions means the cost for someone trying to capture the realized volatility is higher than an option model would predict. If all of the assumptions held, then the option seller could extract the realized volatility from the underlying, as we've discussed, and the profit or loss would be solely determined by how good a guess of realized volatility the implied volatility of our option was. As it is, option sellers have to worry about that guess, about hedging out the realized volatility (in the face of jumps in both stock price and volatility), about interest rates changing, about the dividend stream, and about the cost of doing business. As a result, option sellers will add a margin of error to their best guess of an option's ultimate value. To this they add a little bit more for profit. This becomes the implied volatility seen in the market. Therefore, think of the volatility risk premium as the margin of error and the profit for the option seller. Just as a homeowner's insurance company charges slightly more than the coverage is worth—that slight difference covers their overhead and is the source of profit—option sellers demand slightly more than options are ultimately going to be worth.

THE VOLATILITY RISK PREMIUM—HOW MUCH

The volatility risk premium for any particular underlying is an incredibly elusive moving target. It might exist for a period of time and then disappear unexpectedly. It will expand and contract, ebb and flow. For some periods for some assets it will be negative. It will be negative because the realized volatility will end up being higher than was predicted by implied volatility. In this case the option buyer got a bargain; they got more than they paid for.

The volatility risk premium is a little like an abstract painting: Only when we step back to look at it from a distance, in our case the distance of time, does the form and magnitude become apparent.

SPX options on the S&P 500 Index show a profound volatility risk premium but the size becomes most apparent when viewed over a long time period. For example, Table 5.1 shows the volatility risk premium for the SPX 30-day at-the-money (ATM) call from December 1989 to December 2011.

Table 5.1 Volatility Risk Premium for the SPX 30-Day ATM Call

Average Implied Volatility	25.37%
Average Ultimate Realized Volatility of S&P 500 Index	16.44%
Average Cost of Option as Percentage of the Index	1.890%
Average Value of the Option as Percentage of the Index	1.726%
Average Difference Between Cost and Value	0.164%
Average Dollar Difference	$1.26
Source: NationsShares	

This is an apples-to-apples comparison because the ultimate realized volatility was calculated over the exact same time period as the implied volatility.

As we've seen in Chapter 1, the time value of an option is greatest when the option is at-the-money. Does that mean that the volatility risk premium is greatest for an at-the-money option? See Table 5.2 for the volatility risk premium for the SPX 30-day 5-percent out-of-the-money (OTM) put.

Table 5.2 Volatility Risk Premium for the SPX 30-Day 5% OTM Put

Average Implied Volatility	25.37%
Average Ultimate Realized Volatility of S&P 500 Index	16.44%
Average Cost of Option as Percentage of the Index	0.785%
Average Value of the Option as Percentage of the Index	0.498%
Average Difference between Cost and Value	0.287%
Average Dollar Difference	$2.87
Source: NationsShares	

Time value is greatest at-the-money, but that's not necessarily where the greatest volatility risk premium, at least in volatility terms, will be found. In fact, the greatest volatility risk premium, in volatility terms, is closely related to the concept of skew, which we'll discuss in Chapter 6. This means that it might be in at-the-money options, it might be in out-of-the-money puts (generally the case for equity index options), it might be in calls (generally the case for commodities), or it might not exist for a period.

HOW TO THINK ABOUT THE VOLATILITY RISK PREMIUM

The volatility risk premium is compensation for option sellers taking additional risk (risk that is asymmetrical), and for the fact that the assumptions inherent in an option model don't hold. It's the price option buyers pay to achieve the following objectives:

- Define risk and free themselves from the vagaries of option pricing models
- Generate leverage
- Protect their investment
- Reduce the volatility of a portfolio

Option buyers thus free themselves from worry about our world when it contradicts the assumptions of option pricing models.

THE VOLATILITY RISK PREMIUM BY ASSET CLASS

The general size of the volatility risk premium, its location (at-the-money, or below or above at-the-money levels), and its persistence varies by asset class. This makes sense as certain commodities (e.g., crude oil) tend to gap higher when unforeseen events occur unlike equity indexes that tend to gap lower; crude oil's tendency to gap higher may mean that upside calls display the greatest volatility risk premium. This is closely related to *skew*, a term discussed in Chapter 6. For an individual equity, gaps and jumps are likely in either direction so the greatest volatility risk premium, in dollar terms, is usually at-the-money but if puts get really expensive due to bad news or if calls get really expensive due to takeover talk then the volatility risk premium for an individual equity can shift from at-the-money. Tables 5.3, 5.4, and 5.5 show the volatility risk premium for several asset classes over a recent two-year period.

Table 5.3 Volatility Risk Premium for USO (Crude Oil)

Average Implied Volatility	33.33%
Average Realized Volatility	29.38%
Average Volatility Risk Premium (I.V. minus R.V.)	3.95%
Highest Volatility Risk Premium (I.V. minus R.V.)	18.53%
Lowest Volatility Risk Premium (I.V. minus R.V.)	−14.43%

Table 5.4 Volatility Risk Premium for GOOG (Google Inc.)

Average Implied Volatility	28.81%
Average Realized Volatility	27.82%
Average Volatility Risk Premium (I.V. minus R.V.)	0.99%
Highest Volatility Risk Premium (I.V. minus R.V.)	20.55%
Lowest Volatility Risk Premium (I.V. minus R.V.)	−21.21%

Table 5.5 Volatility Risk Premium for TLT (U.S. Treasury Bond ETF)

Average Implied Volatility	16.69%
Average Realized Volatility	17.10%
Average Volatility Risk Premium (I.V. minus R.V.)	−0.41%
Highest Volatility Risk Premium (I.V. minus R.V.)	8.29%
Lowest Volatility Risk Premium (I.V. minus R.V.)	−18.82%

If you'd been short options for United States Oil (a crude oil ETF, ticker symbol USO) during this period and used the underlying to capture the realized volatility, you'd likely have made money because the volatility risk premium was strongly positive, particularly as a percentage of implied volatility. However, there was at least one month that would have been a sickening ride. That's the month when implied volatility at the start of the month predicted movement for that month translating to an annualized volatility of 31.01 percent, only to see the realized volatility for that month to turn out to be 45.44 percent.

If you'd been short Google Inc. (GOOG) options during this period and used the underlying to capture the realized volatility, you'd likely have made money because the volatility risk premium was positive. However, there was a two-month period that would have left a volatility seller pretty queasy. It started with the month when implied volatility was below the ultimate realized volatility by 21.21 percent, which was followed up by a month that saw realized volatility come in 19.85 percent higher than implied volatility had been at the start of the month. Be prepared. This is the sort of price action that can lead to a trader swearing off short option positions forever.

If you'd been short Barclays 20+ Year U.S. Treasury Bond Exchange Traded Fund (TLT) options during this period and used the underlying to capture the realized volatility, you'd likely have lost money. It's unusual for the volatility risk premium to be negative over such a long period, but the market can stay volatile longer than people think and longer than option sellers can stay solvent. The largest volatility risk premium of 8.29 percent occurred in a month when implied volatility was 25.73 percent at the start of the month and realized volatility ended up being only 17.44 percent. However, that month wouldn't have made up for either of the two worst months.

THE VOLATILITY RISK PREMIUM OVER TIME

Nothing about option trading is fixed. Realized volatility changes constantly. Implied volatility does as well. The participants' appetite for risk increases and decreases. Similarly, the volatility risk premium isn't static. It expands and contracts, and for long periods it can be negative, meaning that realized volatility is higher than implied option volatility.

Over time, the volatility risk premium is self-correcting, meaning that ultimately, if realized volatility is higher than implied for a long-enough period, traders will stop selling options at those implied volatilities. Instead, they'll adjust the price of options (and hence the volatility implied by those prices) higher, until they think implied volatility is now high enough to cover their expenses (realized volatility being the most important expense, but also including the margin of error to account for the failure of assumptions in option pricing models plus profit). In fact, option sellers are always trying to sell options so that the implied volatility is higher than realized volatility is going to be. Sometimes they're just wrong.

Likewise, if implied volatility is too high relative to realized volatility, then traders will be more willing to sell options and get short implied volatility at those levels. In fact, additional participants may enter the market for those options and do so by selling.

Just as someone can enter the home insurance market and drive down the price of insurance and profit margins (we assume claims wouldn't change) for home insurers—until the point where the next potential insurer realizes they'd drive prices down such that the profit isn't worth the trouble and risk—additional potential option sellers may think that the volatility risk premium isn't high enough to compensate for the effort and risk. Thus the volatility risk premium is much like anything else; it’s subject to supply and demand. If more hedgers are willing to pay a higher volatility risk premium, then the volatility risk premium will increase. Option prices may be too high, but the result is that over time they’re generally as low as they’re going to get unless additional option sellers enter the market or the realized volatility regime changes substantially and for a significant period.

This is why having the volatility risk premium working on your behalf as an option seller is a little like having the odds on your side at a casino. Over the long run and assuming enough discrete chances, you’ll come out ahead. That doesn’t mean that in the short run you won’t lose, and that some of those losses won’t be pretty sickening.

TAKEAWAYS

- Over time, the volatility risk premium is positive, meaning that implied volatility (the cost of options) is greater than realized volatility (the value of options).
- The volatility risk premium exists in part due to the failure of assumptions in option models, and in part due to demand from option buyers seeking protection or the asymmetry of option returns. The volatility risk premium is also the compensation demanded by option sellers for their willingness to face the asymmetry of option returns.
- The volatility risk premium exists in options on every asset class but not in any asset all the time.
- The volatility risk premium is self-correcting. If it disappears then option buyers will be willing to pay more for options, and option sellers will demand more for options, which will drive option prices (implied volatility) higher while having no impact on option values (realized volatility).
- Being very wrong about the volatility risk premium, that is, being short implied volatility when realized volatility is much higher, can lead to sickening results.
- The way to collect the volatility risk premium is to be short options, but every option seller should use the volatility risk premium sensibly.

CHAPTER 6

Implied Volatility and Skew

Of all the inputs into the Black-Scholes option pricing model, the only one that's not knowable is volatility. Interest rates might change slightly over the term of the option, but any change is likely to be fairly small and the effect of changes (the rho sensitivity we discussed in Chapter 4) in interest rates on option values is usually even smaller. While dividends might not be precisely knowable, particularly for longer-dated options, we can generally be very confident of the dividend stream, and even for those longer-dated options we can come really close to knowing the amount and timing of dividend payouts. These other inputs are absolutely certain and knowable: time to expiration, strike price, and call or put. Volatility, on the other hand, is anyone's guess—and nearly everyone has a guess. In fact, nearly everyone has several guesses.

The volatility measure we'd like to know—the one that, if we had it would allow us to precisely calculate the correct value for an option—is the realized volatility of the underlying instrument from the time we initiate our option position to the time the option expires. This is the volatility we've discussed previously.

Even if we intend to exit our option trade prior to expiration there's no way to be certain the market price of the option would reflect the correct volatility when we wanted to exit. The only way to make certain that we've got the right number is to take our position to expiration when "everything comes out in the wash." If that future realized volatility number was as knowable as the other inputs then we could plug it into our model and know precisely what each option was worth, not the value assigned by the market, but what the option will ultimately be worth. Again, that doesn't mean we would know the price of each option at expiration. Knowing that requires knowing where the underlying will be priced at expiration. We don't need to know that, in fact we don't care if the underlying is higher or lower from the time we executed our option position, we just need to know how bumpy the path to that price was.

So we can't know the future realized volatility corresponding to the period from when we initiate our option position to expiration, but the market clearly has a "best guess" that participants use to calculate the option prices we see trading. We could use the following criteria to generate a call value of 0.81:

Underlying price: $49.00
Strike price of call option: 50
Risk-free rate: 1 percent
Volatility estimate: 22 percent
Time to expiration: 30 days

Instead we could rely only on those variables that are either directly certain (e.g., strike price, time to expiration) or observable (e.g., underlying price, risk-free rate, observed value of the option) and do the option math this way, as shown below, to generate a volatility input implied by the observed option price of 22 percent. (This is the implied volatility we introduced in Chapter 4.)

Underlying price: $49.00
Strike price of call option: 50
Risk-free rate: 1 percent
Time to expiration: 30 days
Observed value of call: 0.81

Implied volatility is the market's best guess for what the realized volatility will be over the life of our option but it's separate and distinct from what the volatility will ultimately be just as the weather forecast may be our best guess for what the weather's going to be like over the next 30 days but today's best guess is separate and distinct from what the future weather will ultimately be like. Tomorrow's forecast of fair weather doesn't mean there won't be a tornado next week or record-setting high temperatures the week after that.

We can do this reverse engineering calculation for any option and determine the volatility implied by the observed market price for every option. It's just a matter of putting the knowable and observable inputs into the Black-Scholes equation or whichever option-pricing model we're using, and solving for volatility. You can do this using the model at OptionMath.com.

IMPLIED VOLATILITY BY STRIKE PRICE

Since the volatility input to option-pricing formulas refer to the future realized volatility *of the underlying asset* and is independent of the strike price, the implied volatility shouldn't change from one strike price to another, assuming all the strike prices share an expiration date.

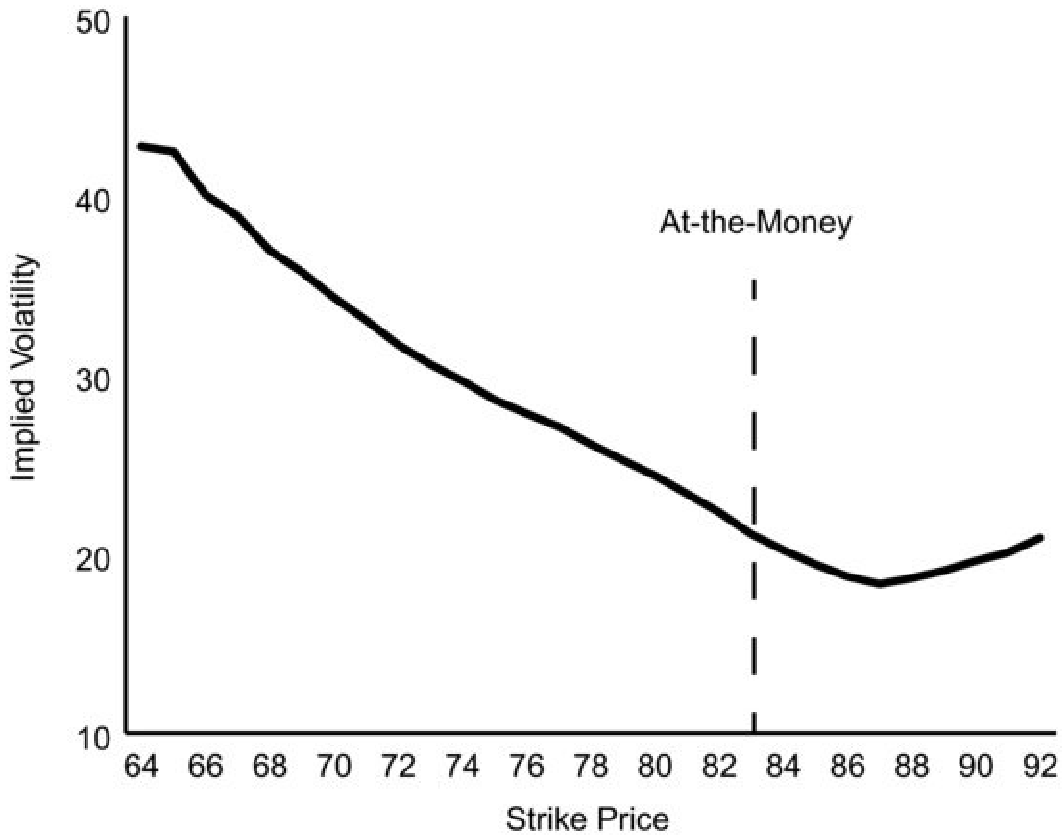
Let’s put some observed option prices into an option-pricing model to make sure that is the case. Using real option prices on the Russell 2000 Exchange Traded Fund (IWM), we find the following volatilities implied by those prices in Table 6.1.

Table 6.1 Implied Volatility by Strike Price

Strike Price	Observed Option Price	Volatility Implied by Observed Option Prices (in percent)
69	0.05	35.77
71	0.07	33.07
73	0.12	30.61
75	0.21	28.63
77	0.39	27.13
79	0.69	25.26
81	1.18	23.38
83	1.47	21.13
85	0.64	19.44
87	0.22	18.35
89	0.09	19.09
91	0.04	20.10
93	0.02	21.56
95	0.00	NA
97	0.00	NA

It doesn’t take long to see that the implied volatilities do in fact change by strike price. In fact, the change seems to have a pattern to it, as you can see from Figure 6.1, which includes all strike prices and extends the range of put strike prices until all option prices are zero.

FIGURE 6.1 IWM Implied Volatility Skew



As the strike prices move downward from the at-the-money option, the implied volatility increases. It continues to increase until the put option prices become zero. As the strike prices increase from the at-the-money option, the implied volatility decreases and continues to do so until reaching the 87 strike where it has bottomed out and begun rising again.

The shape of this graph of implied volatility is very common for equity indexes such as the Russell 2000, Dow Jones Industrial Average, and the S&P 500. The shape is broadly called *skew*, and that's the term we'll use, but it's sometimes called the volatility *smile* when it's more symmetrical, and the volatility *smirk* when it's lopsided like the skew shown for IWM in Figure 6.1.

OPTION SKEW, THE *WHEN*

Does volatility skew always exist? In broad market products like IWM and SPY it's an absolute fixture and has been since the stock market crash of 1987. On October 19, 1987, the S&P dropped by over 20 percent and many traders learned that markets can go down much faster and much further than anyone would have thought possible. On that day the market also moved down much more than an option model dependent on standard deviation of returns would have said was even possible. If we use the actual change of just over 20 percent for the S&P 500 and compare that to a standard deviation of daily changes, we learn that the math says such a loss should occur once every million years or so.

The market on that day displayed sickening jumps and gaps—the sort of noncontinuous trading that option pricing models assume doesn't happen.

Traders also learned that it's not always possible to cover your position even if you don't care what price you pay. Many option traders just refused to sell options on that day and the Chicago Board Options Exchange halted trading in their index option markets. October 19, 1987, was the most dramatic example of this fact: The assumption inherent in option pricing models, that underlying prices are continuous (that is, that they don't jump or gap and can be traded at every price in any quantity as the market moves), is a fallacy. Since that painful lesson, skew has been a constant in the index option markets. The lessons learned in October 1987 are occasionally reinforced as in October 1989, or during the Iraqi invasion of Kuwait in August 1990, or following Long Term Capital Management's troubles in 1998, with the "dot com" meltdown of 2000, on September 11, 2001, and with the recent housing mess.

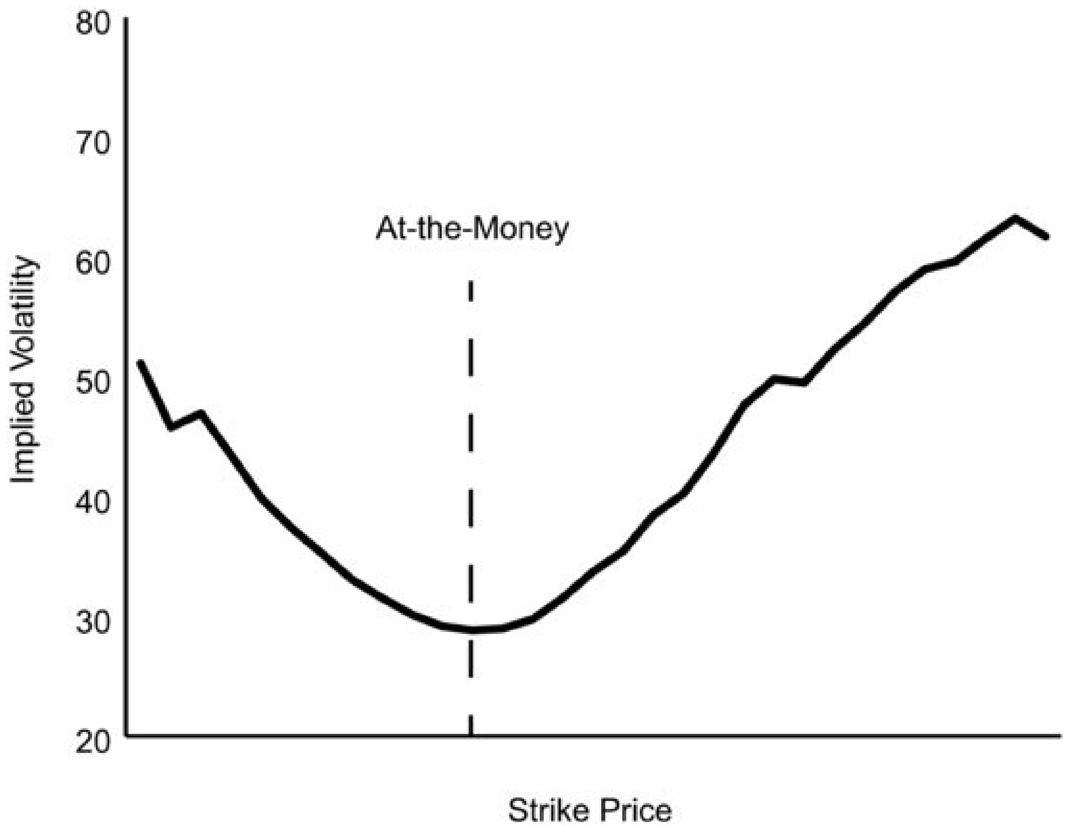
OPTION SKEW, THE *WHERE*

Skew is different, although not necessarily less prevalent, in single stocks where other factors are part of the outlook. Skew is very different in non-equity products like precious metals, fixed income, and currencies. Generally, skew increases, meaning implied volatility increases, in the direction in which the largest and most damaging jumps tend to occur.

In equity indexes those gaps tend to be downward. For example, the average of the worst 10 days for the S&P 500 going back to 1955 is a loss of 9.028 percent while the average of the 10 best days for the S&P is a gain of only 7.578 percent. For certain commodities, with gold and crude oil the prime examples, most severe price changes tend to be upward in response to geopolitical turmoil, financial fears, or (in the case of crude oil), supply disruption.

For example, Figure 6.2 shows option skew in crude oil at a time of significant geopolitical uncertainty in the Middle East.

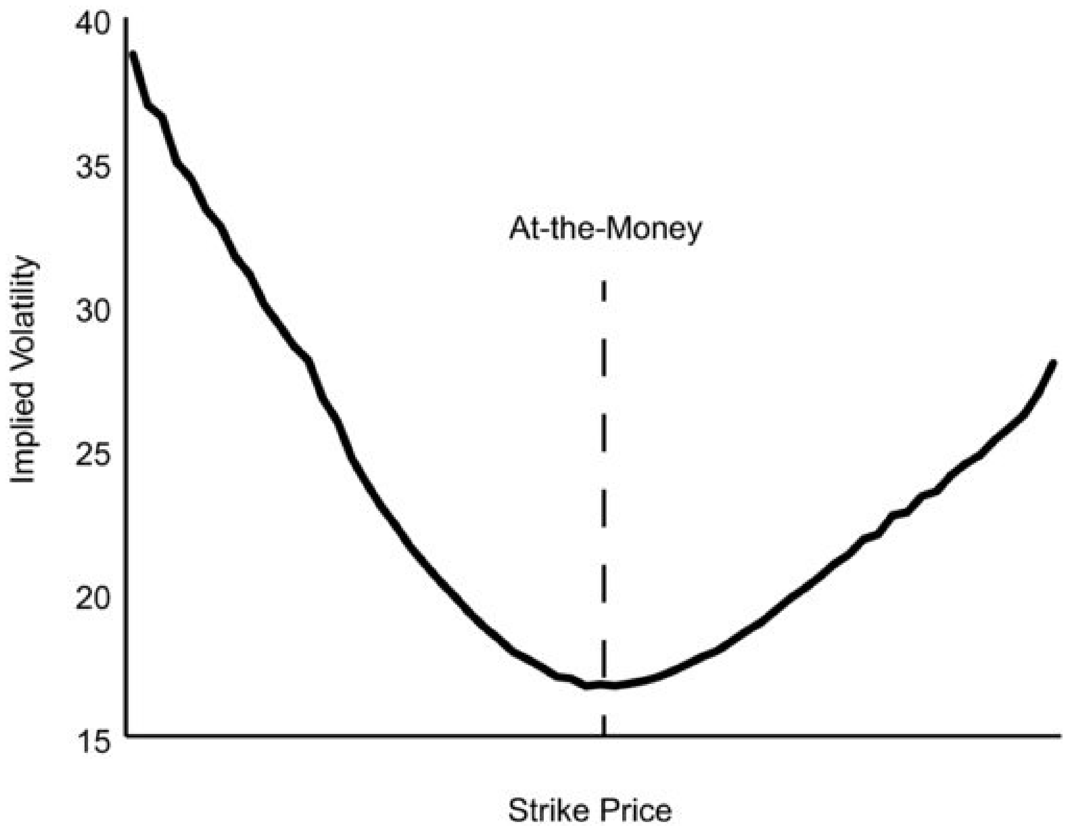
FIGURE 6.2 Crude Oil Skew



Market participants feared crude oil supply disruption and bid up call options in response to the likelihood of just such a supply disruption and attendant price spike. Crude oil shows more skew to the upside since any likely price spike would be to the upside.

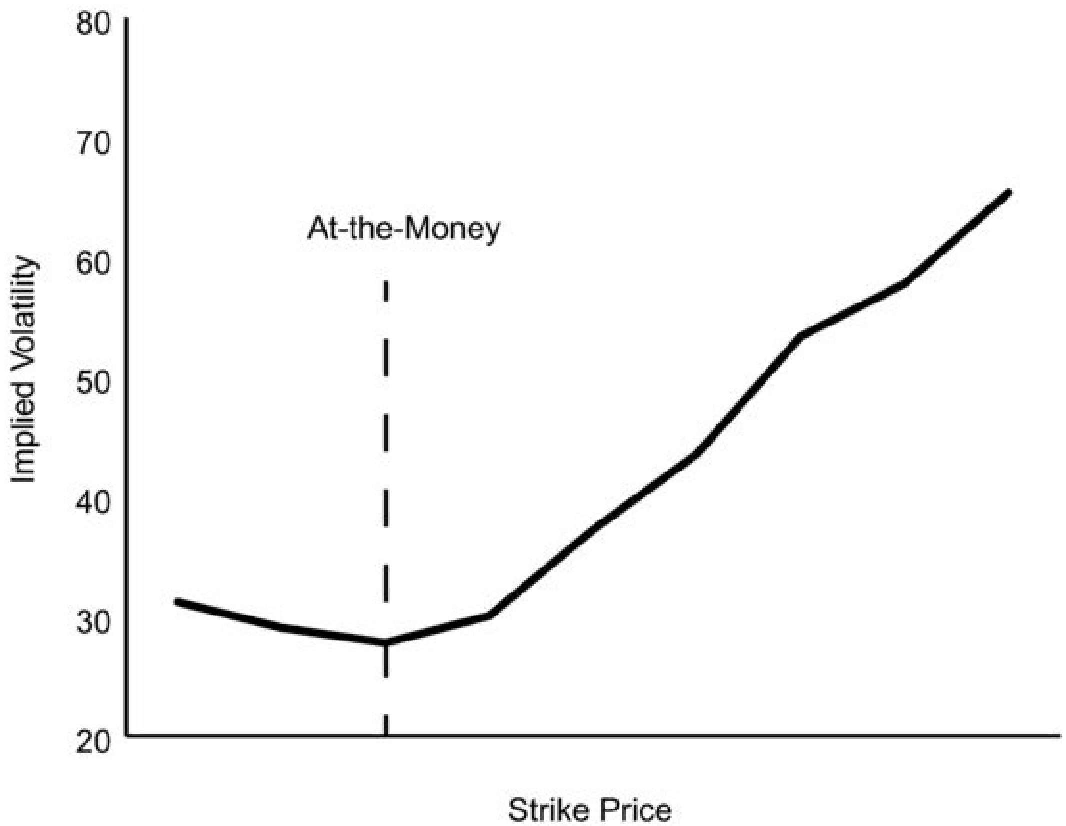
A similar skew exists in gold, as Figure 6.3 shows. Gold will jump in response to financial or geopolitical tumult—the largest one-day jump in GLD, the gold ETF, since it launched is 11.291 percent while the largest one-day drop was just 7.430 percent—it shows call skew, that is, the calls are relatively more expensive than at-the-money options and get more expensive in terms of implied volatility as they get further from at-the-money strike prices. However, since gold is an investment holding for many investors who might buy protective puts, gold shows put skew as well.

FIGURE 6.3 Gold Skew



Individual equities show a wide range of skews; it's a bit like a financial fingerprint in that each one is a little different. Figure 6.4 shows the option skew for Yahoo! (YHOO) at a time when the company was considered a potential takeover target. Speculators had bid up call prices to take advantage of any potential deal to buy the company. Puts, on the other hand, are only mildly elevated.

FIGURE 6.4 Yahoo! (YHOO) Skew



Why does skew exist if the volatility component of an option price applies to the underlying, not to the option? Isn't this like the market asking how much the underlying is going to move over the life of these options, getting several different answers, and saying that all of them are correct at the same time? Yes it is.

Assumptions, the First *WHY* of Option Skew

What does skew say about all those assumptions inherent in the Black-Scholes model?

One of the most important assumptions is that underlying asset prices are lognormally distributed.

Is this how the world really works? Are asset prices really distributed this way? No. In practice, underlying asset price distributions are often very different from lognormal (the term *lognormal* means that the underlying price changes are normally distributed). Actual historical distributions of underlying asset price changes, not the prices themselves but the percentage price changes, usually have fatter tails than expected—October 1987 being the fattest of fat tails—signaling that large moves in the relevant market occur with greater frequency than would be expected by a true normal distribution. That is, there are more extreme moves, both up and down, than we'd expect if the assumption that underlying asset price changes were normally distributed were true. As we discussed earlier, traders' tendencies to account for this phenomenon generate higher put prices (and hence skew) than expected in equity indexes, higher call prices in gold and crude oil, and different implied volatilities for different strike prices in general.

Another assumption is that trading is continuous and without jumps or gaps.

Anyone who's tried to buy or sell stock immediately after an earnings report knows that perfect liquidity is just not the way markets work. The first trade immediately following the report may be several percent from the previous price, meaning that a trader trying to hedge an option position in the way Black-Scholes envisions is simply out of luck. The possibility of a big move wouldn't necessarily generate option skew if perfect liquidity in the underlying existed; the option holder would just constantly adjust his hedges as the big move took place. The fact that it's often impossible to execute these hedges generates skew as option traders get in front of this lack of liquidity.

ASSUMPTIONS AND OTHER REASONS

So the assumptions inherent in the Black-Scholes model, and every other option pricing model for that matter, don't hold. That results in some seemingly illogical results, such as different strike prices of otherwise identical options predicting different amounts of future movement for the underlying instrument. Are there other reasons for skew? Indeed. There are several behavioral and market structure issues that help to generate skew.

First, option buyers, the ones who drive implied volatility higher, tend to focus on downside strikes because they are buying protection and are willing to leave a little on the table before their protection kicks in. This is referred to as "excess demand from put buyers." Similarly, investors in search of extra yield in the form of option premium are willing to sell covered calls—and drive implied volatility lower—in those strikes above at-the-money. These put buyers and covered call sellers are the ones who drive skew. The failed assumptions inherent in option pricing models allow the situation to survive.

Second, there is a tendency for investors to overestimate the odds of a crash while underestimating the odds of the S&P rising by say, 5 percent. This long-shot bias for a crash causes some traders to buy up a bunch of really cheap put options and overpay in the process. This is the same reason people buy lottery tickets.

Third, there is a lack of traders or investors who are willing to constantly sell puts to meet the demand. While several academic papers, notably by Oleg Bondarenko, show that selling puts can be a profitable strategy, even from a risk/reward stand point, it's rarely practiced systematically because it has the ability to bankrupt you and cost a risk manager his job. Many professionals see the constant selling of cheap, out-of-the-money puts as a great way to get rich slowly and go broke quickly so they stay away from the strategy.

Since all these assumptions are made when pricing options—regardless of whether the underlying is IWM, gold, crude oil, or Yahoo!—why do the skews look so different? Again, skew recognizes not only that large, sudden moves are more common than the models suggest, but skew also recognizes the likely direction of the largest and most sudden moves for that asset. Large moves in stock indexes tend to be down. In crude oil and gold they tend to be up. In single equities they tend to go both directions, but in a takeover candidate they tend to head higher.

Why does skew continue to exist? Looking at our table of IWM implied volatilities, the most expensive options—at least in terms of the measure that matters, implied volatility—are the downside options (while there are both puts and calls listed at the 69 strike, the calls very rarely trade). The puts of that strike are where the action is, so we'll use shorthand common to option traders and we'll refer to those options below at-the-money as puts, although calls exist at those strike prices also. Similarly, we'll refer to options above at-the-money as calls. If we accounted for issues like the bid/ask spread (discussed in Chapter 8) and then calculated the implied volatility for the 69 strike call option, we would get a value identical to the put option with that strike price. (If this weren't the case, there would be an opportunity for a risk-free arbitrage.) Not only do the implied volatilities differ by strike price, the puts get more expensive (again, in terms of implied volatility) as they get further from at-the-money. Calls get less expensive as they get further from at-the-money until we get to the 87 strike, when they start to get more expensive.

It's almost as if hedgers who are long the IWM are willing to bid up the implied volatility of these puts in order to buy protection, and hedgers who are long the IWM (or another Russell 2000–based product) are willing to drive down implied volatility of calls by selling covered calls to generate some premium. Both trades may make sense, but why does the market allow this buying of protection and selling of covered calls to overwhelm the logic that *implied volatility belongs to the underlying, not to the option*? If the real value of an option comes from the volatility (i.e., the bumpiness) of the underlying, and if we can use the underlying to extract the realized volatility, then why aren't all volatilities the same? Why doesn't someone arbitrage this difference away?

Wouldn't it just make sense to buy the 87 strike call at an implied volatility of 18.35 and sell the 69 strike put at an implied volatility of 35.77? We're buying the cheapest option on the board and selling the most expensive option on the board against it. Why wouldn't we do that until we'd driven the differences in implied volatilities out of the market? After all, if implied volatility applies to the underlying, we'd be short implied volatility at one strike and long implied volatility at another strike price. Wouldn't the risks offset?

This trade idea assumes that the higher strike price option is a good hedge for the lower strike price option in terms of changes in implied volatility and directionality. That may be the case with one year to expiration, but with less time remaining it's not so. Imagine the market moved down to $69. The put we're short would explode in value and the call we're long would drop to zero. Even if we'd done the trade delta neutral, that is, sold some IWM shares short to eliminate the short-term directionality of the trade, the severity of the move would overwhelm our hedge. We'd lose money, and a lot of it. It's just this sort of gap that skew addresses.

In this example the two options are not good hedges for each other because the strike prices are so far apart. Generally one strike price is a good hedge for another strike price if there's enough time to expiration. Once the underlying asset price moves, or the options get closer to expiration, this breaks down. Skew partly recognizes this inability of one strike to hedge another at some point as traders work to own strike prices close to those they're short. Given a big move, a deep out-of-the-money call is a pretty poor hedge for an in-the-money put, which is what our 69 strike put quickly becomes.

DETERMINING IF ONE OPTION IS A GOOD HEDGE FOR ANOTHER OPTION

This discussion leads to the question, how does a trader determine if an option is a good hedge for another option?

Traders have a quick rule of thumb called the "degree of the angle." If a trader creates a grid with strike prices on the vertical axis and expirations along the horizontal axis it's possible to locate any two options on that grid. Figure 6.5 shows such a grid with two options represented by dots. One option is the 30-day 90 strike put. The other is the 30-day 95 strike put.

FIGURE 6.5 The Width of the Angle Options

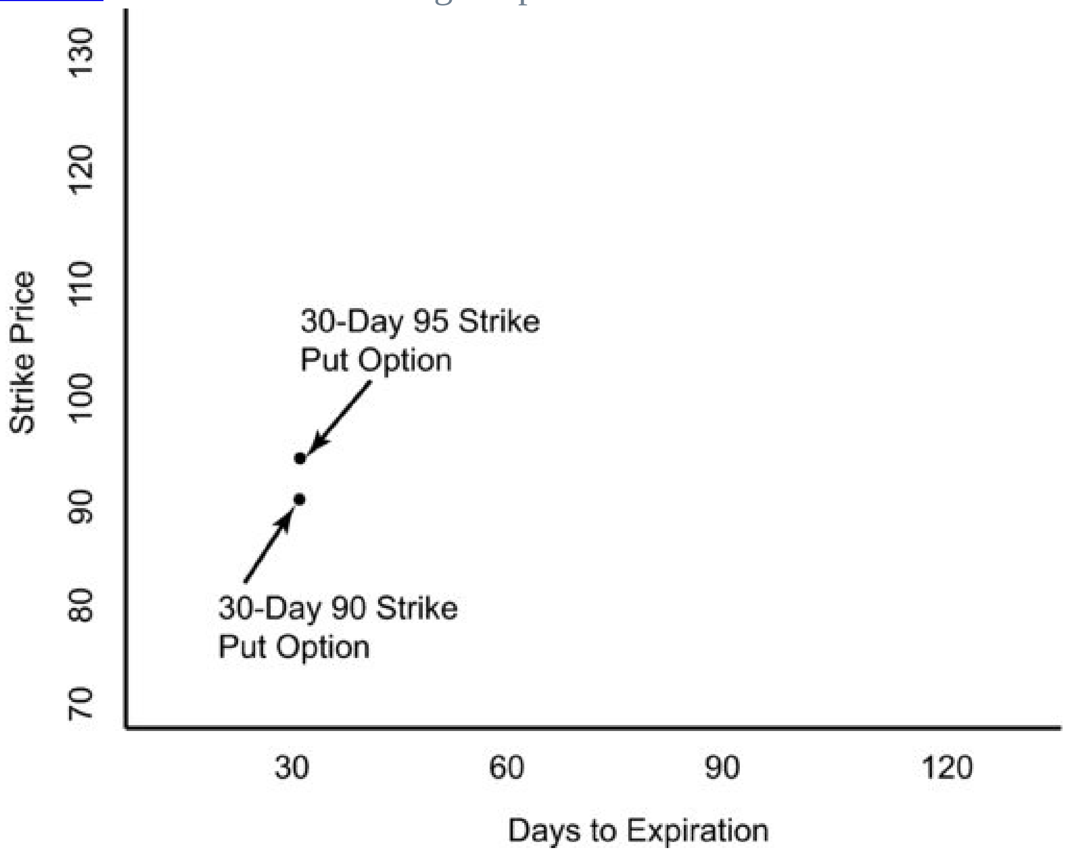


Figure 6.6 shows those two options connected to a point that represents the at-the-money strike price today. The degree of the angle connecting those two is pretty small. The two options are good volatility hedges for each other.

FIGURE 6.6 The Width of the Angle Is Narrow

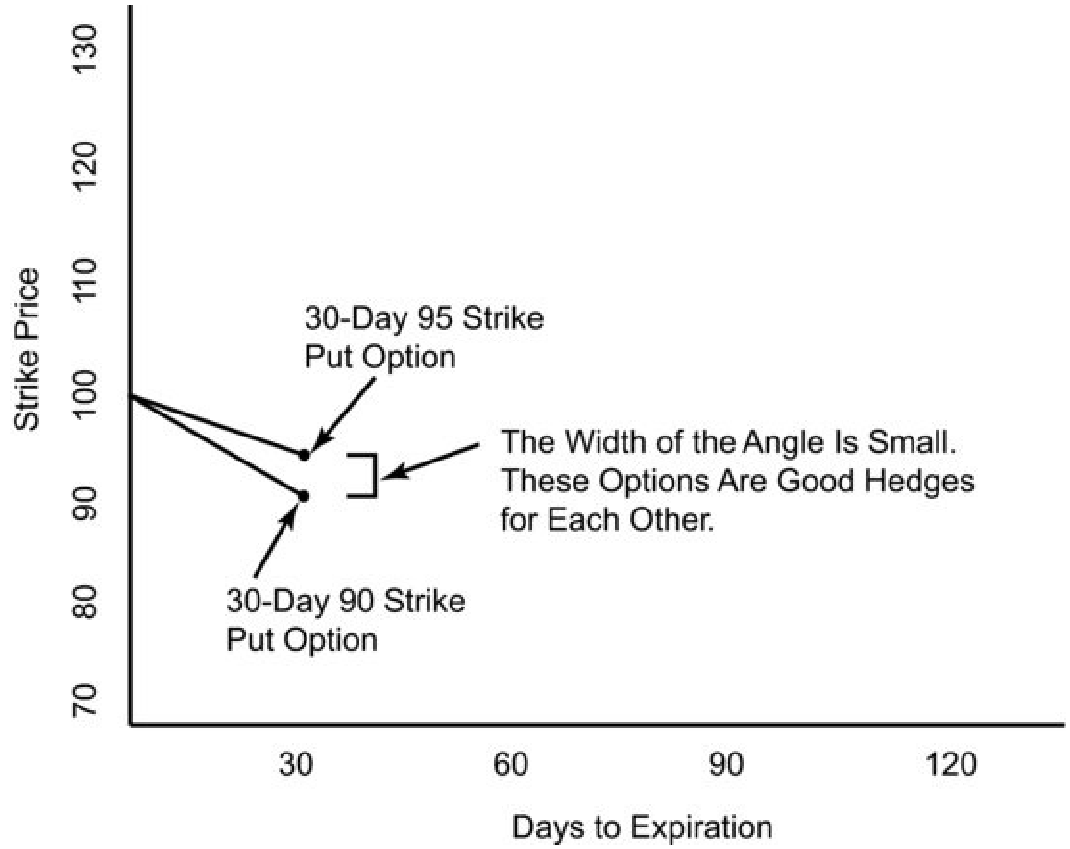
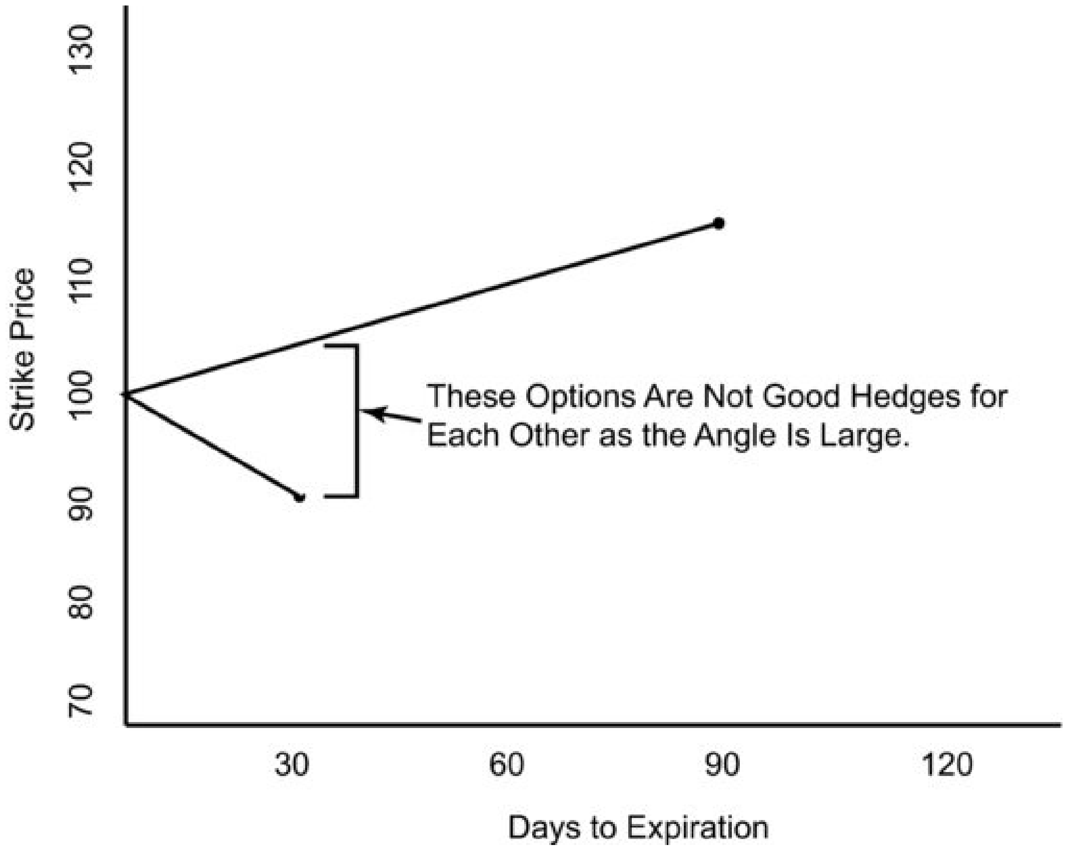


Figure 6.7 shows the same 30-day 90 strike put, but in this illustration the second option is a 90-day 115 strike call. The angle of the lines connecting the two options is much greater. These two options are not nearly as good hedges for each other.

FIGURE 6.7 The Width of the Angle Is Large



SKEW, THE *HOW MUCH*

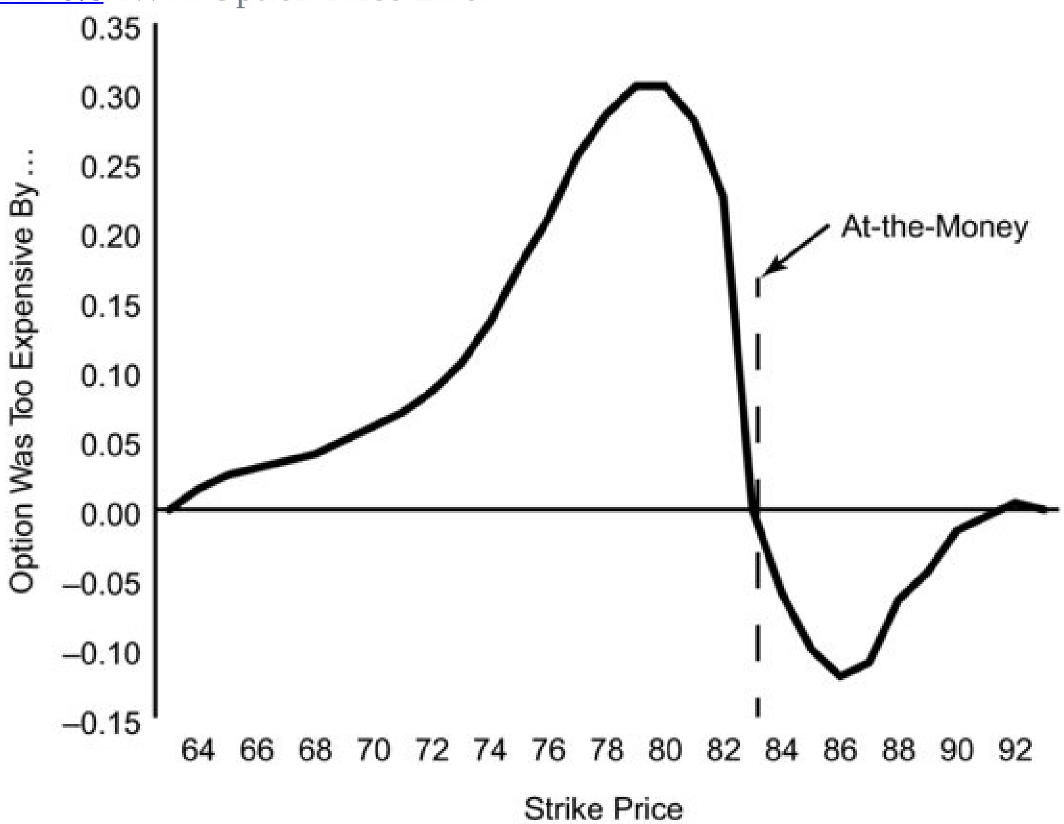
Those IWM out-of-the-money puts are more expensive than the at-the-money options in terms of implied volatility. How much more expensive are they, and how does that relate to price and dollars and cents?

What would the price have been if the implied volatility were the same as the at-the-money volatility? What's the difference between that theoretical price and the observed price? (See Table 6.2.) **Table 6.2** Option Prices without Skew

Strike Price	Observed Option Price	Option Price With Volatility Equal to the ATM Implied Volatility	Difference (Positive Number Means Observed Value Was "Too High")
69	0.05	0.00	0.05
71	0.07	0.00	0.07
73	0.12	0.01	0.11
75	0.21	0.03	0.18
77	0.39	0.13	0.26
79	0.69	0.38	0.31
81	1.18	0.90	0.28
83	1.47	1.47	0.00
85	0.64	0.74	−0.10
87	0.22	0.33	−0.11
89	0.09	0.13	−0.04
91	0.04	0.04	0.00
93	0.02	0.01	0.01

As we would expect, the observed prices for put options were too high—assuming consistent implied volatility—and the observed prices for call options were generally too low. The largest skew-induced error in terms of dollars and cents was at the 79 strike price. This put was trading at 0.69 in the market but would have only been worth 0.38 if it had the at-the-money volatility, a difference of $0.31. Figure 6.8 shows the price discrepancy for all strike prices.

FIGURE 6.8 IWM Option Price Error



Why didn’t the put option with the greatest skew, the 69 strike puts, with an implied volatility of 35.77, show the greatest discrepancy in money terms? Because the impact of volatility on option prices decreases as options move further out-of-the-money.

TAKEAWAYS

- Skew, to an option trader, is a little like gravity. We know it exists, we can use it to our advantage—we’ll learn how to do that in Part Three—but given that it flies in the face of the theoretical framework that option traders rely on, and that the reasons for its existence vary in importance, it’s a little mysterious.
- Skew is the option world’s “work-around” for the fact that the assumptions inherent in option pricing models collide with reality.
- Skew is also the result of the human element in option trading and risk management including the long-shot bias, the tendency for option users to overestimate the likelihood of an outsized move (e.g., downward in the equity index world, upward in gold and crude oil), and to underestimate the likelihood of a moderate move in the opposite direction. As traders, we can use those human inclinations to our advantage.
- Put skew in the equity index universe is also a function of a lack of willingness or an inability of market participants to be systematic sellers of put options.
- The direction (up or down) in which skew is greatest is generally the direction of the greatest and most damaging jumps or gaps.
- Options on nearly every asset will display skew, although the amount will ebb and flow.

CHAPTER 7

Time Value and Decay

Option expiration and the resulting regular decay in value set options apart from nearly every other financial vehicle. Options are a wasting asset and as such the time value, meaning the value of the luxury of waiting to make a decision, will go toward zero as expiration approaches. At expiration this time value becomes zero, you don't have the luxury of waiting any longer to make up your mind.

Every option is a contest between value, which is volatility in the underlying asset, and price, which is really just the accumulated time decay. That battle between erosion and volatility means that the two factors offset each other. If volatility helps your option position, even if it's movement in a particular direction, then the passage of time and the resulting decay generally hurt your position. For example, if you're long the at-the-money call option, then you want movement to the upside and you want a ton of it, the more the better. But if you're long that call option, then the passage of time is your enemy because the price of that option will erode. If you need time to fly then you want the market to sit. If you need the market to move then you want time to stand still.

Option traders have to be careful how they talk about time decay. The entire value of an option doesn't decay; it's only the time value of the option that erodes. The inherent value, that is the value by which the option is in-the-money, will never erode; if an option is worth $1.75 and is in-the-money by $1.00, then $0.75 of that option value is pure time value. It's that $0.75 that's going to erode.

Many option traders make the mistake of only thinking of option prices in terms of the total premium paid or received. They paid $3.00 for an option, so they think that is the cost. But option traders would do better by thinking of the daily decay in option prices as the real price of an option—it's the price the option owner pays for being long that option for that day, and it's the price the option seller expects to receive for bearing the risk in being short that option for that day. It is that day's rent paid or received for having or giving the luxury of waiting. Thinking of option prices in discrete days also helps traders remember that they are only long or short from the previous day's closing price, and that you always have the right to make a more informed trade.

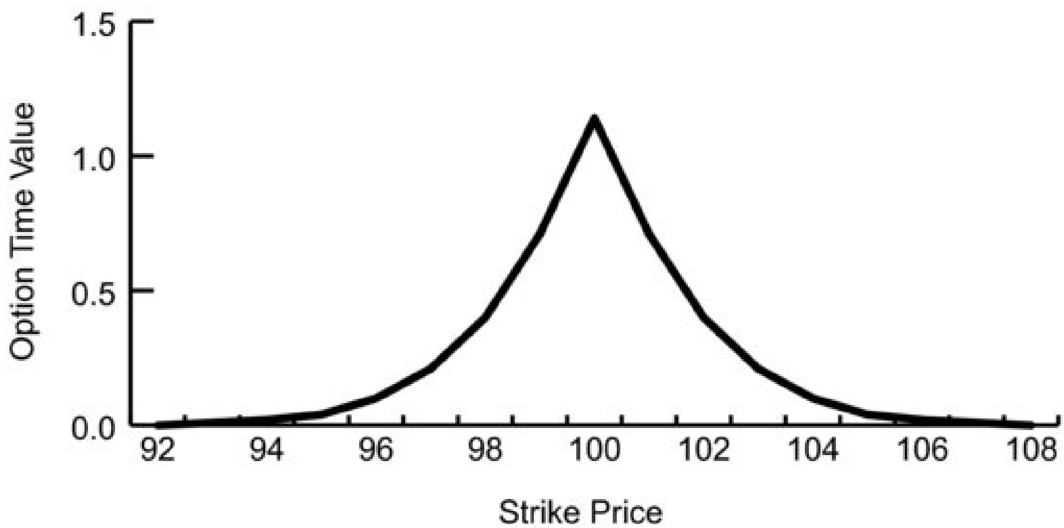
TIME VALUE BY STRIKE PRICE

As we saw in Chapter 1, time value is greatest for an option that is at-the-money, and time value trails off as we get further from at-the-money. How quickly does time value trail off? Let's look at some hypothetical 30-day options and keep all variables fixed with the exception of strike price. (See Table 7.1.) **Table 7.1** Time Value by Strike Price

Strike Price	Option Time Value
92	0.00
93	0.01
94	0.02
95	0.04
96	0.10
97	0.21
98	0.40
99	0.71
100	1.14
101	0.71
102	0.40
103	0.21
104	0.10
105	0.04
106	0.02
107	0.01
108	0.00

The graph in Figure 7.1 is very similar to the graph we saw in Figure 1.7.

FIGURE 7.1 Time Value by Strike Price



The curve is the time value by strike price for 30-day options. Time value is at its maximum of 1.14 for the at-the-money strike price. It falls as the strike prices become further from at-the-money until the time value becomes zero, or very nearly zero; the time value of an extremely out-of-the-money strike price is very close to zero. For our purposes it is zero because it's likely to be less than the minimum price at which the option can trade. Decay affects only the time value portion of an option price, and time value is greatest for at-the-money options. It follows that daily decay is greatest for at-the-money options and trails off as we move away from at-the-money just as total time value does. This makes sense because the time value for all options is going to zero. If the at-the-money option has furthest to go by expiration, then it has to go fastest in order to get there.

Two of these options, the 92 strike put and the 108 strike call, effectively have zero time value. What would the time value of those same options (i.e., options with the same strike price) be if they had ninety days to expiration? They would almost certainly have some time value. Zero time value to some time value would be quite an increase. Would an at-the-money option that's about to expire and which still has a little time value see the same sort of increase in time value if we extended the expiration to 90 days?

THETA—THE MEASURE OF DAILY OPTION TIME VALUE EROSION

We know that at-the-money options will erode faster than out-of-the-money options because they have further to go to get to zero but have the same amount of time as any other option with that expiration date. Other than that, we know when our option is going to expire, we know what we're paying/receiving for our option, so why care about other issues surrounding decay other than it being the day's measure of what the buyer expects to pay and what the seller expects to collect? I divide my option price by days to expiration and, bingo, I know what my option is going to cost/pay me today, right? Let's see, using the following numbers.

Underlying price: $80.00

Strike price of the call option: 80

Implied volatility: 50 percent

Time to expiration: 90 days

Theoretical value: $8.00

If we divided that $8.00 price by 90 days to expiration we get 0.089, so we might expect the daily erosion of that option to be 0.089.

We can calculate the expected price erosion by using an option pricing model like the one at OptionMath.com. The formula for this calculation can be found in the Appendix. Using this pricing model we learn that the model expects the daily erosion to be 0.045. Why is there such a difference? The "straight line" erosion is double that generated by the model. Which one is correct? Is there a way to take advantage of this discrepancy?

With, say, 90 days to expiration the erosion of time value for an at-the-money option is obviously finite. Even if we don't know precisely what the erosion should be, we know the option isn't going to be worthless, all else being equal, when we wake up the next day with 89 days left to expiration. Yet on the day of expiration the rate of decay is infinite; when we woke up on expiration morning the time value of the option was positive, maybe not by much but it was positive. At the moment of expiration the time value becomes zero. The rate of erosion, for example the erosion we'd expect each day, seems to increase, moving from finite to infinite on the day of expiration. This would be why the linear erosion assumption of 0.089 daily differs from the result of 0.045 generated by the model. It seems that erosion may speed up, buy why?

OPTION PRICE EROSION DOESN'T HAPPEN IN A STRAIGHT LINE

It seems that option price erosion may speed up, but it also seems logical that option prices may erode in a straight line as time passes. So which is it, and why?

Option price erosion doesn't happen in a straight line. Why? Because return is a function of time, and risk is a function of the square root of time. The result is that erosion for an at-the-money option increases exponentially.

Let's see how this works out with our previous example, but let's change the numbers slightly.

Underlying price: $80.00

Strike price of the call option: 80

Implied volatility: 50 percent

Time to expiration: 30 days

Theoretical value: $4.60

What if all the option specifics we used in the samples remain constant except for time to expiration, which decreases to 30 days? Our option pricing model tells us that call option is worth $4.60 (since it's at-the-money all of the price represents time value) and our option pricing model tells us the price of this call option will erode by $0.077 that day. The first proof that the model is correct and that erosion doesn't happen in a straight line is that the price of our 30-day option isn't one third of the price of our 90-day option.

What if we're really close to expiration? All the other option specifics remain constant but there's only five days to expiration? We'd expect that call option to be worth $1.87, and we expect the price to erode by $0.188 that day.

Because of the option math and the nature of risk, time value does not erode in a straight line. Erosion gets faster as time passes and eventually moves very fast becoming essentially infinite at the moment of option expiration, when time value goes from something to nothing. Putting our examples into an option pricing model confirms that erosion changes, it accelerates as time passes and expiration nears.

If we were to calculate the expected daily erosion for every day, all else being equal, we'd find that the expected erosion is actually exponential.

As we see in Table 7.2,the daily erosion is initially relatively small. The erosion each day is a little bit greater than it was the day before and it is a little bit less than it will be tomorrow. It increases exponentially until at the moment of expiration the erosion is infinite. The important point is that at-the-money options erode faster as expiration nears. Figure 7.2 shows what the typical time value erosion would look like for an at-the-money option.

Table 7.2 Expected Time Value Erosion by Expiration, At-the-Money Option

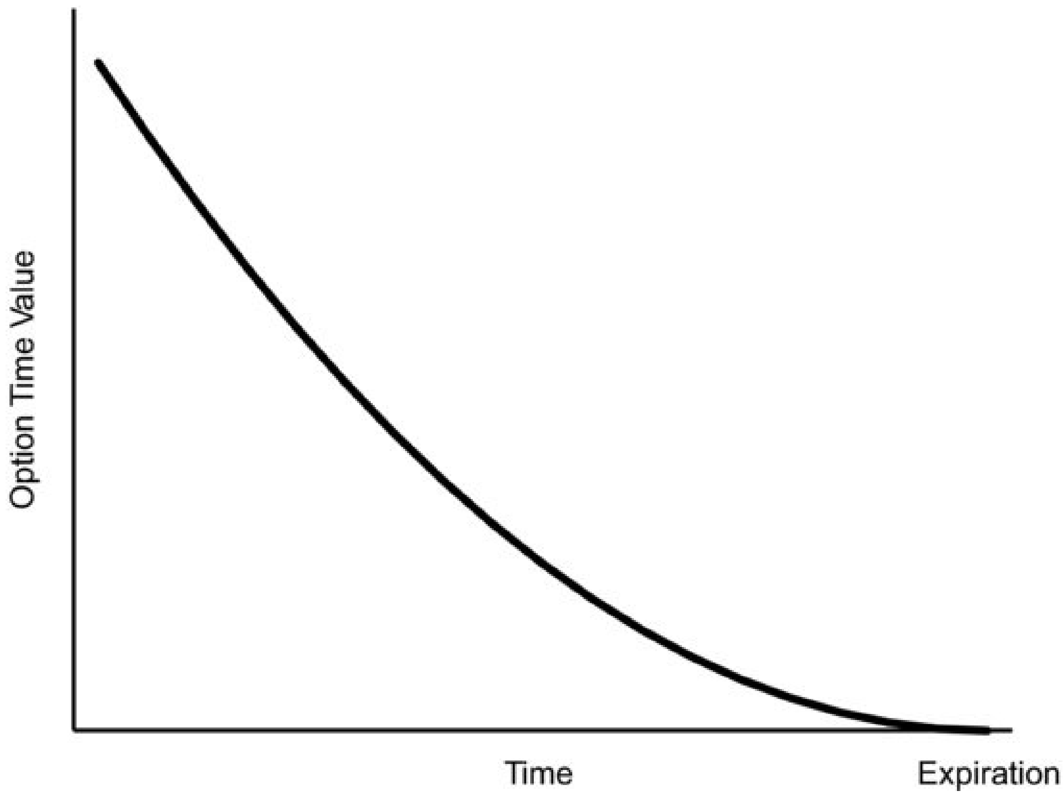
Days to Expiration	Theoretical Option Value	Expected Daily Price Erosion

90	8.00	0.045
60	6.52	0.055
30	4.60	0.077
20	3.75	0.094
10	2.65	0.133
5	1.87	0.188

FIGURE 7.2 Typical Erosion for an At-the-Money Option

Erosion doesn't happen in a straight line because of the relationship between the math of reward and the math of risk, but that doesn't mean erosion happens the same for all options. We see in Figure 7.2 the half-parabola shape for at-the-money options. Given that the relationship between time and risk is different for an out-of-the-money option, what would that erosion graph look like? Figure 7.3 is the typical graph of the time value erosion for an out-of-the-money option.

FIGURE 7.3 Option Price Erosion for an Out-of-the-Money Option



Most of the erosion of out-of-the-money options occurs earlier in their term. Eventually there’s no time value to erode away. The important point for the option trader is that far out-of-the-money options erode more slowly as expiration nears but they’re eroding from a very cheap price because the bulk of the time value has already come out of the option price.

For these exercises our use of the terms *at-the-money* and *out-of-the-money* are relative. If the underlying stock is at $99.95, then the 100 call is technically out-of-the-money but we’d expect it to act pretty much like an at-the-money option. In fact, most option traders would say the 100 call is the at-the-money call option in that situation.

Don’t think that these erosion relationships change drastically if the price of the underlying stock changes by a small amount. These relationships change gradually. But this difference in the timing and rates of erosion is a phenomenon we can exploit using calendar spreads, as we’ll see in Part Three.

OPTION PRICE EROSION, THE *WHAT*

Option price erosion is purely a function of the fact that options are wasting assets. The expected option price erosion (theta) is purely a function of the option math. Unlike some other important measures like option skew, which we discussed in Chapter 6, option price erosion isn't a function of the underlying asset. All options will erode and are expected to do so without regard to factors outside the option math. Now this doesn't mean that the actual option price changes we experience will equal what is expected, even from an option pricing model; in those cases there are other factors at work. Generally, implied volatility will have changed.

The starting points on Figure 7.2 and Figure 7.3, the prices of the option and the expected daily price change due to erosion, will change with changes in implied volatility, but the general shape of the curves won't change.

But this raises the question: How much does implied volatility impact the rate of option price erosion for an at-the-money option? How does that curve we saw in Figure 7.1 change with different levels of implied volatility? Let's assume all the other variables are unchanged and the option has 30 days to expiration.

The erosion as a percentage of option price decreases slightly as implied volatility increases as we see in Table 7.3, but the impact is minimal and is largely a function of compounding. Table 7.4 shows erosion for an out-of-the-money option.

Table 7.3 Expected Option Price Erosion by Implied Volatility, At-the-Money Option

Implied Volatility	Theoretical Option Value	Expected Daily Erosion (Theta)	Percentage of Option Value
5%	0.49	0.009	1.84%
10%	0.95	0.016	1.68%
20%	1.86	0.032	1.72%
50%	4.60	0.077	1.67%
100%	9.15	0.152	1.66%
200%	18.08	0.294	1.63%

Table 7.4 Expected Option Price Erosion by Implied Volatility, 10% Out-of-the-Money

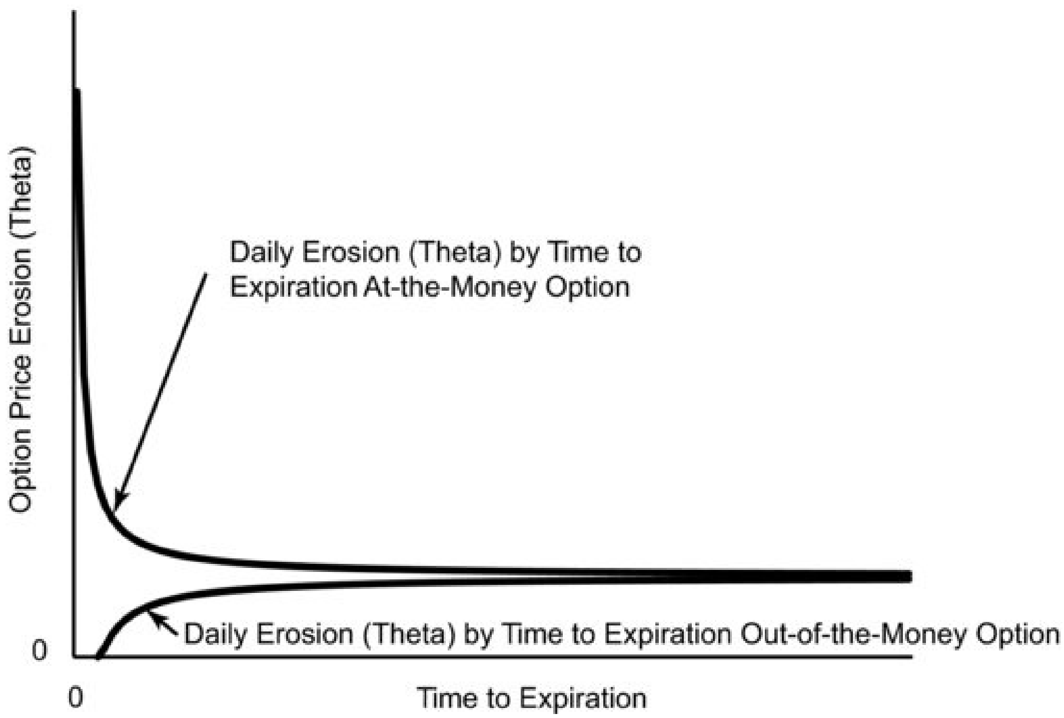
Implied Volatility	Theoretical Option Value	Expected Daily Price Erosion
5%	0.01	0.000
10%	0.06	0.002
20%	0.98	0.015
50%	6.21	0.054
100%	16.05	0.111
200%	35.20	0.204

It's not important for the retail option trader to be able to calculate this daily erosion, particularly for directional trades, but it's vital to understand that erosion isn't linear; for an at-the-money option or a just out-of-the-money option it speeds up as expiration nears. A 30-day option is going to erode more tomorrow in dollar terms than an otherwise identical 60-day option will. It's also vital to understand that there are trades and structures that take advantage of it and trades and structures that are really punished by it.

ANOTHER WAY OF LOOKING AT DAILY EROSION

It's easy to get wrapped up in the actual erosion of options because that's what we see on our screen or in our brokerage statement. The expected daily erosion is generally once removed from our experience. We have to calculate it and even if we actually see it, then it's only as the difference between what the option was worth yesterday and what it's worth today. Figure 7.4 shows in sharp relief how the theta of an at-the-money option and an out-of-the-money option will change with time to expiration.

FIGURE 7.4 Changes in Theta Over Time



The important lesson to be gleaned from Figure 7.4 is that erosion will increase exponentially for an at-the-money option eventually becoming infinite at the moment of expiration. For an option that is far enough out-of-the-money the phenomenon of erosion works differently near expiration. Nearly all of the time value will have already been wrung out of the option price leaving it very close to zero. This being the case, that there's little time value to erode away, theta will actually decline as expiration nears. In this situation there is little use in selling an out-of the-money option if it's so near expiration that erosion is slowing.

TAKEAWAYS

- Time value of an option is greatest when that option is at-the-money.
- The time value of the at-the-money option erodes more quickly as time passes until the erosion becomes infinite at the moment of expiration.
- The time value of an out-of-the-money option will erode more slowly as time passes when the option is close to expiration. This is due to the fact that most of the time value will have already disappeared for an out-of-the-money option.

CHAPTER 8

The Bid/Ask Spread

The bid/ask spread is how market makers make their money, and some of them have made a ton of it.

Everyone who's traded stock or options knows that the last traded price is just the beginning. When it's actually time to execute a trade you're faced with two prices, the *bid price* and the *ask price* (sometimes called the *offer* or *offer price*). The bid price is the price that the market is bidding for your stock or option. It is the price the market is willing to pay you for your stock or for options if you want to sell. If you wanted to sell a single share or option immediately, then you'd expect to receive the bid price.

The ask price is the price that the market is asking for in order to sell you stock or options. It is the price the market is willing to accept in exchange for selling your stock or option to you. If you wanted to buy a single share or option immediately, then the ask price is the price you'd expect to pay. Think of the bid price as the wholesale price, think of the ask price as the retail price.

WHAT DO WE MEAN BY "THE MARKET"?

When we refer to "the market" we really mean the combination of all the market participants. There might be market makers, high-frequency traders, hedge funds, and long-term investors who are willing to pay the bid price. The bid you see on your screen is generated by all those who have entered limit orders saying that they're willing to pay that bid price (but no more) in order to buy this stock or option. You could join this bid by placing a limit order to buy at that price. You may get your limit order filled, that is, you may buy the stock at that price, or you may not see your order filled. You'll get your limit order to buy filled only if someone is willing to sell to you at that price. It may be just a single order or a few orders willing to sell at that bid price, in which case the few buyers are selected by the exchange through an algorithm that may take into account when the buy order was entered, market-maker status (and hence market-maker responsibility to the market), size of the order, and other factors. It may turn out that the market in general decides that the stock or option is worth less than the bid price, in which case all of the bids at that price will be filled.

The bid may be composed of a single limit order for only a few shares, or it might be composed of many separate limit orders representing many thousands of shares. Sophisticated data feeds will tell you the total number of shares or options bid for at that price, as well as the number of separate orders bidding at that price.

The same is true for the ask price. A market maker may be willing to sell at the ask while a long-term investor may be willing to sell stock owned for decades at that same ask price. Again, you can join this offer by placing a limit order to sell at that price. Many different types of market participants are likely to have offers to sell the stock or option at that ask price.

It's not only possible but it's likely that the same trader or market maker is willing to both pay the bid price and sell at the ask price and simultaneously has orders entered to accomplish both. These true market makers are happy to buy at the bid price in the expectation that they might later sell at the ask price in order to close their position. They'd be nearly as willing (more on why they wouldn't be just as willing later) to first sell at the ask price in the expectation that they'll later pay the bid price to close their position. The difference is their hoped-for profit. That profit is likely to be small in absolute terms for each transaction but multiply by thousands or hundreds of thousands of such trades each day, and market makers can generate significant profit. The risk to market makers is that the market will move against them before they are able to close out their position, resulting in a loss.

True market makers provide liquidity by serving as willing buyers to sellers and by serving as willing sellers to buyers. The bid/ask spread is the compensation for this service. Market makers are an important element in any well-functioning market. Imagine you wanted to buy a particular, not very commonly traded, option. If there were no market makers willing and able to take the risk of selling that option to you (and in the process, put their own money at risk), you'd have to wait until someone else needed to sell that exact option. Even then there is no assurance that the difference between the price you're willing to pay and the price they're willing to accept wouldn't be insurmountable. And we haven't even addressed the fact that you might want to buy ten options and they might only have three options to sell.

Just because market makers are an important part of the landscape doesn't mean we have to donate to their livelihood. Smart traders will try to diminish the bite the bid/ask spread takes out of trading profits. Really smart traders will try to put the bid/ask spread to their advantage.

MARKET MAKERS

The term *market maker*, in both the equity and option worlds, actually refers to several different types of traders doing several different things.

Some market makers are lead market makers, meaning they have certain advantages but also have certain responsibilities. On the New York Stock Exchange they're called Designated Market Makers (DMMs), and they've replaced the old specialists. Like those old specialists, DMMs have the responsibility of maintaining a fair and orderly market in their stocks. On option exchanges like the International Securities Exchange (ISE), one of the biggest option exchanges in the world, the lead market makers are called Primary Market Makers (PMMs). PMMs continuously post bids and offers in all of the options for which they are designated and have responsibility for maintaining fair and orderly markets.

Other market makers have less responsibility and may simply use technology to stream bids and offers for most of the options on selected underlyings. For example, at the ISE, these are referred to as Competitive Market Makers (CMMs) or Electronic Access Members (EAM).

Generally these market makers will post a bid price, the price they're willing to pay, and an ask price, the price at which they're willing to sell, for each option on the underlying stocks they follow. Again, this is done with limit orders. Years ago this interaction was accomplished face to face. Options on each underlying stock were traded at a particular post on the exchange floor. The lead market maker or a broker would request a quote, meaning both a bid and an offer, from the "crowd" that traded the options at that post. The broker would request both a bid and an offer, even if he knew he had an order to sell these options, in an effort to force the assembled traders to provide prices that are as close as possible to fair value. The assembled traders would consult trading sheets that listed every option and its value for every potential underlying price. If the assembled traders all independently thought the option was worth approximately $3.10 (some might think it's worth $3.08, some might think it's worth $3.12, some might think it's worth something in between but all are going to believe that the option is worth about $3.10—if some of them thought it was worth significantly more or less than that then they'd end up trading among themselves until the price had reached equilibrium), then they might collectively bid $3.00 and offer it at $3.20. Now imagine that the broker comes into the pit and asks for only a bid for this option. He's tipped his hand that he's likely a seller. The assembled traders, knowing that the broker is likely to be a seller, might bid $2.75. They would not even have to offer the option for sale.

Today, this bidding and offering is done instantaneously and electronically. Today's market makers input general parameters into trading computers, which automatically transmit bids and offers for each option for a specific underlying stock. If the price of the stock moves, even if it moves by only a penny, the trading computer will recalculate its bids and offers for all the options on that stock, cancel those that are no longer valid, and post new bids and offers.

BID/ASK SPREAD, THE *WHAT*

Table 8.1 shows actual bids and offers for some options on SPY, the S&P ETF. There were 15 days to expiration and the SPY market was 132.56 bid, 132.57 ask, 132.57 last trade.

Table 8.1 SPY Option Bids and Offers

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
7.68	7.79	125	0.19	0.20
6.80	6.84	126	0.25	0.26
5.89	5.92	127	0.33	0.34
4.96	5.03	128	0.44	0.45
4.13	4.18	129	0.59	0.61
3.36	3.38	130	0.80	0.81
2.62	2.64	131	1.06	1.07
1.96	1.98	132	1.39	1.40
1.39	1.40	133	1.82	1.83
0.93	0.94	134	2.35	2.37
0.57	0.58	135	3.00	3.02
0.33	0.34	136	3.75	3.77
0.18	0.19	137	4.59	4.63
0.10	0.11	138	5.51	5.56
0.06	0.07	139	6.48	6.51
0.04	0.05	140	7.44	7.55

Just a cursory look at these numbers generates some interesting questions. Why is the spread between bid and ask so large for in-the-money options if it's so small for out-of-the-money options with the same strike price? The spread is only $0.01 for many of these out-of-the-money options. Since that's as small as it can get I'm agnostic as to which option I trade, at least in terms of the bid/ask spread, right? Other questions arise: What do these bids and offers say about the “fair value” of any particular option? Given these prices, what kind of order should I execute, and if I enter a limit order what should my limit price be? There are many others but we’ll begin with these.

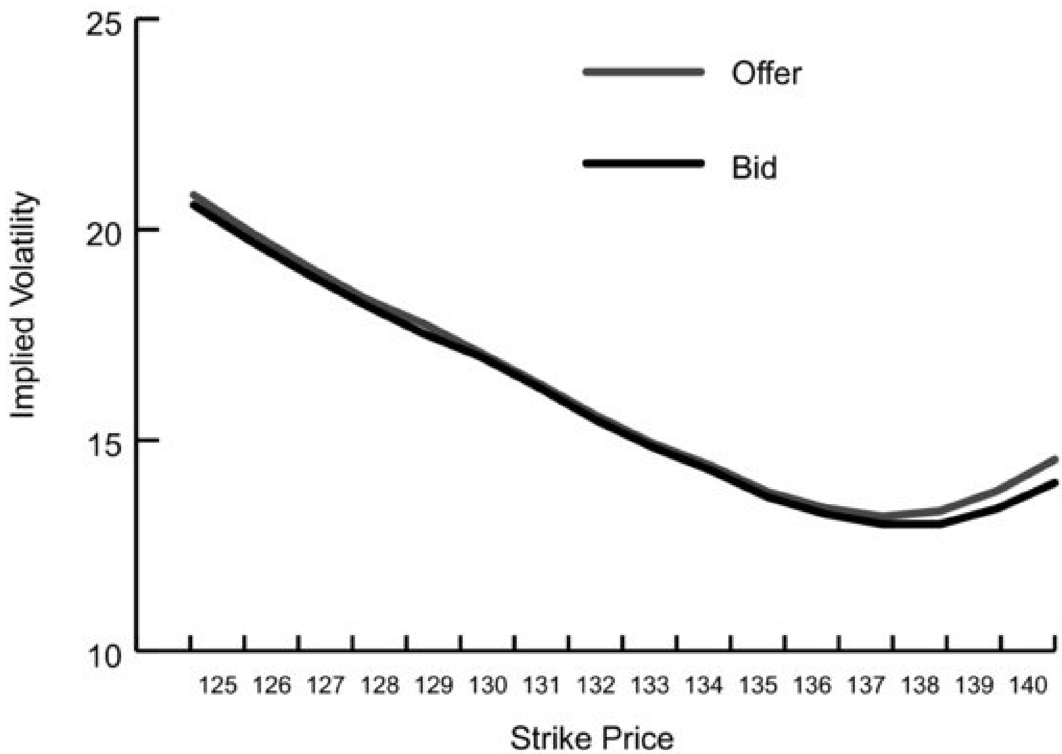
As we’ve discussed, the true cost of an option, the apples-to-apples comparison price, is implied volatility. If we took these prices and generated implied volatilities, what would we get? Table 8.2 shows the bids and offers from Table 8.1 translated into implied volatilities assuming that the SPY price was the last traded price, $132.57. Remember that implied volatility is a percentage and we’ve removed the “%” sign—just as we’ve removed the “$” sign from the option prices in Table 8.1 to make the table clearer.

Table 8.2 SPY Option Bids and Offers by Implied Volatility

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
18.20	21.28	125	20.58	20.82
19.26	20.15	126	19.72	19.93
18.75	19.26	127	18.93	19.11
17.49	18.50	128	18.20	18.35
17.16	17.77	129	17.53	17.77
16.85	17.07	130	16.98	17.07
16.15	16.35	131	16.26	16.35
15.48	15.68	132	15.48	15.59
14.83	14.92	133	14.83	14.92
14.29	14.40	134	14.20	14.40
13.65	13.77	135	13.65	13.90
13.25	13.39	136	13.10	13.39
13.01	13.19	137	12.58	13.44
13.01	13.32	138	12.46	13.87
13.38	13.80	139	13.01	14.17
13.99	14.54	140	11.49	17.22

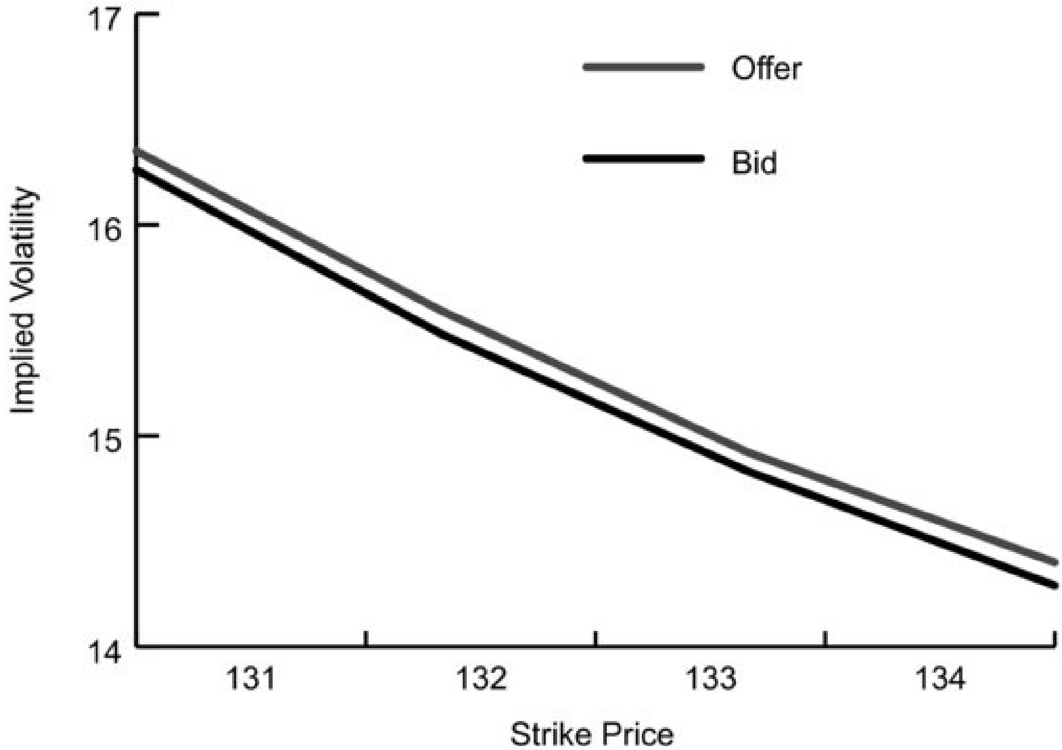
Things look a little different when viewed in terms of implied volatility. Among the call options the smallest bid/ask spread is at the 133 strike where the spread is only 0.09 volatility points (14.92 – 14.83). That is also the smallest spread as a percentage of the volatility. It’s less than 1 percent of the volatility at that strike (0.09/14.83). It’s no accident that the option with the smallest bid/ask spread in volatility terms is the first option from at-the-money (132.57) to have a $0.01-wide spread. From there the spread remains $0.01 wide in dollar terms but continues to increase in volatility terms. This increase is merely a function of the fact that the spread can’t get smaller in dollar terms, but as an option gets further out-of-the-money and decreases in price that $0.01 represents a bigger difference in implied volatility. Figure 8.1 shows a graph of the bid/ask spread of SPY in terms of volatility.

FIGURE 8.1 SPY Bid and Offer by Implied Volatility



Looking at Figure 8.1 it's easy to see that the true bid/ask spread, the spread between the bid implied volatility and the ask implied volatility, is relatively narrow for all strike prices. The absolute range in implied volatility across all strike prices makes viewing Figure 8.1 difficult for at-the-money strike prices. Figure 8.2 shows bids and offers by implied volatility for a smaller range of strike prices.

FIGURE 8.2 SPY Bid and Offer by Implied Volatility for a Smaller Range of Strike Prices



You've probably noticed that the spread for deep-in-the-money options is big in both dollar and volatility terms. The dollar spread for the 125 calls is $0.11 and the volatility spread is over 3.00 volatility points, even though the dollar spread for the 125 puts is only $0.01 and the volatility spread is only 0.24 volatility points. Why is that? First, there's very little trading of deep-in-the-money options like the 125 calls in this situation. That means that there's very little need for market makers to compete for trades. If they don't need to compete, they don't need to improve their markets by increasing their bid and/or reducing their offer.

DELTA'S IMPACT ON BID/ASK SPREADS

A more compelling issue for market makers bidding and offering those 125 strike calls is delta hedging. Option market makers seek to strip the directionality out of their trades and thereby turn them into volatility-based positions. They do this by delta hedging their options. They would do this in the case of these 125 strike calls by selling SPY shares if they were buyers of the calls and by buying SPY shares if they were sellers of the calls. They would hedge using SPY in an amount that would offset the directionality of the position. That amount is the delta of the option we discussed in Chapter 4.

The same option pricing model that generated these implied volatilities tells us that the delta of these 125 calls is 93. The 125 calls will move by 93 percent of the amount the SPY does. This means our market maker would have to execute 93 shares of SPY for each call option traded. Seen in this light it's obvious that the width of the bid/ask spread in the underlying becomes an issue for the option market maker. How big an issue is it?

Instead of calculating these implied volatilities using the last traded price for SPY, as we've done so far, what would we get if we calculated the implied volatility of the option's bid versus the bid of SPY? This would represent the effective implied volatility an option market maker would pay in buying the call on the bid and hedging by selling the underlying SPY on the bid. If we did that we'd find that the bid in implied volatility terms is actually 18.50. We might do the same thing using the call offer price and the SPY offer price. This would represent selling the call at the offer and paying the offer for SPY ($132.57) to delta hedge the option position and strip the short-term directionality out of the trade. But we don't need to do this separately. We calculated these original implied volatilities assuming that SPY was at $132.57 because that was the last traded price. Thus, those original implied volatilities represent the "offered" implied volatility. That bid/ask spread in implied volatility terms (18.50/21.28) is better, but it's still pretty wide. It'll stay wide because there's no incentive for the market to improve the spread, and that wide spread is necessary to compensate the market maker for the risk inherent in having to hedge by buying or selling a bunch of shares of SPY.

In an underlying with a very active, liquid option market like SPY, directional traders don't have to pay too much attention to the real bid/ask spread for options that are at-the-money or close to at-the-money because the money spread is only $0.01, as small as it can get, and the result is that the volatility spread is pretty small too. It's as small as it can get as long as $0.01 is the minimum price increment for the option.

WIDER BID/ASK SPREADS

What about options that don't have $0.01-wide bid/ask spreads? This might be the case because the underlying is much more expensive. In that case the options have to be much more expensive, meaning a small bid/ask in implied volatility terms will generate wider spreads in dollar terms. Let's do this comparison by looking at SPX options. SPX options trade at the Chicago Board Options Exchange (CBOE) exclusively and are options on the actual S&P 500 Index. Because they're options on the actual S&P 500 Index they're very similar but not identical to SPY options. The SPX option bids and offers shown in Table 8.3 were noted at exactly the same moment as the SPY bids and offers used above.

Table 8.3 SPX Option Bids and Offers

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
78.10	80.80	1245	1.25	1.95
69.20	71.30	1255	1.75	2.75
60.00	62.00	1265	2.40	3.30
51.00	53.00	1275	3.50	4.50
41.80	44.30	1285	4.70	5.70
34.30	36.00	1295	6.40	7.50
26.70	28.40	1305	8.80	10.30
20.00	21.50	1315	12.00	13.60
14.50	15.60	1325	16.50	17.80
9.40	10.60	1335	21.10	22.70
6.00	6.90	1345	27.30	29.10
3.30	4.10	1355	34.70	36.60
1.75	2.40	1365	43.00	45.20
1.00	1.45	1375	52.20	54.70
0.50	0.90	1385	61.80	63.80
0.35	0.60	1395	71.60	73.80

These options show much wider bid/ask spreads in dollar terms. This might make sense given the difference in cost of the underlying, but even the least expensive options like the 1395 calls and 1245 puts seem to have wide bid/ask spreads in dollar terms. What do they look like in implied volatility terms? (See Table 8.4.)

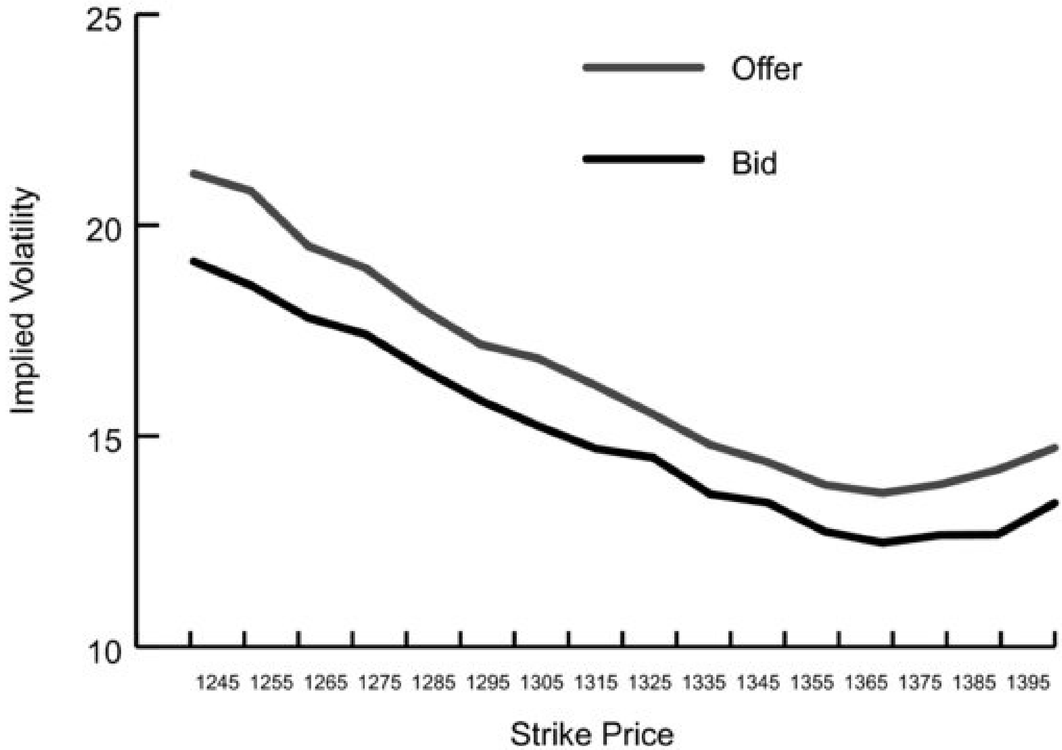
Table 8.4 SPX Option Bids and Offers by Implied Volatility

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
13.93	23.40	1245	19.14	21.22
17.24	22.13	1255	18.57	20.81
17.13	20.90	1265	17.80	19.50
16.71	19.83	1275	17.41	18.98
15.44	18.83	1285	16.58	17.99
15.84	17.85	1295	15.84	17.17
15.24	17.03	1305	15.24	16.84
14.79	16.20	1315	14.70	16.20
14.49	15.52	1325	14.39	15.61
13.62	14.79	1335	13.23	14.79
13.42	14.38	1345	12.47	14.49
12.73	13.84	1355	11.75	14.39
12.47	13.65	1365	10.52	14.83
12.65	13.85	1375	8.53	16.21
12.66	14.20	1385	8.77	16.39
13.41	14.72	1395	8.71	18.26

Wow, even in implied volatility terms these bid/ask spreads are really wide. The at-the-money call was the 1325 strike, and the spread between the bid and ask was 1.03 volatility points (15.52 – 14.49). Some of the deep-in-the-money bids are going to appear odd because SPX options are European-style meaning they can only be executed at expiration, but for the at-the-money call that shouldn't have much impact on the width of the bid/ask spread.

What would a chart of the bid implied volatility and ask implied volatility for these calls look like? This is shown in Figure 8.3.

FIGURE 8.3 SPX Bid and Offer by Implied Volatility

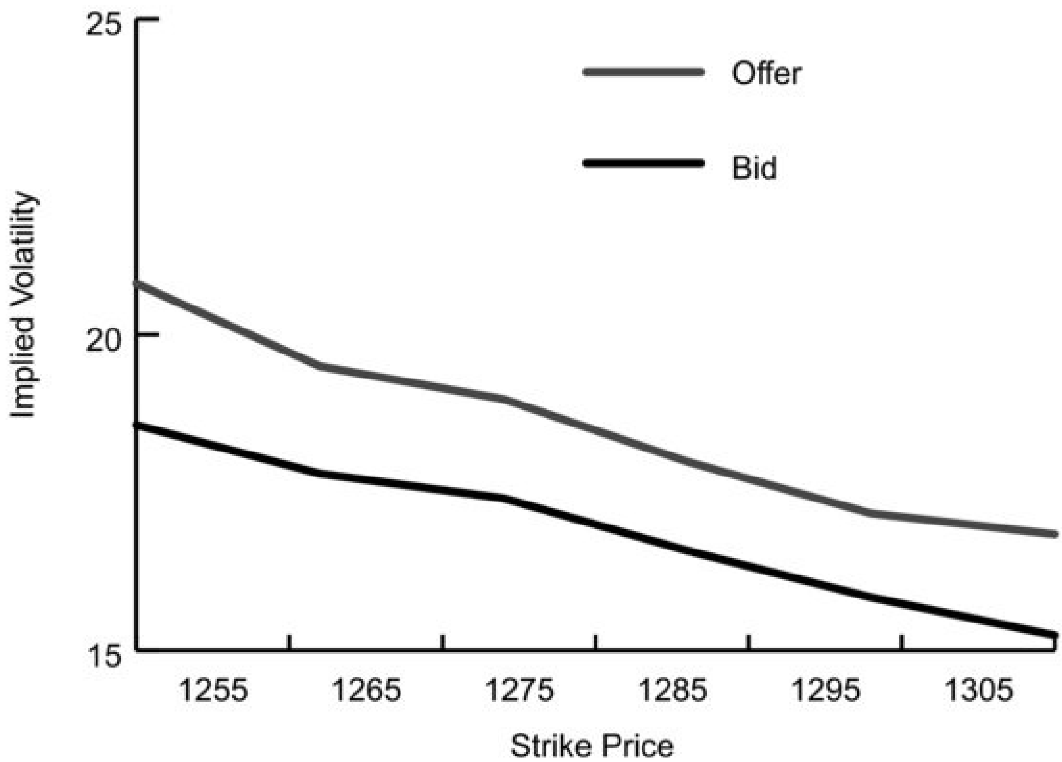


Comparing Figure 8.3 to Figure 8.1 shows a stark difference in the real bid/ask spread between SPY options and SPX options.

Let's also look at a range of strike prices similar to the smaller range we looked at in Figure 8.2.

Comparing Figure 8.4 to Figure 8.2 also shows a startling difference in the real bid/ask spread between SPY options and SPX options.

FIGURE 8.4 SPX Bid and Offer by Implied Volatility for a Smaller Range of Strike Prices



THE BID/ASK SPREAD WHEN THERE'S MORE COMPETITION

These bid/ask spreads on a real basis, as measured by implied volatility, are huge, almost obscenely so. Why? Because SPX options are only listed on one exchange, the CBOE, so market makers in SPX options have no outside competition. They have much less reason to improve their markets by raising their bids and/or lowering their offers. This is likely to be the case for any option that is listed on only one exchange or that is thinly traded. In contrast, Russell 2000 options trade in much lower volume than SPX options, but the market for Russell 2000 options tends to be tighter in implied volatility terms because they're listed on several exchanges and the universe of market makers has to compete for orders. It's also likely that the actual bids and offers for SPX options are tighter than the electronic indication that we see. SPX options are still largely executed by traders standing face to face in a pit rather than electronically on a screen. If we were to call to the CBOE floor and ask for a quote it might very well be tighter than what we see on our screen. Or it might not.

The preliminary takeaway is that the real bid/ask spread, the spread in terms of implied volatility, is a function of many things, but one of those things is whether the options are multi-listed and how much competition there is between market makers. Since 2000, almost all equity options are multi-listed. Most ETF options (e.g. SPY) are multi-listed. Combine multi-listing with the huge interest in SPY options and you end up with very efficient option markets. There's so much volume in SPY options that a market maker can make less per trade and make up for it with the greater volume. Since the SPX market makers have the market to themselves, they have no incentive to cut each other's markets.

EQUITY OPTIONS

What if we do the same sort of option analysis for an equity, that is, for a single stock, rather than for an index or ETF? Do we find that the real bid/ask spread makes for relatively easy trading like SPY options or do we have to continue to really pay attention to our execution? Let's look at options on Google (GOOG) in Table 8.5.

Table 8.5 Google Option Bids and Offers

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
69.20	70.00	515	0.30	0.45
59.40	59.90	525	0.40	0.50
49.50	50.10	535	0.60	0.70
39.90	40.40	545	0.90	1.00
30.50	31.00	555	1.55	1.70
21.80	22.30	565	2.80	3.00
14.30	14.70	575	5.20	5.40
8.40	8.70	585	9.20	9.40
4.30	4.60	595	15.10	15.40
2.15	2.25	605	22.80	23.20
0.95	1.10	615	31.60	32.00
0.50	0.55	625	41.10	41.70
0.30	0.35	635	50.90	51.70

The widths of these bid/ask spreads seem moderately wide. They're not huge like some SPX options, but they're not $0.01 wide either.

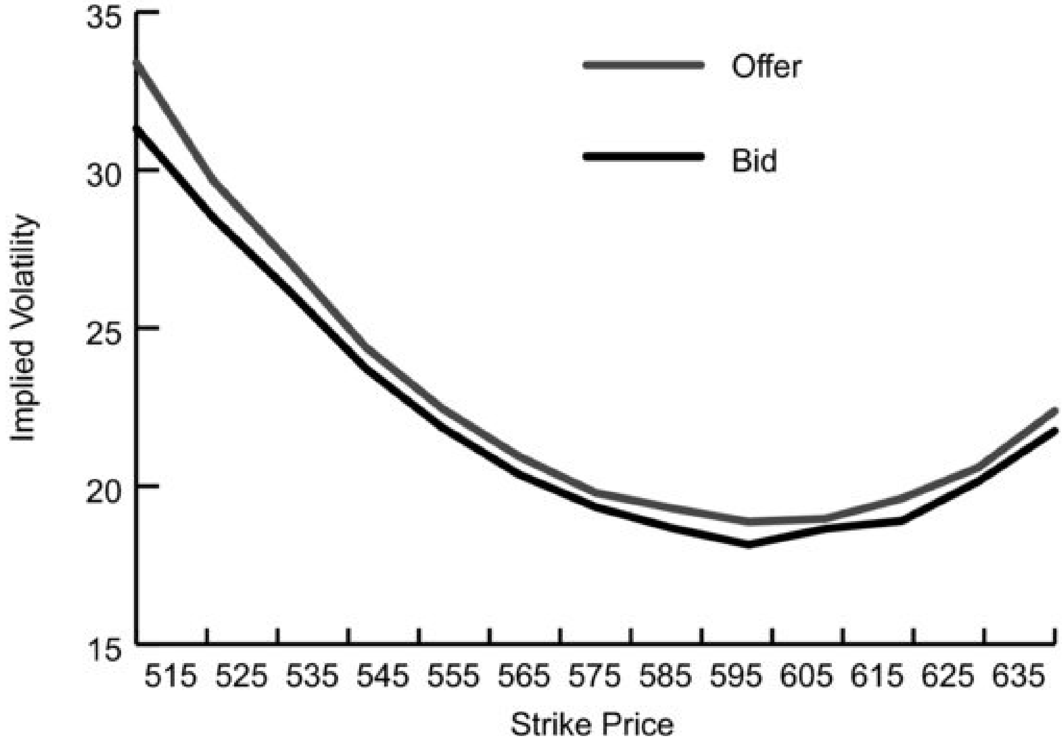
By now we know that the real bid/ask spread is the one we get when we calculate implied volatilities. What are the implied volatilities of these prices for GOOG options? (See Table 8.6.)

Table 8.6 Google Option Bids and Offers by Implied Volatility

Call Bid	Call Offer	Strike Price	Put Bid	Put Offer
25.70	37.78	515	31.31	33.39
26.71	32.26	525	28.51	29.68
23.96	28.95	535	26.17	27.10
22.83	25.78	545	23.72	24.39
21.14	23.12	555	21.85	22.45
19.95	21.41	565	20.37	20.94
19.27	20.18	575	19.34	19.79
18.67	19.30	585	18.52	18.94
18.15	18.87	595	17.99	18.70
18.65	18.97	605	17.97	19.22
18.90	19.61	615	17.74	19.76
20.15	20.59	625	17.46	22.44
21.75	22.38	635	14.41	26.42

The real bid/ask spread, the one measured by implied volatility, is still pretty wide for Google options. The difference between the implied volatility for the 585 calls is 0.63 volatility points (19.30 – 18.67). The chart of these bids and offers by implied volatility can be seen in Figure 8.5.

FIGURE 8.5 Google Bids and Offers by Implied Volatility



Google options are multi-listed, that is they're listed on several exchanges, so why aren't the real bids and offers tighter?

Multi-listing has almost certainly improved (i.e., narrowed) the width of the real bid/ask spread in GOOG options, so let's look at the underlying stock. At the time these quotes were noted, the bid for GOOG stock was $584.04, and the ask for GOOG stock was $584.21. That bid/ask spread for Google shares is pretty wide all by itself. It's much wider, even in percentage terms, than the $0.01-wide market we saw in SPY shares. If we compare that 585 call bid price of $8.40 to the stock bid price of $584.04 (remember that a market maker who buys calls is going to sell stock as a hedge), rather than the midpoint of the stock's bid and ask as we did to calculate the implied volatilities we see in Table 8.6, we find that the implied volatility is 18.76. If we compare the call ask price of $8.70 to the stock ask price of $584.21 we find that the implied volatility was 19.23. In those terms the bid/ask for that call option is 18.76 bid versus 19.23 offered. The spread is only 0.47 in implied volatility terms. Consider the additional factor that only 200 shares of GOOG were bid for at $584.04, and that only 100 shares were offered for sale at $584.21. If, as hedgers, we have to execute 1,000 shares of GOOG, there's also going to be slippage. If we're buyers of the call we're sellers of stock. We get to sell 200 shares at $584.04, unless someone beats us to them, and we're going to have to sell 800 shares below $584.04, exactly where we don't know, effectively increasing the implied volatility we've paid even further.

If we traders are sellers of the calls then we're going to have to buy Google stock. We get to buy 100 shares at $584.21 but we're going to have to pay more than $584.21 for the other 900 shares. We don't know precisely what we'll have to pay but it will effectively decrease the implied volatility of the option we've sold. All in all, the real market for GOOG options is pretty fair but we should probably still use limit orders to execute our trades someplace between these bids and offers for reasons we shall see.

THE BID/ASK FOR OPTION SPREADS

In a market with very small bid/ask spreads it's easy to overlook the impact if you're just buying or selling options outright. Giving up a half cent from fair value to pay the ask price on a SPY call isn't likely to impact the outcome of our trade. The volatility-based spread may seem high, but the actual money at stake, literally $0.01, isn't. But what about those trades that have several legs, such as butterflies? Now our trade has four different elements, and if we give up the width of the bid/ask spread four times (once for each wing and twice for the body since we do twice as many of those options) then it's possible that we're getting into territory where it's tough to make money even if we're right about volatility and direction. In options with wide bid/ask spreads it's actually possible to get into a situation where it's impossible to make money.

How do we calculate the bid and the offer for a spread from the markets in the constituent options? Let's look at the SPY options again and look at a simple spread that's buying one call option and selling another call option. If we wanted to buy the 135 call and sell the 136 call then what would the market, the bid and the offer, for that spread be?

The market is willing to sell the 135 call to us for \$0.58. It's simultaneously willing to buy the 136 call from us for \$0.33. If we did both of those trades, bought the 135 call and sold the 136 call, we'd be long the 135/136 call spread and we would have paid \$0.25 (\$0.58 − \$0.33) for the spread.

If we wanted to sell that same call spread we would have been able to sell the 135 call at \$0.57. We would have been able to buy the 136 call at \$0.34. If we did both of those trades we'd be short the 135/136 call spread and we would have received \$0.23 (\$0.57 − \$0.34) for the spread.

From this it's easy to see that the market is willing to pay \$0.23 for that spread—that's the bid for the spread. The market is willing to accept \$0.25 for the spread—that's the offer for the spread. The market for this spread is 0.23 bid/0.25 ask *on legs.*

Why is this spread, which would require very little hedging from the market maker, wider in terms of bid/ask spread than a much riskier outright option? Both of the constituent options have a bid/ask spread that's only \$0.01 wide. If we assume that fair value of these SPY options is the midpoint of the bid and the ask, then we have a fair value of \$0.575 for the 135 call and of \$0.335 for the 136 call. Using those values, what's the fair value of our spread? It turns out that it's \$0.24. Market makers will go hungry if they buy and sell at fair value all day. The highest bid that provides some profit is \$0.23; the lowest offer that provides some profit is \$0.25. It's no accident that those are the same bid and offer we got when we calculated the market by looking at the individual legs.

Market makers in very liquid options like options on SPY will calculate their idea of an option's fair value to at least one decimal place. If a market maker thinks the 135 call is worth \$0.5725 then he might well be willing to bid \$0.57 and offer \$0.58 simultaneously. What does this mean for our call spread? If the same market maker thinks the 136 call is actually worth 0.3375 then on legs he thinks the 135/136 call spread is worth \$0.2350 (\$0.5725 − \$0.3375). In this case he might very well bid \$0.23 for this spread and offer it at \$0.24.

Google on the other hand has very wide markets. If we wanted to buy the 585/595 call spread in Google then we see that the market is willing to sell us the 585 call for \$8.70 and willing to pay \$4.30 for the 595 call. If we executed those trades we would have paid $4.40 ($8.70 − $4.30) for the spread.

What if we wanted to sell that same 585/595 call spread? The market is willing to pay us $8.40 for the 585 call and is willing to sell us the 595 call for 4.60. In this case we would have sold the spread for $3.80.

This market for the Google 585/595 call spread, 3.80 bid/4.40 ask, is the market for this spread on legs. This may very well be different from the bid/ask quoted if we asked for a market for the spread as a package, that is, as a single trade. The value of this spread is probably close to the difference in the midpoint for both options. If we do that math we find that the 585 call is probably worth close to $8.55. The 595 call is probably worth close to $4.45. Using those prices the spread is probably worth close to $4.10. There's very little hedging a market maker would have to do if we executed our trade as a spread, that is, sold them one leg and simultaneously bought the other leg. The delta of the one leg would largely offset the delta of the other leg. The market maker on the opposite side of our spread would only have to hedge the difference. An option pricing model tells us the delta of the 585 call is 42. It also tells us the delta of the 595 call is 31. The delta of the 585/595 call spread is 11 (42 − 31). If a market maker bought one of these spreads he'd have to sell just 11 shares of GOOG.

If traders or market makers in GOOG options were lazy or obstinate or thought we were foolish enough to just sell this spread at $3.80 (the bid on legs) or buy it at 4.40 (the offer on legs) then they might not budge on their market of 3.80 bid/4.40 ask for the spread as a package. In that case it makes sense to "get in the middle." If we want to buy this spread we could enter a limit order to pay $4.10 for the spread. This might prompt someone to offer the spread for sale at $4.20 (after all, it's only worth the $4.10 we're bidding). We've gotten them to improve their offer, which we can now buy.

If we wanted to sell the spread we could enter a limit order to sell at $4.10. This might prompt someone to bid to buy the spread at $4.00, a bid we could now sell.

This means we'd expect to pay/receive a price very close to the actual value of the spread. If we called our broker and asked for the market for the 585/595 call spread we'd probably get a quote around that $4.10 value. In this case the market for the spread was quoted at $4.00 bid, $4.20 offered.

THE BID/ASK OF MULTI-LEGGED SPREADS

Imagine we believe that Google is going to move sideways or down between now and expiration of these options. We decide we want to sell a call butterfly in Google to collect some premium and to profit if our outlook is correct. If we decide to sell the 585/590/595 butterfly we're going to sell one of each of the 585 calls and the 595 calls and we're going to buy two of the 590 calls. Our maximum potential profit is the net premium we receive and our maximum potential loss is $5 (the distance between any two strike prices) less the premium we receive.

If we execute all of these options at the market, that is, we sell at the bid price and buy at the ask price, then how do we make out? Let's use the prices we used previously and see. We'd sell one of the 585 calls at $8.40 and we'd sell one of the 595 calls at $4.30. We'd take in a total of $12.70. We'd also buy two of the 590 calls at $6.40 each for a total of $12.80. We've spent $12.80 and we've taken in $12.70 so we're actually selling the butterfly for a net debit of $0.10. And that's our maximum profit! The very best we can hope for is a $0.10 loss. That means our maximum potential loss is $5.10. Because of the width of the bid/ask spread we've put on a trade that can never make a profit.

When trying to trade multi-leg spreads in names with wide bid/ask spreads your execution is absolutely vital to profitability. Brokers will take your order as a spread, meaning they'll execute the trade as a butterfly rather than as a series of individual orders. Even then, using a limit order is critical.

What's the fair value for our Google butterfly? If we could do all the legs at the midpoint of each respective bid/ask spread then we'd sell the 585 call at $8.55 and the 595 call at $4.45. That's a total of $13.00 we would collect. We'd pay $6.25 for each of the two 590 calls to complete the butterfly, or a total of $12.50. This time we've received a net credit of $0.50 for selling our butterfly. That's more like it.

WHAT'S THE REAL FAIR VALUE OF AN OPTION BASED ON THE BID/ASK?

It's natural to look at a bid/ask spread and think that the real fair value for that option, as determined by the market, is the midpoint. That's likely to be really close in certain options including those with narrow bid/ask spreads and those that are really liquid. However, this assumes that the next initiator of a trade is equally likely to be a seller as a buyer, meaning that our market maker feels that when selling an option the odds of buying it back soon are pretty good. If that's so, then the bid/ask should be symmetrical around the fair value.

For options that are illiquid, the asymmetries of both pay off and information come into play. Market makers may feel that if they sell an illiquid option there's no way of knowing if the next order is going to be a sell or a buy. They may feel that they're at an information disadvantage and that they need to protect themselves from a catastrophic loss by leaning their bid and ask so that they're a little more likely to be buyers than sellers. Thus, in the case of illiquid options, market makers will lean their bids and offers such that their bid is closer to their opinion of fair value, and their offer is further away. Since the potential damage from being wrong when selling an option is greater than the potential damage from being wrong when buying an option, and since it can be much more difficult to buy back options in a very thinly traded name and that this problem can become much more severe in the midst of turmoil, our market makers will lean a little toward being on the buying side. This will change if our market makers feel more confident or if they've accumulated a large position and need to lean their bids and offers differently in order to facilitate closing out this position.

TAKEAWAYS

- The real measure of the bid and of the ask, and of the spread between the two, is in terms of implied volatility.
- The bid/ask spread for in-the-money options is wide because of the number of shares of the underlying that a market maker would have to execute as a hedge along with the lack of need to improve that market.
- Even though a bid/ask spread in dollar terms is as small as it can get, we're not agnostic as to which options we trade if we're concerned about the real bid/ask spread.
- What do the bid and ask tell us about the "fair value" of an option? For very liquid options it's probably reasonable to assume that the fair value of an option is very close to the midpoint of the bid and ask. For illiquid options it's likely that the fair value of an option is much closer to the bid price than the ask price.
- What sort of order should I enter? It generally makes sense to enter limit orders. One exception is a straight buy or sell order for an option that has a $0.01 spread between the bid and ask. The extra cent that can be made by joining the bid price and ultimately paying it, or joining the offer price and ultimately receiving it, is going to have a meaningless impact on the outcome of our trade. If our trade works and is profitable, it will be so because we had the right ideas as to direction, magnitude,

and speed, not because of our execution.

- The same might be said for a simple spread order in very liquid options. If we're executing a vertical spread in SPY, and each constituent option has a bid/ask spread that's $0.01 wide, then the effective width of the bid/ask spread for the vertical is only $0.02 wide. That $0.02 is a bigger percentage given that our vertical has a smaller potential profit, but $0.02 is still just about as small as we can hope for.
- It's a very different story for options that have wide bid/ask spreads. Limit orders are critical for an execution that leaves us a fighting chance to have a profitable trade.

CHAPTER 9

Volatility Slope

There is a long history in the equity markets of implied volatility increasing as the markets fall and, to a lesser degree, of implied volatility falling as the markets climb.

As bad news begins to be reflected in stock prices, the future volatility of those stock prices tends to increase because stock prices and stock market volatility are negatively correlated—they tend to go in opposite directions. We first discussed the need for investors to be compensated for additional volatility (which is really risk) in Part One. Conversely, when good news begins to be reflected in stock prices the future volatility of those stock prices tends to decrease. Unfortunately, future volatility doesn't decrease as fast, or by as much as, it increases. This mismatch is often referred to as volatility asymmetry—volatility, both realized and implied, moves in the opposite direction of the underlying market, and it goes up a lot faster than it goes down.

THE CORRELATION BETWEEN MARKET PRICES AND IMPLIED VOLATILITY

This negative correlation is most evident in index options and less so (sometimes much less so) in options on individual equities, but how big can this negative correlation between market direction and volatility be over time? A little blip in the price of the S&P 500 shouldn't have much of an effect on implied volatility, should it? We'll focus on implied volatility because it's the real cost of the options we want to trade, and because changes in implied volatility tend to be followed by changes in realized volatility.

A little blip in prices of the S&P 500 can indeed have an astonishingly large impact on implied volatility on the S&P 500. From day to day the relationship is obvious, and it's clear over even shorter timeframes as well.

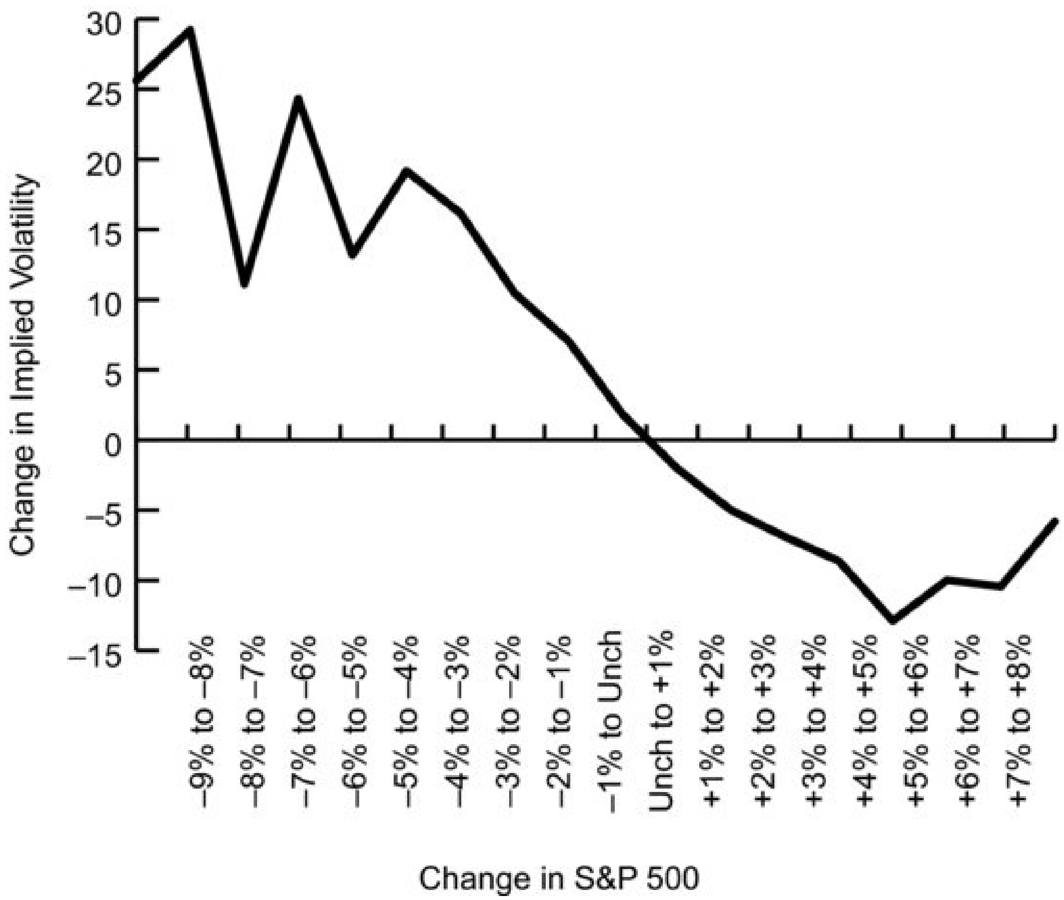
Let's look at Table 9.1 and see how the Volatility Index (VIX), the Chicago Board Options Exchange (CBOE) measure of S&P 500 implied volatility, changes based on that day's change in the price of the S&P 500. We can break the daily changes in the S&P down into several "buckets," each 1 percent wide. We can then determine the days that showed that change in the S&P and note the change in the VIX for those days. The result is the average daily change in the VIX for each bucket of outcomes for the S&P.

Table 9.1 Changes in VIX by Changes in S&P 500

Day's Change in S&P 500 Price Fell in the Range of:	Average Daily Change in VIX for Those Days
−10% to −9%	+25.61%
−9% to −8%	+29.21%
−8% to −7%	+11.11%
−7% to −6%	+24.32%
−6% to −5%	+13.18%
−5% to −4%	+19.17%
−4% to −3%	+16.16%
−3% to −2%	+10.47%
−2% to −1%	+7.05%
−1% to Unchanged	+1.83%
Unchanged to +1%	−1.99%
+1% to +2%	−4.98%
+2% to +3%	−6.88%
+3% to +4%	−8.62%
+4% to +5%	−12.89%
+5% to +6%	−9.99%
+6% to +7%	−10.44%
+7% to +8%	−5.80%

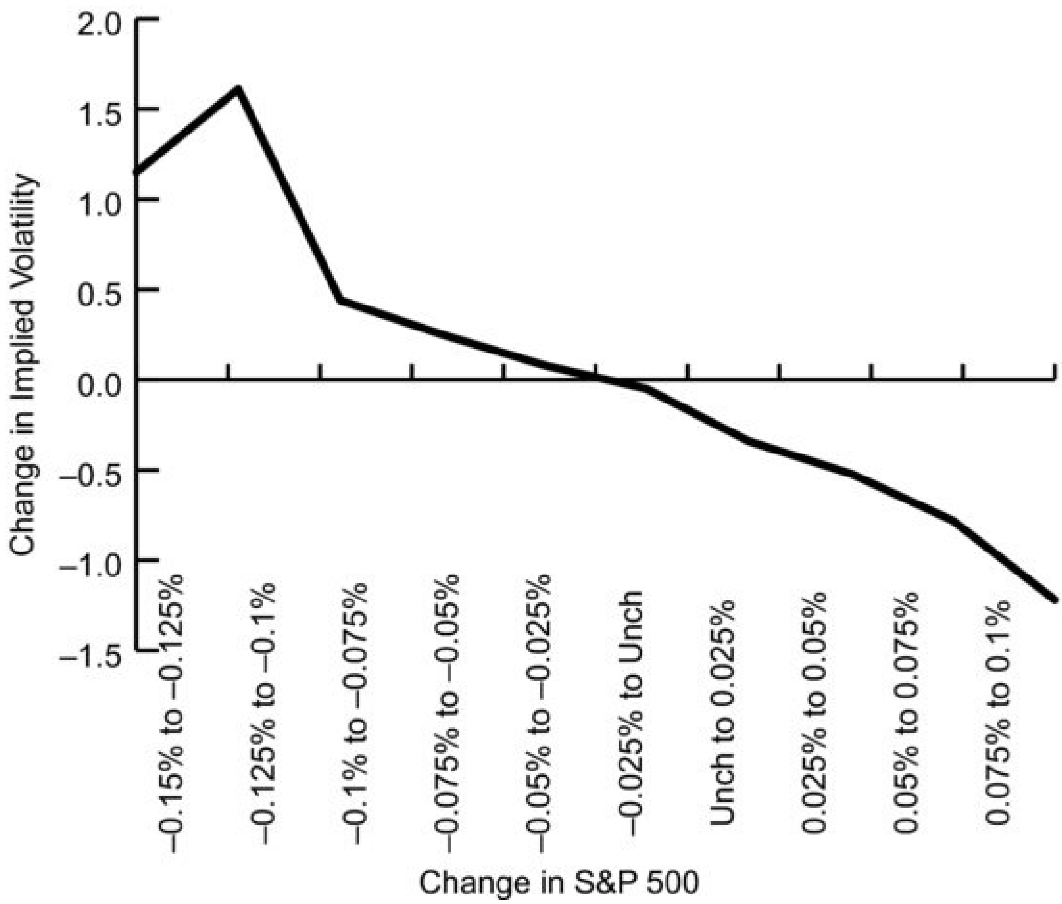
The change in a day's S&P 500 price is clearly related to the change in implied volatility, as measured by the VIX, for that day. On days when the S&P rallied, even slightly, the VIX tended to fall. On days the S&P was down, implied volatility was generally higher. On days the S&P was down substantially, the VIX was up substantially. As any drop in the S&P 500 intensifies, the increase in implied volatility intensifies as well. Figure 9.1 shows a graph of this phenomenon.

FIGURE 9.1 Changes in Stock Price Drive Changes in Implied Volatility



While this demonstrates the relationship for each day, it's also clear that the relationship exists over a much shorter timeframe, which is even more perplexing. We'd think that a tiny one-minute move in the S&P wouldn't impact the implied volatility that S&P option traders around the world are willing to pay, yet it does. Figure 9.2, which graphs one-minute changes in the S&P over the course of one trading day, and the resulting change in implied volatility for the buckets of S&P change, tracks this phenomenon.

FIGURE 9.2 Very Short-Term Changes in Stock Price Drive Changes in Implied Volatility

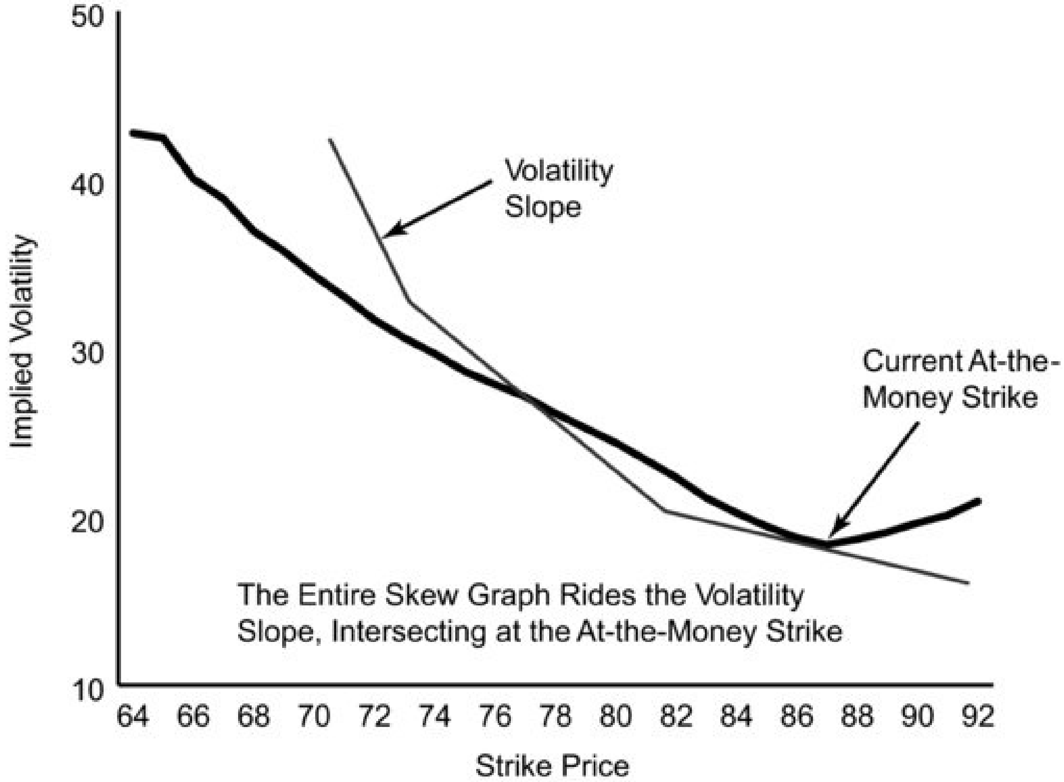


The Volatility Slope

The path that implied volatility takes as the price of the underlying asset changes is called the *volatility slope*.

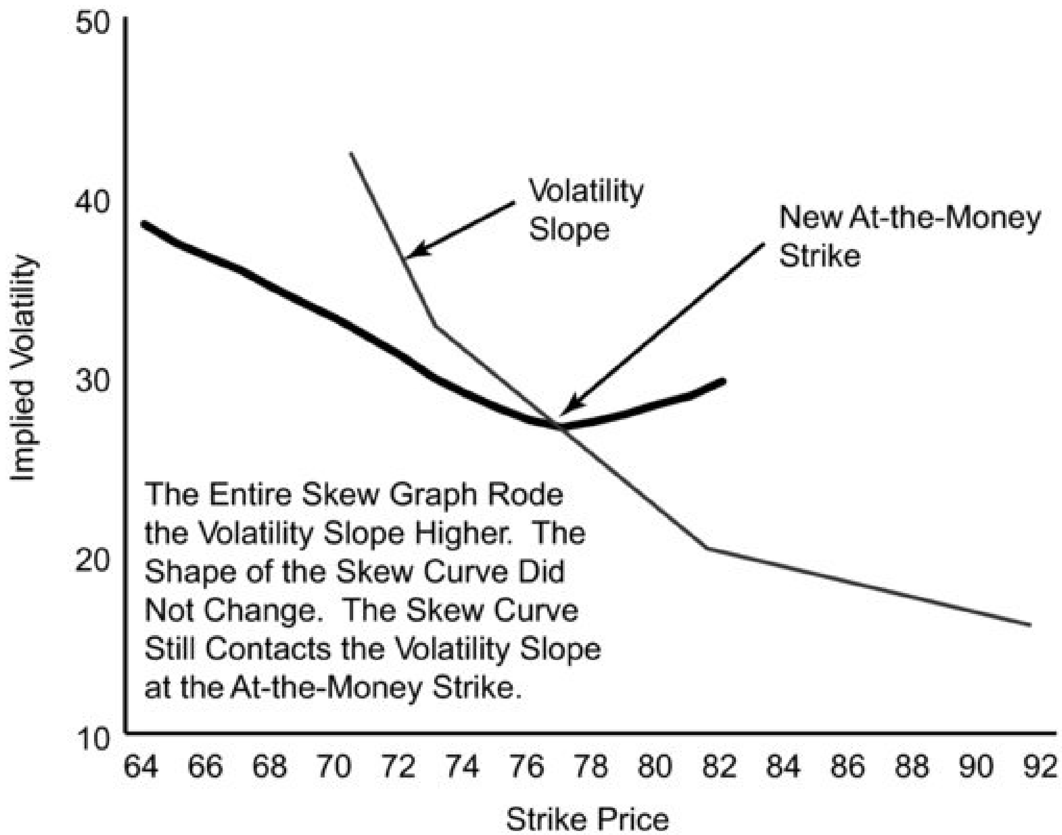
Imagine that the entire volatility skew chart, like the one we saw in Figure 9.1, moves up and down with changes in the underlying market with the volatility skew curve always touching the volatility slope at the at-the-money strike price. The result is that the shape of the skew curve doesn't necessarily change (in reality it will probably change somewhat, due to the passage of time if nothing else), but rather the entire curve essentially slides along the slope, intersecting it at the at-the-money strike, moving higher as the market falls and sliding lower as the market rallies. That would look something like Figure 9.3.

FIGURE 9.3 Volatility Slope



How would the skew curve ride the volatility slope, and what would that look like? Figure 9.4 shows the skew and the volatility slope after the Russell 2000 ETF (IWM) has fallen, and after skew has moved along the volatility slope.

FIGURE 9.4 Volatility Slope after the Market Moves



THE VOLATILITY SLOPE, THE *WHY*

Why does implied volatility follow the volatility slope, even over tiny changes in the price of the underlying asset? There are three theories. The first two are based on a company's fundamental value. Thus, these two should be longer-term and lagging effects. As such, these two can't account for the entire effect because they're longer-term and lagging, and we've seen that equity indexes ride the volatility slope for periods as short as one minute.

The three theories are:

Leverage: The first theory to explain the volatility slope phenomenon assumes that negative equity returns increase leverage because the value of a firm has decreased while the amount of debt is unchanged. Thus, the company is more highly leveraged and is riskier. More risk leads to more volatility. Remember Company B's CEO, Swing-for-the-Fences Freddy, from Part One? The leverage effect tries to explain how negative returns lead to higher implied and realized volatilities.

Volatility Feedback: The second theory imagines that changes to volatility, particularly positive changes (meaning that volatility has increased), lead to decreasing returns. The volatility feedback theory tries to justify, not explain, how an increase in volatility may result in negative returns for the stock price. It seems to have the effect (changes in volatility) occurring before the cause (changes in the market).

Behavioral: The price pressure argument proposes that investors and traders of options bid up prices for put options in order to get downside protection or downside exposure in the fear (for investors) or hope (for traders) of further losses during downturns. The potential for a small downturn to morph into a colossal drop is also an important driver as traders and investors try to get in front of such an event. Thus, investors bid up put option prices because they're averse to losses and try to prevent them when they seem most possible. Losses create fear of more losses; gains create hope for more gains. It's as if investors and traders have forgotten the investors' homily that "past performance is no guarantee of future results."

It's not important for us to understand why volatility changes with changes in the underlying, but it does, and in Part Three we'll learn how to take advantage of the phenomenon. However, the more we know about it, the better we'll understand it, and the greater the number of situations in which we'll recognize its usefulness.

Volatility slope isn't the only phenomenon driven by investors' and traders' tendency to extrapolate current conditions, meaning they project current market and volatility changes into future changes. This is why a trader or investor is willing to pay up for a put option after a big down move—even though the damage has already been done.

THE ASYMMETRY

The fact that implied volatility remained high following the market crash in October 1987, the collapse of Long Term Capital Management in 1998, and the events of September 11, 2001—yet never got very high in the market run up during the technology bubble of 1999–2000—demonstrates that the volatility slope is more impactful when the market is headed lower and volatility is headed higher than when the market is headed higher and volatility is headed lower.

Since this volatility slope works more in one direction than in the other direction, it's referred to as asymmetrical. Some investors refer to the entire phenomenon as *volatility asymmetry*, but we'll stick with volatility slope since it also conveys the direction that implied volatility is likely to take, and not just the relative degree of the change.

The result of volatility slope on option traders is that for put selling strategies, correctly deducing that the market will head lower is doubly useful. In waiting until after the move downward traders will find that the put or put spread they want to sell will be more valuable for two reasons. The first is due to its sensitivity to changes in the price of the underlying price (this sensitivity is the delta of an option we discussed in Part One), and the second is due to the fact that implied volatility, and hence option prices, will be higher due to volatility slope.

VOLATILITY SLOPE AND SKEW ARE RELATED

It's no surprise that the volatility skew and volatility slope in Figure 9.3 have similar shapes; volatility slope and volatility skew are related. Some traders prefer to think of volatility changes due to price changes in the underlying as simply moving along the volatility skew graph.

The two points of view generate similar outcomes—volatility increases when the market falls and decreases when the market rallies. That said, ignoring volatility slope by making skew do both jobs is a little like using a hatchet to perform surgery. It might get the job done, but it's not very precise.

Skew doesn't always look like it looks in Figure 9.3, which shows option skew and a volatility slope for IWM options. As we saw in Chapter 6, skew looks very different for those assets that tend to jump rather than fall in the case of unexpected events or news. Those assets include commodities such as gold and crude oil but also include stocks that are takeover targets like Yahoo!, which we also discussed in Chapter 6. For those assets the volatility slope will likely curve upward as we move to the right from at-the-money much more sharply than our chart of IWM shows. For those assets the volatility slope will also look similar to skew.

TAKEAWAYS

- Implied volatility increases as market prices for the underlying decrease, and implied volatility decreases as market prices for the underlying increase.
- The degree by which implied volatility changes is asymmetrical. It goes up more when the market falls than it falls when the market rallies.
- This negative correlation applies over even very short time frames.
- Volatility slope, our name for the path of this negative correlation, is much more applicable to equity indexes than individual equities.
- There are several theories about why the volatility slope exists, but behavioral factors are likely to have the most impact.
- Volatility slope and volatility skew are related.
- Volatility slope can be used by traders and is particularly important in strategies that use out-of-the-money put options.

PART THREE

The Trades

CHAPTER 10

Covered Calls

Selling a covered call is often the first trade a new option trader executes, and with good reason. Covered calls, sometimes called *overwrites*, take advantage of several of the phenomena we discussed in Part Two, the volatility risk premium being the most important of the phenomena.

A covered call is executed when you sell a call option against stock that you own. The risk from the short calls is "covered" by ownership of the underlying stock. Importantly, you sell calls representing a number of shares that is equal to or less than the number of shares you own.

It's important to stress that we'd never sell uncovered or "naked" call options. The risk is just too great, but owning the underlying stock in an amount at least equal to the shares represented by the calls we sell means we've defined our risk if the stock rallies, even if the stock rallies tremendously. If the underlying stock rallies then ultimately the price of the call option our trader is short will rally $1 for each $1 in the price of the underlying stock. Each $1 increase in the price of the call option will cost our trader $100 per option shorted. However, each $1 increase in the price of the underlying will earn our trader $100 per round lot of 100 shares even if the stock rallies hugely. As long as our trader has sold calls representing the number of shares of stock owned, the stock will cover the short calls. Table 10.1 shows the relationship between covered and naked calls for a trader short 5, 10, and 15 call options with a long position of 1,000 shares.

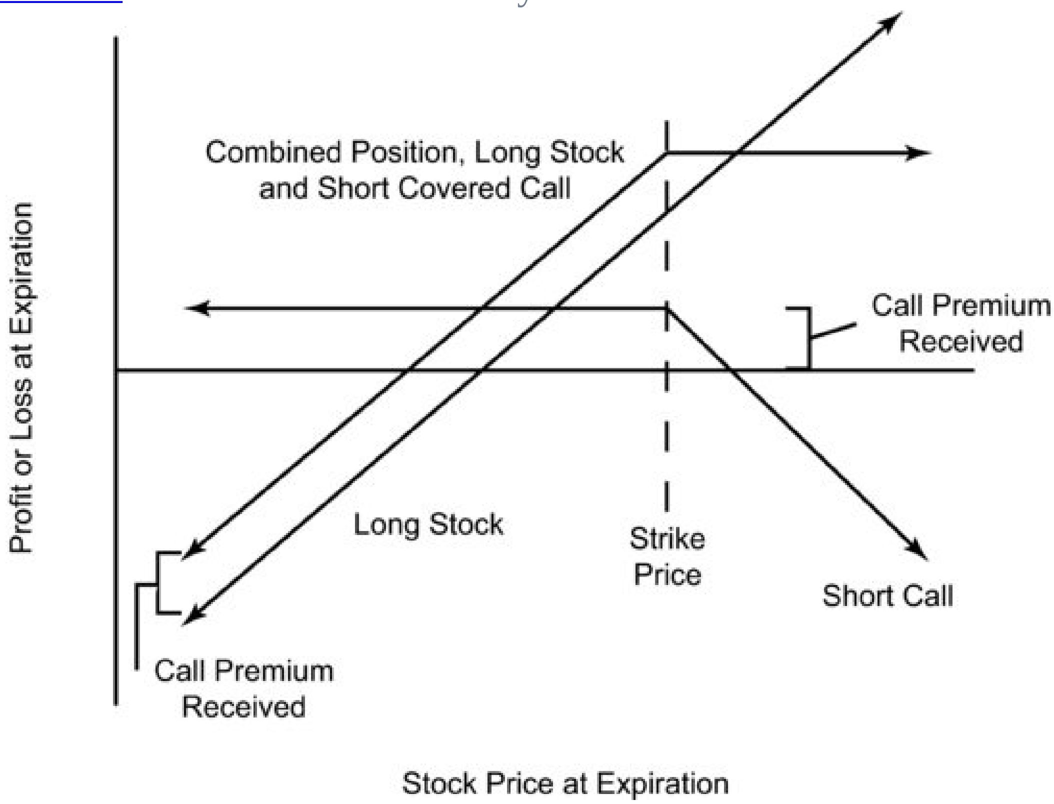
Table 10.1 Covered and Naked Calls

Long 1,000 Shares	
Short 10 Call Options	Calls Are Covered
Long 1,000 Shares	
Short 5 Call Options	Calls Are Covered
Long 1,000 Shares	
Short 15 Call Options	10 Calls Are Covered, 5 Calls Are Naked

Our trader's risk is defined because no matter how much the stock rallies, the worst that can happen is the stock will be called away. This happens when the owner of the call options that have been sold exercises the calls, and our trader is forced to sell the stock at the strike price of the call.

Regardless of whether the owner of the call options exercises them, our trader gets to keep the premium for selling those call options. Because traders get to keep this premium no matter what, it's actually possible to make money on the stock owned and collect and keep all of this premium. More about that later. Figure 10.1 shows the payoff for the stock our trader owns, the call option sold, and the hybrid covered call position.

FIGURE 10.1 Generic Covered Call Payoff



COVERED CALLS ARE BEST FOR STOCKS YOU ALREADY OWN AND WANT TO KEEP

While it's entirely possible to have your stock called away if you sell covered calls—if you use the strategy often enough it's just a matter of time before getting called away happens—covered calls work best on a stock that you like and believe will ultimately rally, but that you think is stuck in neutral for some time.

If you owned a stock and didn't like it, and didn't think it would ultimately rally, or if you thought it faced short-term problems that would weigh on the stock price, then selling covered calls wouldn't be the right strategy. You'd probably be better off simply selling the stock and then thinking about bearish option strategies to profit from the expected break in the stock price. If selling the stock would have adverse tax consequences, then you'd want to hedge the downside exposure using another strategy. While covered calls offer some downside protection in the form of the premium received, that's not the best way to think about covered calls or to use them. We'll talk more about covered calls and how to prevent adverse tax consequences of getting called away later in this chapter. For now, Table 10.2 shows the four scenarios that result from selling covered calls when the stock either rallies or falls, sharply or slightly.

Table 10.2 Relative Outcome from Selling Covered Calls

Stock Price Action	Position Result	Relative Outcome
Stock Rallies Slightly	Keep Premium, Don't Sell Stock, Maximum Profit Achieved	Great
Stock Rallies Sharply	Keep Premium, Sell Stock, Regret Selling Covered Call	Less Good
Stock Falls Slightly	Keep Premium, Don't Sell Stock, Premium Cushions Drop	Good
Stock Falls Sharply	Keep Premium, Don't Sell Stock, Loss on Stock Exceeds Premium	Less Bad

Covered calls or overwrites should always be done on stock you already own. There's absolutely no reason to buy stock just so you can sell calls on it. Buying the stock and simultaneously selling covered calls, sometimes called a *buywrite*, is just a way to spend twice as much as necessary in commissions. If you don't already own the stock, then the next chapter will discuss cash-covered puts, which offer precisely the same risk/reward as a buywrite and don't require you to pay two commissions. Don't believe the risk/reward for a buywrite and a cash-covered put are identical? We'll do the option math in the next chapter to prove it.

THE PHENOMENA AND COVERED CALLS

Of the phenomena we discussed in Part Two, the volatility risk premium is the most important for covered calls. It's this risk premium that, over time, will lead to returns that are superior to just buying and holding stocks.

Time decay should help drive profitability for a covered call as well, particularly if we make it a point to sell options that have greater daily time decay (i.e., theta). For this reason selling shorter-dated covered calls is almost always better than selling longer-dated covered calls, and selling the weekly options, which are available on a limited selection of indexes, ETFs, and individual equities, is an even better way to get the option math of time decay working in our favor.

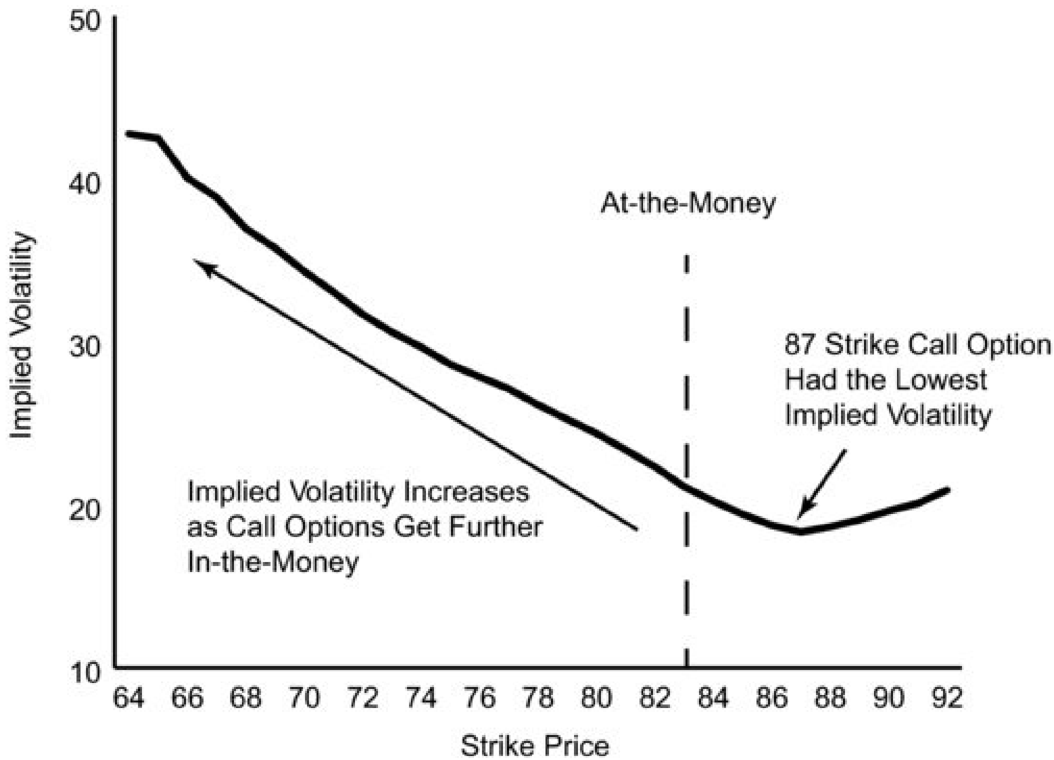
The bid/ask spread for our covered call can help make our position more profitable. For very liquid options with narrow bid/ask spreads, selling the covered call at the bid price won't hurt us too much. The SPY options we discussed in Part Two had bid/ask spreads that were only $0.01 wide, so selling a covered call on SPY at the bid price will cost us only half that amount, since it's reasonable to think that the fair value of our call option is the midpoint of the bid/ask spread. That's not likely to significantly impact the ultimate profitability of our trade.

For options that are liquid but with wider bid/ask spreads like the Google options we examined in Part Two, there is a real danger for the width of the bid/ask spread to have a negative impact on our covered call if we simply sell the bid price. Going back to the Google example, the at-the-money call (the 585 strike) had a bid price of $8.40 and an ask price of $8.70. If that means the fair value of the call is $8.55, then simply selling the bid price would cost $0.15 which is nearly 2 percent of the call's value, too much to simply give away.

In illiquid options with wider bid/ask spreads, we can offer our covered call in the top half of the bid/ask spread and actually use the bid/ask spread and illiquidity to our advantage. We'll discuss all of these situations later in this chapter.

Skew may hurt our covered call trade if we choose to sell an out-of-the-money call that falls in the trough of the skew that we saw in Part Two. Figure 10.2 is similar to Figure 6.1, which displayed option skew for IWM options, options on the Russell 2000 ETF.

FIGURE 10.2 Skew and the Covered Call



If we were long the Russell 2000 ETF (IWM) and wanted to sell a covered call, then selling the 87 strike call would result in selling the lowest implied volatility, the real measure of how expensive options are. Likewise, skew may help our covered call if we chose to sell an in-the-money call option that has an implied volatility that is greater than the at-the-money call option. If we sold the 75 strike call then we'd really be taking advantage of skew. We'd be selling an option with an implied volatility that is significantly higher than that of the at-the-money call. That 75 call has other issues that mean it may not be the best covered call to sell, but skew isn't one of them. It's important to remember that skew will help or hurt our covered call trade when we initially execute it.

Volatility slope may make taking our trade off before expiration easier or more difficult depending on whether our stock has moved up or down since we initiated our position. Similarly, volatility slope may help or hinder our efforts to make a follow-up trade, as we'll discuss later in this chapter. If our stock has fallen significantly since we sold our covered call, then the resulting general increase in implied volatility means that our call may be more expensive than it would be if the stock hadn't moved and if the volatility skew curve hadn't moved up the volatility slope. If the stock has fallen enough, then the call may be worthless or nearly so; if the stock has only dropped slightly then it'll still have some value, and it will have more value than it would otherwise and thus be more expensive to repurchase than it would be otherwise.

If we had sold an out-of-the-money call option and the stock rallied slightly, then volatility slope will have likely helped our trade, since the entire skew graph rides the volatility slope lower. If our call is still out-of-the-money or is at-the-money, then it's possible that the combination of time-decay and volatility-slope would result in our option being worth less than we sold it for, despite being closer to at-the-money. One exception will be if we sold the strike price at the bottom of the skew trough. In that case, no matter which way the stock moves, our strike price will move up the volatility slope. The passage of time may mean that our option is worth less than we sold it for, but in this case that's due to erosion, not skew.

Figure 10.3 provides the *general* impact of all of the phenomena on our covered call. Any of these can be overwhelmed by the others and by other factors, such as movement of the underlying stock or a change in the general level of implied volatility.

FIGURE 10.3 General Impact of the Phenomena on Covered Call

	Impact on Covered Calls
Volatility Risk Premium	Volatility Risk Premium will help the profitability of a covered call since the call is generally sold for more than it is ultimately worth.
Time Decay	Time Decay will be the source of daily price changes (ignoring market movement). Since daily time decay (theta) is greater for shorter-dated options, those are the best covered calls to sell.
The Bid/Ask Spread	The Bid/Ask Spread should have little impact if the options are very liquid and have a narrow spread. A wider bid/ask spread can make getting a covered call sold at a fair price difficult. For illiquid options a wide bid/ask spread can be an advantage.
Skew	Skew will help or hurt profitability of our covered call depending on the strike sold.
Volatility Slope	Volatility Slope won't impact our covered call at initiation but can hurt follow-up actions if the stock has dropped and can help follow-up actions if the stock has rallied.

Ultimately the goal of a covered call is to enjoy the natural diversification that the hybrid position offers and to collect the volatility risk premium incorporated in the price of the option.

BREAKEVEN POINTS

Since we’re always going to sell covered calls on stocks we already own, it doesn’t make much sense to use the purchase price of the stock in calculating breakeven points or return figures. We may have bought the stock years ago at a price much lower (or higher) than the current market price. Since our call option price is a function of the current market price for the stock, and since we’re really only long our stock from the current market price (because we’ve made, in one way or another, the decision not to sell our stock right now), the current market price is the proper price for calculating breakeven levels and return figures.

The *downside breakeven point* is the price of the stock when we executed our option minus the premium we received for selling the covered call. (See Table 10.3.) If the stock is above this level at expiration but below the upside regret point, then we’ve come out ahead by selling the covered call. (See Table 10.4 for data describing the upside regret point of a covered call.) Since we’re selling covered calls only on stock we want to own anyway, this downside breakeven level is really just for our information. We’d own the stock anyway, but as long as the stock is above that breakeven point at expiration we’ve come out ahead by selling the covered call.

Table 10.3 Covered Call Downside Breakeven Point

Breakeven Point Calculation	
Market Price of Stock	98.75
Covered Call Strike Price	100
Covered Call Premium Received	4.50
Downside Breakeven Point	94.25 (Stock Price Minus Premium)

Table 10.4 Covered Call Upside Regret Point

Regret Point Calculation	
Market Price of Stock	98.75
Covered Call Strike Price	100
Covered Call Premium Received	4.50
Upside Regret Point	104.50 (Strike Price Plus Premium)

The *upside breakeven point* isn’t really a breakeven point since we’ll have made money on our stock and we’ll have kept the call premium we received. It’s better to call this point the *regret point*, since that more fully explains what it means to us: Above this point we will regret having sold our covered call because our stock will be called away and the forgone profit on the stock is greater than the premium received from selling the call option. The regret point is the strike price of our option plus the premium received. At precisely this point we're exactly as well off having sold our covered call as we would be if we hadn't. Above this point we're worse off for having sold the covered call. Below this point we're better off having sold the covered call.

Let's look at a broader example to determine not only the downside breakeven point and the upside regret point, but the profit and loss at any price for the underlying stock. To do that let's assume a trader owns 100 shares of LMN Corporation, which is currently trading at $77 per share. The trader sells an 80 strike call option on LMN for $4.00; by doing so he's executed a covered call. His ownership of 100 shares covers the upside risk in being short one call option. If LMN is below $80 at expiration, the call option expires worthless and the trader's potential responsibility to sell his LMN stock at $80 expires as well. He keeps the $4.00 he received for selling the call and he's $4.00 better off than if he hadn't sold the call.

If LMN is above $80 at option expiration, then the owner of the option is going to exercise his right to buy the shares at $80. Assuming our trader didn't buy back this call prior to expiration he's going to be *assigned* to sell the shares. Assignment is the opposite side of exercise. The trader long the option exercises it and, in the case of a call option, buys the underlying stock at the strike price. The trader short the option is assigned, more or less randomly, to sell the underlying stock at the strike price. If LMN is trading at $83 at option expiration, the call option will be exercised by the option owner and, in the case of our trader's covered call option, the owner of the call option will buy LMN at $80 per share. Our trader will be required to deliver his 100 shares and he'll receive $80 for each of them. Our trader will also get to keep the $4.00 initially received for selling the covered call, and will be better off by $1.00 than if he hadn't sold the covered call, even though the stock got called away.

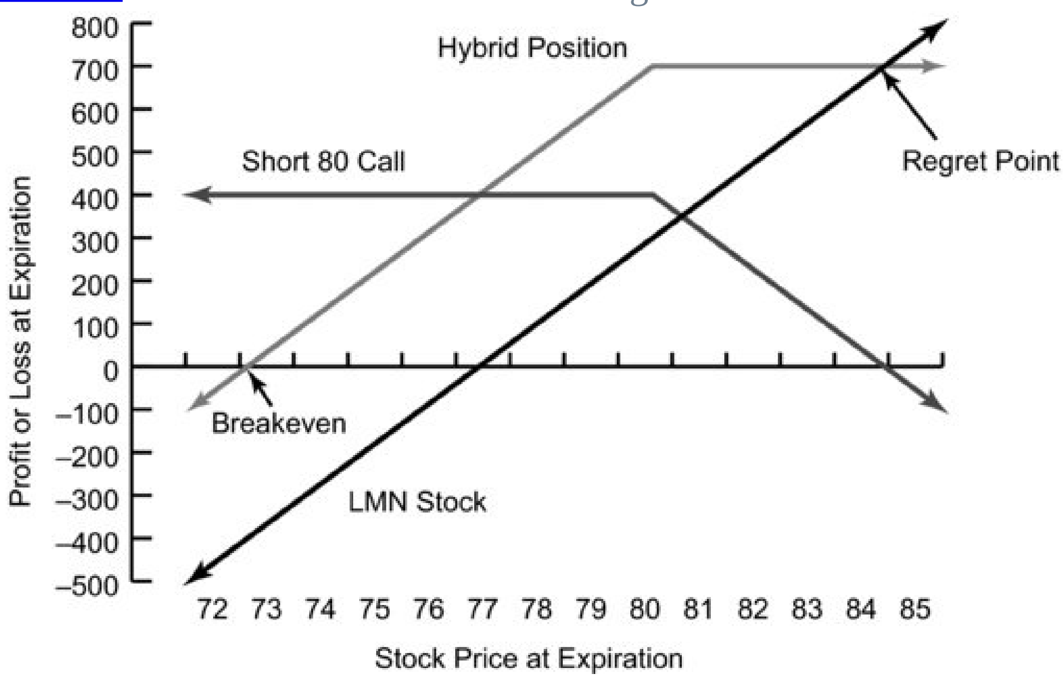
Table 10.5 shows the profit and loss for a range of prices at expiration for this covered call position. From this it's easy to see how the breakeven and regret points are calculated. Creating a table like this is often the best way to understand any option trade. Pay particular attention to the profit or loss at inflection points, such as the strike price (or strike prices for strategies with more than one option) and breakeven and regret points. Soon you'll understand these issues instinctively and won't have to create a chart each time, but it's a great way to learn. In this situation the breakeven price is $73. That's the price where the total profit or loss is zero. The regret point is $84. Above that level our trader is worse off for having sold the covered call.

Table 10.5 Profit and Loss from LMN Covered Call

LMN Price at Option Expiration	Profit or Loss on LMN Stock	Value of LMN 80 Call Option at Expiration	Profit or Loss on Call Option	Total Profit or Loss
72	−500	0	400	−100
73	−400	0	400	0
74	−300	0	400	100
75	−200	0	400	200
76	−100	0	400	300
77	0	0	400	400
78	100	0	400	500
79	200	0	400	600
80	300	0	400	700
81	400	1	300	700
82	500	2	200	700
83	600	3	100	700
84	700	4	0	700
85	800	5	−100	700

Figure 10.4 highlights the covered call breakeven and regret points for LMN Corporation.

FIGURE 10.4 Covered Call Breakeven and Regret Points



The maximum profit from any covered call position occurs when the underlying stock is at the strike price at expiration. In the case of the LMN covered call the maximum profit occurs when LMN is at $80 at option expiration. The maximum profit is also achieved when the underlying stock is above the strike price at expiration. This relationship, maximum profit occurring with the underlying stock at the short strike price at expiration, holds for nearly every option strategy, not just covered calls. We'll discuss this later in Part Three.

An important element of a covered call is that it limits the profit potential from ownership of the underlying stock. You're selling much of this profit potential for cash. As we've seen when discussing the volatility risk premium, over time, we're selling this potential for more than it's worth, but that doesn't mean it won't feel like a swift kick to the head when we've sold a covered call only to see our stock rally well past the regret point. A central element to successful option trading is to remain disciplined when this happens and make the best possible follow-up trade if there is one. If there isn't a good follow-up trade then the best tactic is to learn from the situation; again, be disciplined enough to realize that this sort of thing will happen from time to time, but if we have the option math on our side, over time good things are going to happen.

BREAKEVEN POINTS AND RATES OF RETURN

It's usually helpful to normalize the breakeven point, the regret point, and the amount of premium received so that we can compare them rigorously rather than subjectively. It's also helpful to turn the rates of return into annualized numbers to remove the number of days to expiration as a factor.

Option Premium Yield

The easiest and possibly most important rate is the yield that the covered call will generate. If the covered call is at-the-money or out-of-the-money, then the yield is simply the premium received divided by the stock price. In the case of the LMN call we discussed, the yield would be $4/$77 or 5.20 percent. (See Table 10.6.) To annualize this number quickly we'd simply multiply this 5.20 percent by the number of time periods in a year. If our 80 strike call was a 30-day option, then the annualized yield would be 5.2 percent times 12, or 62.4 percent. This number is an approximation since it doesn't take compounding into account, but it will provide a useful guide to the annualized yield that can be compared to other structures. The formula for precisely annualizing yield can be found in the Appendix.

Table 10.6 Option Premium Yield

Option Premium Yield	
Current Stock Price	77.00
Call Premium Received	4.00
Option Premium Yield	5.20% (4.00/77.00)
Annualized Yield	62.40% (5.20% x 12)

If we use an option pricing model like the one available at the website OptionMath.com we'd find that this option had an implied volatility of about 60 percent so these options are pretty expensive. We'd expect a high annualized yield from a high implied volatility.

If our covered call is in-the-money, then the yield is correctly calculated by using only the time value of the option. To use the entire option premium would be to include the inherent value as part of the option premium yield, which would overstate the yield; it's stealing from Peter to pay Paul because we'll be called away at a price lower than the current market price. In the LMN example, if the 75 strike call had been worth $5, then $2 is inherent value. The yield from selling that covered call would be $3/$77, or 3.90 percent. To say it was $5/$77, or 6.49 percent, would be like stealing $2, the amount by which the $75 is in-the-money, from the value of the stock and adding it to the call.

This option yield as we've calculated it is the best number to use because it assumes that the underlying stock doesn't move for the term of our option. This is in line with the analysis that leads us to consider selling covered calls in the first place—that we own a quality stock but it's not going anywhere for the term of our option.

Return if Called Away

The return if called away is simply the difference between where the stock is trading currently and the regret point compared to the current price of the stock. For our LMN covered call the regret point was 84 and the stock was currently trading at $77.00. The difference is 7 points. This 7 points can also be calculated by adding the amount by which the option is out-of-the-money to the premium received. (See Table 10.7.) The return if called away is thus $7/$77 or 9.1 percent. If we were to annualize this it would be a 109.2 percent annual return. Again, this annualized number is an approximation, since it doesn't take compounding into effect.

Table 10.7 Return if Called Away

Return if Called Away	

Current Stock Price	77.00
Upside Regret Point	84.00
Difference	7.00
Return if Called Away	9.10% (7.00/77.00)
Annualized Return if Called Away	109.20% (9.10%×12)

These annualized numbers should be used for comparison purposes only. There's no assurance that a covered call seller would be able to get the same level of yield next month as they received this month.

USING COVERED CALLS FOR DOWNSIDE PROTECTION

Many option traders believe covered calls should be used to provide downside protection. This is dangerous, as it suggests more protection than is really offered and leaves the owner of the stock with a false sense of security. In our LMN example, the $4 received in the form of call premium only protected ownership of the stock down to the breakeven point of 73, a drop of about 5 percent. Given 60 percent implied volatility and 30 days to expiration the option math tells us there's about a 41 percent likelihood LMN will be below 73 at option expiration. That's an awful big likelihood that our covered call isn't going to provide enough protection. If we're worried about LMN dropping, there are better strategies, starting with selling the stock, which can be employed. One problem with using covered calls for downside protection is that if the stock does drop, then the volatility slope will make closing the position by buying the call back more expensive than we might expect.

An option trader is better off thinking of a covered call as a way to generate income by taking advantage of the phenomena we discussed in Part Two while generating a breakeven point that is below the current stock price.

If we consider covered calls to be downside protection the risk is that the stock falls by more than the option premium received. Since we're only selling covered calls on good stocks, stocks that we want to own anyway, we're certainly better off than if we hadn't sold the covered call, but this is a little like falling down and breaking a leg but being happy that we found money on the ground while we were rolling around in pain. Finding the money is a positive, but it may not be a net positive.

The more important risk in a covered call is if the underlying stock rallies to a price that's greater than the strike price plus the option premium received. This is the regret point we've already discussed. Since we're writing covered calls on stock we like, it seems logical that this is the more likely outcome. Since our effort to prevent this occurrence changes the math of the breakeven point, we're naturally going to sacrifice some downside protection to decrease the likelihood of being called away. If we think of covered calls as downside protection, we'll tend to go the other way and sacrifice the upside in search of greater downside protection. That doesn't make much sense for stocks we like.

IF OUR STOCK RALLIES

If the underlying stock rallies then we might find our stock called away. This is not necessarily bad, and prior to expiration we have alternatives to simply sitting back and getting the notice of assignment.

Prior to expiration or assignment you always have the right to buy your option back. In doing so you have extinguished your responsibility to sell your stock at the strike price but at the cost of the premium you have to pay. This premium might be more or less than the premium you initially received.

Just because our stock has rallied doesn't mean we will necessarily get called away. If LMN rallies from $77 to $79 at option expiration, then the 80 call option our trader sold will have no inherent value and the owner of the option will not exercise it. Why would the owner do that—meaning why pay $80 (the call option's strike price) for stock that could be bought at $79 in the open market? Our covered call trader has made money on both sides of this trade. The LMN stock has appreciated by $2 and the call option sold for $4 will expire worthless. With LMN at $79 at option expiration, our trader is $600 better off.

If the stock does rally enough then our covered call trader will indeed find the stock called away. Getting called away might actually result in the maximum potential profit from this hybrid covered call position. In the LMN example we looked at previously, if LMN is at 81 at expiration, then we'll find that the owner of the 80 call will exercise the option—to not exercise would be to forgo the $1 of inherent value of the option—but the covered call seller will have made the maximum amount of profit: $400 on LMN stock as it has rallied from $77 to $81, and $300 on the call option as it was initially sold for $4 and is worth $1 at expiration.

SELECTING THE COVERED CALL

In-the-Money, At-the-Money and Out-of-the-Money

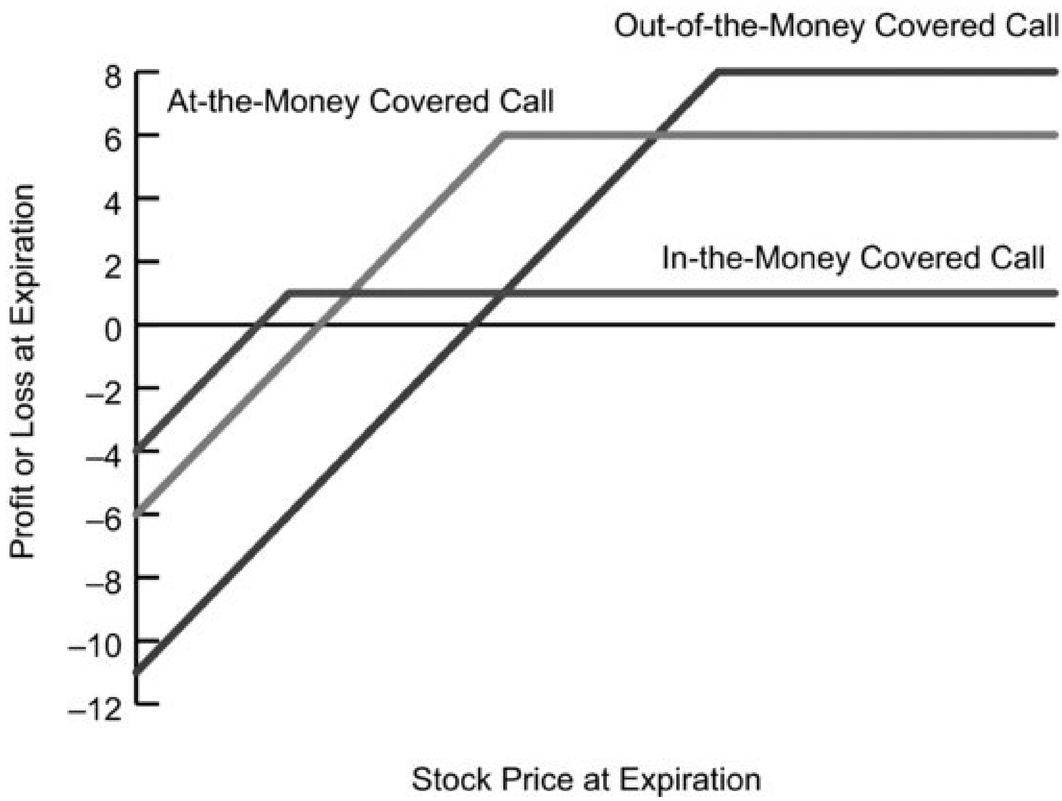
As we saw in Part One, at-the-money options have the greatest amount of time value and thus the greatest daily erosion (i.e., theta). In-the-money call options have the highest implied volatility thanks to skew, and out-of-the-money call options have the least likelihood of losing the stock that we want to keep. Which one should we sell?

As we said in Part One, there's no right answer, and even in using an option pricing model like the one at OptionMath.com we can only compare the likelihood of getting called away (the delta) and the daily erosion (the theta) rather than find the best call option to sell.

The difference between these three moneyness alternatives isn't so much the difference in the options but rather it's the difference in the resulting hybrid position.

A covered call that's significantly in-the-money results in a hybrid position that's very much like a bond. The odds of getting our stock called away are very high, but in that case we'll be left to collect cash based on the strike price and the time value of the call when we sold it. This total amount of cash is unlikely to change, so the total payoff is likely to be very stable, much like a bond. As the likelihood that the call option will end up in-the-money (i.e., delta) increases, this bond-like nature of our position increases. Figure 10.5, a profit-and-loss chart for covered calls that are in-the-money (ITM), at-the-money (ATM), and out-of-the-money (OTM), shows the payoff for a deeply in-the-money covered call. There's very little additional profit generated but there's also very low probability of a loss. A loss occurs at a much lower price, further left in the chart, than for the other covered calls.

FIGURE 10.5 Payoff chart for ITM, ATM, and OTM Covered Calls



A covered call that's significantly out-of-the-money results in a combined position that's very much like the outright ownership of the stock. The bulk of the returns from the hybrid position will come from the underlying stock, and very little of the returns will come from the option. The only contribution the option will make is the premium received, and if the option is significantly out-of-the-money then this premium will be very small. If the delta of our call option is very low, meaning the likelihood of getting called away is very low, this increases the stock-like nature of the returns of the hybrid position. Figure 10.5 also shows an out-of-the-money covered call as the highest payoff chart. It has a very high potential profit, but this requires the stock to rally substantially and provides very little additional profit if the stock is unchanged. It also offers very little downside protection. A loss occurs for an out-of-the-money covered call at a higher price (further right on Figure 10.5) than for the other two types of covered calls.

A covered call that is at-the-money results in a combined position that's as different as possible from either a bond or stock. As much of the return as possible will be generated by the time value of the option. The day-to-day returns will fluctuate, as the time decay is greatest with an at-the-money option. A covered call that is at-the-money offers the greatest amount of time value, but the likelihood of getting called away is near 50 percent, which may be too high.

One important word about the at-the-money option—option pricing models assume that the underlying asset or stock is going to appreciate by the risk-free interest rate for the term of the option. This means that the truly at-the-money option may not be what you think it is.

If another stock was trading at $100 and the risk-free interest rate was 12 percent, then an option pricing model would expect the stock to appreciate by 12 percent annually, or about 1 percent monthly. In this case, with 30 days to expiration, the real at-the-money call option would be the 101 strike call option. This is the call option that would have a delta (i.e., the likelihood of finishing in-the-money) of 50. This will also be the call option with the greatest amount of time value and the greatest amount of daily price erosion.

When interest rates are low the effect will be very small but interest rates won't always be low, so it's important to identify the "real" at-the-money strike price.

In-the-Money

An in-the-money covered call will have a greater implied volatility than an at-the-money or out-of-the-money call, as we've seen in Part Two in our discussion of skew. This means that an in-the-money call option, that's a call option with a strike price below the current market price of the stock, will have more time value than a call option that's out-of-the-money by an equal amount. This additional time value and greater option premium will work to increase the profitability of this covered call, but selling an in-the-money call option, particularly one that's deeply in-the-money, is really a lot like putting in an order to sell the stock. The price received is very likely to be the strike price plus the premium received. The only way this is not the amount received is if the stock drops below the strike price and the owner of the option does not exercise.

Many novice covered call sellers will look at a deeply in-the-money call and think that's the one they want to sell because it's more expensive than an at-the-money call or an out-of-the-money call. The problem with this thinking is that most of that option premium is inherent value, which doesn't do the covered call seller any good. Selling a covered call to capture the inherent value is just a function of taking value from the stock we own and transferring it to the call option we're selling. I don't gain anything by selling a call option that's $20 in-the-money for $20. I collect $20 for selling the option but it'll end up getting called away from me at a strike price that's $20 below the current market value. I'm no better off by doing this than I am from taking a $20 bill from one pocket and moving it to another pocket.

Some option practitioners say that an in-the-money covered call is the most conservative covered call but again, this is the equivalent of selling our stock and it's certainly true that selling our stock and keeping the proceeds in cash is a pretty conservative move. It's also one that makes earning a profit pretty tough.

Selling an in-the-money covered call, particularly a deeply in-the-money call, generates a hybrid position that's very bond-like.

Out-of-the-Money

Out-of-the-money covered calls offer the maximum profit potential for the combined structure, but this maximum profit is only realized if the underlying stock rallies and the point of maximum profit, as it usually does, occurs when the stock is at the strike price we've sold. The problem with this potentially greater upside is that the option premium received is reduced as the call option gets further out-of-the-money.

Of the phenomena we discussed in Part Two, skew is the largest potential problem for selling out-of-the-money covered calls. Implied volatility generally falls as we move to strike prices that are above the at-the-money strike price, as we saw in Figure 10.2. Eventually the implied volatility will turn upward again, but in the IWM skew we examined that only occurred once the call price was below $0.25, and in the case of our IWM 87 call option the last price as quoted was $0.22. That was less than 0.3 percent of the price of the underlying, so any gain from selling the 87 strike call would have been minimal. Even if we were satisfied with $0.22 in premium it would likely be reduced by the commission charged to execute that trade.

As we discussed in Chapter 6, one of the reasons skew exists is that owners are willing to sell covered calls and they thereby drive down the price (and the implied volatility) of these out-of-the-money calls. The smart option trader will stay away from selling this cheapest call for two reasons. First, it doesn't get the math of the phenomena working for us, and second, we don't want to follow the herd.

Selling an out-of-the-money covered call, particularly one that's significantly out-of-the-money, generates a hybrid position that's very stock-like.

At-the-Money

The at-the-money covered call has many elements working for it. It has the greatest amount of time value, so it has the greatest amount of daily erosion of all the options that share that expiration date. The at-the-money call has a fair implied volatility and the volatility risk premium means that, over time, we're selling the call for more than it will ultimately be worth. We could sell calls with a greater implied volatility but, as we've seen, that would drastically increase the likelihood of getting called away, which means that, in many ways, selling an in-the-money covered call is like selling our stock.

The true at-the-money covered call has about a 50 percent likelihood of being exercised, so we're as likely to keep our stock as to have it called away. Since we like the stock, a 50 percent chance of getting called away may seem like too much, but we always have the opportunity to make a better informed decision later. We'll discuss those tactics later in this chapter when discussing follow-up trades.

Of the phenomena we discussed in Part Two, the volatility risk premium is the biggest driver of the ultimate profit of our covered call trade, with the daily erosion being related as the daily erosion is how we collect the time value, which includes the volatility risk premium.

Since the at-the-money call option has the greatest amount of time value, it also offers the potential for the greatest additional return. (See Table 10.8.) Looking back at the IWM options, IWM was at $82.64 when those prices were quoted. That would make the at-the-money call the 83 strike call. The 83 call was quoted at $1.46 bid/$1.48 ask. Let's assume that the fair value was $1.47 and let's assume that is the price we received. That means that the return from selling that covered call would be 1.78 percent ($1.47/$82.64) or nearly 7 times greater than the return from selling the out-of-the-money call we looked at, the 87 strike call. Since the 83 strike call is actually a little out of the money, the delta of the 83 call would be slightly less than 50. The actual delta was 47, meaning there was about a 47 percent chance that the option would be in-the-money at expiration.

Table 10.8 Selling the At-the-Money Covered Call

IWM Price	82.64
83 Strike Call Bid/Ask	1.46/1.48
83 Strike Call Fair Value	1.47
83 Call Yield	1.78% ($1.47/$82.64)
83 Call Option Delta	47

This leads us to one of the elements that the at-the-money covered call has working against it: the likelihood of getting our stock called away and the potential need for a follow-up trade to keep that from happening.

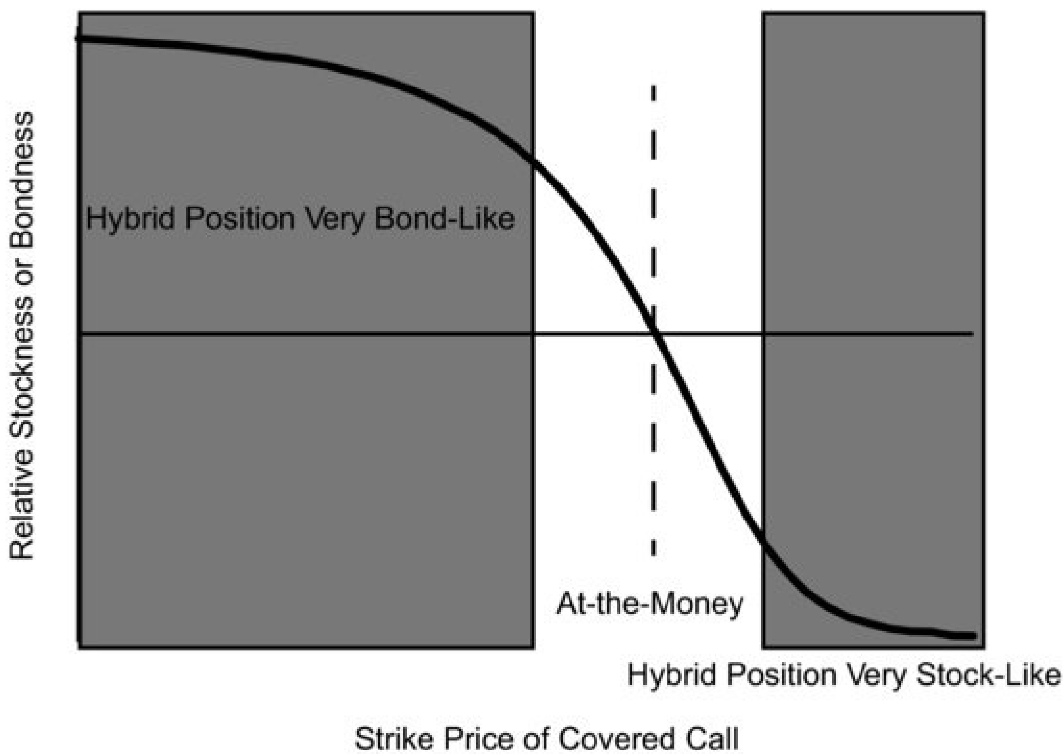
Ideally, if we'd sold the 83 strike covered call, IWM would rally only very slightly and would be just below 83 at expiration. We'd make the maximum amount from our covered call in that we'd collect and keep the entire $1.47 received, and because IWM is just below the strike price we wouldn't be assigned to sell our stock. We could then analyze IWM again and potentially sell it, sell another covered call, do nothing or do something else.

Selling the at-the-money covered call generates a hybrid position that takes the maximum advantage of time value and daily erosion and also generates a position that has the best of the qualities of a bond and the best of the qualities of a stock.

Stock-Like or Bond-Like

The easiest way to determine whether your hybrid position will be stock-like or bond-like is simply to look at the delta of the option you're thinking of selling. The pricing models at OptionMath.com can calculate the deltas of the call options that are candidates for selling as a covered call. If it has a high delta, then the hybrid position will be very bond-like. If it has a low delta, then the hybrid position will be very stock-like. If it has a delta near 50 then the hybrid position will enjoy the best of both worlds. Figure 10.6 shows this in graph form.

FIGURE 10.6 Covered Call Bondness or Stockness



COVERED CALLS AND DAILY PRICE EROSION

Daily price erosion will theoretically be how we collect the value from the covered call we sell. Since daily erosion, also called theta, increases as time to expiration nears, a call seller (actually any option seller) is generally better off selling shorter-dated calls than longer-dated calls.

The LMN 80 strike price call option that our theoretical covered call seller wants to execute has time value of $4.00, an implied volatility of about 60 percent, and theoretical daily price erosion of $0.086, meaning that today we'd expect the price to decline to $3.914 solely due to the effect of time decay. The exact same option with 60 percent implied volatility but 60 days to expiration would be worth about $6.20 and have daily erosion of only $0.063. (See Table 10.9). These calculations can be made using the tools at OptionMath.com.

Table 10.9 Covered Call, Daily Erosion, and Time to Expiration

LMN 30-Day 80 Strike Call Option	
Price	4.00
Expected Daily Erosion	0.086
Delta (Likelihood of Getting Called Away)	45
LMN 60-Day 80 Strike Call Option	
Price	6.20
Expected Daily Erosion	0.063
Delta (Likelihood of Getting Called Away)	49

In this case, as in almost every covered call situation, the covered call seller would be better off selling a series of 30-day covered calls rather than a single 60-day covered call. With LMN calls the effect of selling a series of calls would be to collect $4.00 now and $4.00 in 30 days, assuming that all else stays the same, or a total of $8.00. Compare this to the $6.20 collected if our covered call seller were to sell a 60-day call option. In addition, the delta of that 60-day option is greater, reflecting a slightly greater likelihood of getting called away than from selling a series of 30-day calls.

Because theta stops increasing for options that are significantly distant from at-the-money, this may not be the case for deeply in-the-money or out-of-the-money calls, but this is only one of many reasons not to use calls that are significantly distant from at-the-money.

COVERED CALLS AND THE VOLATILITY RISK PREMIUM

The volatility risk premium is the real source of the additional return generated by covered calls. As we discussed in Part Two, the volatility risk premium for options can be substantial. For SPX options (options on the S&P 500), the volatility risk premium has added to the price of the at-the-money call options and generated additional return for the covered call seller. Going back to 1990, the at-the-money SPX call was priced at 1.890 percent of the S&P 500, yet it only ended up being worth 1.726 percent of the S&P 500. That translated to these calls being overpriced by an average of $1.26 each month. (See Table 10.10.) **Table 10.10** SPX 30-Day At-the-Money Call Option Volatility Risk Premium

Average Call Price as Percentage of the S&P	1.890%
Average Value of Call Option as Percentage of the S&P	1.726%
Call Option Was Overpriced by an Average of	0.16% of the S&P
Greatest Overpricing (October 1998)	2.69% of the S&P
Greatest Underpricing (September 2008)	6.03% of the S&P

Notice the asymmetry inherent in the greatest overpricing of the call of 2.69 percent versus the greatest underpricing of the call of 6.03 percent.

PLACING YOUR COVERED CALL ORDER

Your covered call order generally will need to be executed in the same account that owns the underlying, covering stock. This will be a requirement of your broker to make certain that the stock exists if it has to be delivered in order to satisfy an assignment notice and to make certain the stock can be freely delivered and isn't encumbered.

If the options we want to sell are generally liquid with a narrow bid/ask spread, then there's very little to be gained with a complicated execution. For example, Table 10.11 shows a recent SPY market.

Table 10.11 SPY Covered Call Execution

SPY Last Trade 138.75		
	Bid Price	Ask Price
35-Day 139 Call Option	2.00	2.01

In this case it's reasonable to assume that the market's estimation of fair value of this option is $2.005. It's also reasonable to offer the option for sale at $2.01 using a limit order, particularly if the market was higher that day. It would also be reasonable to simply sell the call at $2.00. The difference between our realized price of $2.00 and the fair value of $2.005 is as small as is possible and that $0.005 is unlikely to have much of an impact on the profitability of our trade.

However, even though we want to sell our call at the market bid, it's always a good idea to enter this order as a limit order to sell at $2.00 rather than as a market order to sell. Remember that a market order will sell your call at the highest current bid, but if something unusual happens it's possible that the market will drop suddenly and a market order to sell might get filled at $1.90 or even lower. If you enter a limit order to sell at $2.00 and the market for these calls drops, then you can leave your order to get filled at $2.00 or you can reexamine the situation in light of this volatility.

If the option we want to sell is in a liquid option market with wide bid/ask spreads like the Google options we reviewed in Part Two, then we want to be a little more careful in our execution.

Again in this case it's reasonable to assume that the fair value of this call option is the midpoint of the bid and the offer, $19.60 in this case. Many traders would place a limit order to sell the covered all at $19.60 and it would be tough to argue against that type of order. If Google were to rally just $0.10, then the fair value of this option would be about $19.65. Since this call is very close to at-the-money, the delta is very close to 50. Remember that because delta equals the option's price movement relative to the underlying's price movement, we know that if the stock rallies by $0.10 the at-the-money call option price will increase by $0.05, and it's likely a market maker would buy the call at our $19.60 limit price. However, the only way that $19.60 limit will be filled is if Google does indeed increase in price. In this situation, particularly for those who don't want to monitor their execution, it would be perfectly acceptable to sell the covered call at the $19.50 bid price. Again we would use a limit order to make certain we received the $19.50 we expected but the $0.10 difference from the fair value is only a tiny fraction of the total option value and is unlikely to substantially impact the profitability of our trade. (See Table 10.12.)

Table 10.12 GOOG Covered Call Execution

GOOG Last Trade 610.45		
	Bid Price	Ask Price
35-Day 615 Call Option	19.50	19.70

If our option is rarely traded and has a wide bid/ask spread then we need to be very careful in our execution, and we can use the fact that we're providing liquidity to our advantage and demand to be paid for doing so. Table 10.13 shows such a market.

Table 10.13 Onyx (ONXX) Pharmaceutical Covered Call Execution

ONXX Last Trade 37.37		
	Bid Price	Ask Price
35-Day 38 Call Option	1.45	1.65

In this case the options rarely trade, the total daily option volume at the time was less than 2,500, and the fear for market makers is that if they sell an option they may not be able to reduce or close that risk without paying the ask price of someone else. If unexpected news is released and the market maker wanted to pay the ask price to close the position, he may find that the news has chased other market makers from offering. The market maker may not be able to buy the option back at any price. Because of this, the market maker would rather be a buyer than a seller of thinly traded options and will adjust his bids and offers accordingly. We can assume that the fair value of this option is below the midpoint of the bid/ask. It's probably very close to $1.50.

In this situation we can offer our call for sale at the midpoint, or $1.55, and actually be selling the option for more than its fair value. We could even get a little greedier and offer it for sale at $1.60. Regardless, in this situation we'd have to use a limit offer and would likely have to monitor the execution with the goal of canceling our order if a $0.20 rally in ONXX didn't result in getting our order filled, since a $0.20 rally should increase the value of our 50 delta option by $0.10. If you left your $1.55 offer in the market indefinitely, then the few market makers paying attention would have no reason to buy that option before they absolutely had to. They would "lean" on your offer until buying the call at $1.55 means paying well below fair value.

FOLLOW-UP ACTION

Just because you've executed an option trade doesn't mean you have to take it all the way to execution. That's often the best solution but you always have the right to make a better trade or, in the case of a covered call, to make a follow-up trade that improves your original trade.

Follow-up action generally falls into two categories, buying back the call we're short and rolling into another option by buying back the option we're short, and selling another option. While rolling there are essentially four alternatives: rolling up, rolling down, rolling up and out, and rolling down and out.

In rolling up we buy back the option we're short and sell an option with the same expiration but a higher strike price. In rolling down we buy back the option we're short and sell an option with the same expiration but a lower strike price. In rolling up and out, we buy back the option we're short and sell a higher strike call that expires later. In rolling down and out we buy back the option we're short and sell a lower strike call that expires later. The first three all have their place. The fourth, rolling down and out, is rarely the right solution.

Buying Back

There's no reason to remain short a covered call if the call has very little time value left and if there's a significant amount of time until expiration. This will generally happen if the stock has fallen since executing the covered call. It might also happen if some time has passed and implied volatility and option prices have fallen. In the first case there is probably little reason to buy back this option. We own a stock we want to own, so the drop in price is a risk we would have borne even if we weren't short the covered call. Assuming we sold a fairly short-dated covered call there can't be more than two or three weeks until expiration. Getting called away now that the stock has dropped is a very remote possibility and given the recent weakness might actually be a bonus, since we could move on to another stock without the wild swings.

In the second situation, where implied volatility and option prices have fallen without the underlying stock dropping, buying back the covered call is likely to make sense, particularly if we don't spend much for it. Remember that the bulk of the price erosion will take place close to expiration, and if there's significant time value left we don't want to forgo that. Buying back a covered call in this instance generally makes sense only if the option can be purchased for less than $0.10 and if there is a fair amount of time to expiration (i.e., at least a week).

A final situation where buying back our covered call can make sense is when allowing our stock to be called away would be a taxable event and force us to realize, and pay taxes on, gains that were previously unrealized. In this situation it might very well make sense to buy back the call, but if realizing a gain is so onerous that you'd buy back covered calls every time it appears they'll expire in-the-money, you should probably not be selling covered calls against that stock to begin with.

GETTING ASSIGNED

For those worried about realizing a taxable gain, it's important to know when we're likely to be assigned to sell our stock at the strike price.

If our covered call has any time value at all then it's unlikely we'll get assigned, with one exception. If the covered call has time value, even if it's just a few cents, the owner would be better off simply selling the call out and thereby collecting that remaining time value. If the owner exercises the option he forgoes any time value remaining in the option price. Table 10.14 provides an example.

Table 10.14 Getting Assigned

Stock Price	58.42
50 Strike Call Option with 15 Days to Expiration	8.55
Time Value	0.13
Value from Selling Call Option	8.55
Value from Exercising the Call Option	8.42

In this simple example, exercising the call option early would mean losing the $0.13 of time value included in the price. The exerciser would own stock at $50.00, the strike price, but at the cost of the call option, which is worth $8.55. The stock is now worth $58.42, a difference of $8.42. On the other hand, simply selling the call option for $8.55 and buying the stock at $58.42 results in collecting the $0.13 in time value and coming out $0.13 ahead.

The one important exception is when a dividend is looming. In this situation it makes sense for the owner of the call option to exercise it early if the amount of the dividend he'll collect is greater than the time value of the option.

In this situation, as shown in Table 10.15 for the HGIJ Corporation, it would seem the likelihood of early assignment is remote since there's the possibility that the stock would drop back below $55 before expiration and because the option has time value. If the owner of the call option exercised his 55 call he'd buy the stock at $55 but no longer have his option. He would have paid $55 plus the $7.15 option price, or $62.15, for stock worth $62.11. By exercising his call he's abandoned the luxury of waiting. Why would anyone do this by exercising early?

Table 10.15 Dividends and Early Assignment of Call Options

HGIJ Corp. Last Trade 62.11		
	Bid Price	Ask Price
June 55 Call Option	7.15	7.20
A Dividend of 1.00 Is Due to be Paid to Those Who Own the Stock Tomorrow		

Because the owner of the stock collects the $1 dividend that's due to be paid, while the owner of the call option does not.

The owner of the call option has three alternatives:

1. He can do nothing and hold the option.

2. He can exercise the option early.

3. He can sell the option at $7.15 and buy 100 shares of stock at $62.11.

What should this call owner do?

If he holds the option, which is the first alternative, his position is unchanged, but tomorrow the stock will go ex-dividend, meaning an owner is no longer entitled to the $1.00 per share. The $1.00 dividend is deducted from the stock price. The stock will open tomorrow at $61.11 and the call option will open at $6.15. Simply staying long the option will have cost the owner of the call option $100.

If the owner of the option exercises early and pays the 55 strike price for HGIJ, which is the second alternative, he loses the $7.15 value of the option and essentially purchases the stock at $62.15 (the 55 strike price plus the $7.15 option value). When the stock opens ex-dividend tomorrow the owner will see the stock drop to $61.11, but he will receive the $1.00 per-share dividend and he will have stock and cash worth $62.11. The owner of the call will have lost the $0.04 in time value, but that's better than losing the $1.00 that would have been lost if nothing had been done, and so the owner is better off exercising the option early rather than holding it.

The third alternative is selling the option and buying stock. Since the option is trading for $0.04 over its inherent value the result of selling the option and buying the stock is nearly identical to the second alternative, which is early exercise. Again, the owner of the call won't have come out very much ahead but he won't have lost anything either.

The result of a looming dividend is that early exercise of in-the-money call options is a very real possibility, particularly if they're trading for just their inherent value or if the time value remaining is less than the amount of the dividend. If having your stock called away would be a real burden, then paying attention to dividend timing is an important element in the likelihood of early exercise.

ROLLING

Rolling your covered call to another strike and potentially to another expiration is how traders take advantage of the opportunity to make a smarter, better informed trade as more information becomes available. In the case of rolling up, it will cost some of the premium previously received, but will reduce the likelihood of having our stock called away. In the case of rolling down it will generate additional premium at the cost of being short a lower strike price and thus having a greater chance of being called away. In the case of rolling up and out it will reduce the likelihood of having stock called away without surrendering any of the premium initially received but resets some of the option math against us.

Even though you always have the right to make a better-informed trade, good traders know that just wanting to trade isn't a good enough reason to make a follow-up trade. In determining whether to roll and how to roll, discipline and a little steely-eyed analysis is necessary.

Rolling Up

The covered call writer expects the stock he owns to trade sideways or appreciate slightly. If he thought it was going to turn lower he would likely sell the stock or look for another strategy that provides more protection than a covered call. As we've seen, if the stock rallies slightly this is the best of all possible worlds for the covered call writer. He can make a little bit on the stock and make all of the premium received for selling the call. On the other hand, if the stock is now near the strike price with the potential to be above the strike price at expiration, or if the stock rallies sharply, our covered call seller might want to take some action to be certain to keep the stock. The most straightforward trade would be to buy back the call, but that causes certain problems as we've discussed, including buying an option just as the daily erosion reaches its maximum point.

Another strategy is to roll the strike price up. In rolling up, call sellers buy back the call option they are short and sell another call option with the same expiration date but with a higher strike price.

For example, if our covered call seller was long 100 shares of PQR Corporation, which was trading at $77.50, and sold the 80 call option for $3, the downside breakeven would be $74.50 and the regret point would be $83.00. The maximum profit would be $5.50, $2.50 on the stock the option seller is long and $3.00 on the call the option seller is short. This maximum profit would be realized with PQR at or above $80 at expiration. Inside the range of $74.50 to $83.00 he is better off having sold the covered call but if PQR is above 80 at expiration he's going to have his stock called away.

If PQR is at $80 with two weeks to expiration our covered call seller may want to take some action to reduce the likelihood of seeing the stock called away and might decide to roll the 80 call up to a higher strike price with the same expiration.

With PQR at $80 the 80 call might now cost $4.00 and the 85 call might cost $1.50. The covered call writer can roll up by buying back the 80 call at $4.00 and selling the 85 call at $1.50. In buying the 80 call and selling the 85 call, the covered call writer has bought the 80/85 call spread.

Now PQR must be above $85 at expiration in order for the stock to be called away. Rolling up will cost $2.50 ($4.00 − $1.50). Rolling up will always cost money as the lower strike call, the call option our trader is buying back, will always cost more than the higher strike call, the call option the trader sells and ends up short. Rolling up should always be executed as a spread, buying the lower strike call and selling the higher strike call, for the reasons we discussed in Part Two.

If PQR is at or above $85 at expiration, the profit on the entire position would now be $8.00.

Covered call sellers in this position would have both increased the maximum profit and raised the price at which they were called away. How?

These traders would have increased the maximum profit while simultaneously raising the price at which they're called away in two ways, first by raising the downside breakeven point such that the stock only has to fall to $77.00 to reach breakeven and thus increasing the likelihood it's reached, and second, by raising the level at which the maximum profit is achieved and thus reducing the likelihood that it's reached. In this case it's raised from $80 to $85 meaning PQR stock now has to rally further, to $85.00, to achieve this maximum profit.

The downside breakeven is always raised by the amount spent to roll up. In this case the 80/85 call spread our trader bought cost $2.50, so the downside breakeven is raised by $2.50, from $74.50 to $77.00. Table 10.16 shows the rolling up data we've tracked for the PQR Corporation.

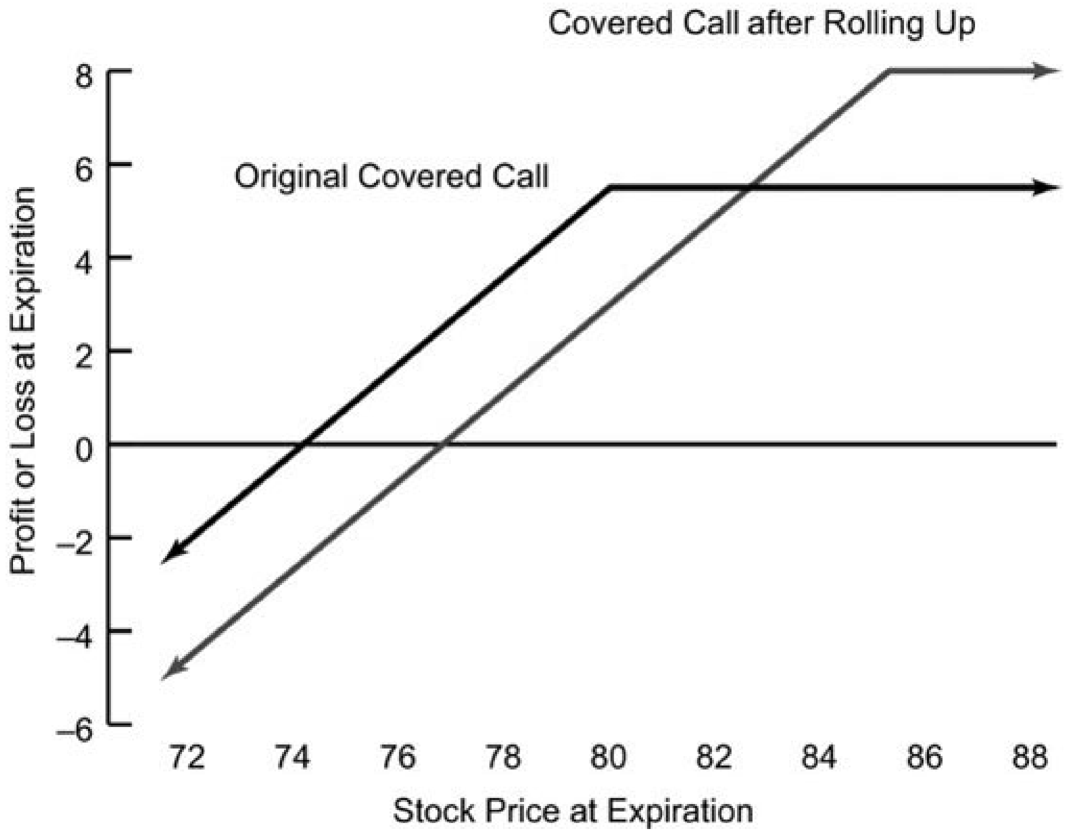
Table 10.16 Rolling Up

Initial Covered Call	
PQR Price	77.50
Call Strike Price	80
Call Premium Received	3.00
Downside Breakeven Point	74.50
Upside Regret Point	83.00

After PQR Rises to 80.00	
Follow-up Trade	Buy 80/85 Call Spread to Roll Up
Premium Paid	2.50
Total Premium Received	0.50
New Downside Breakeven Point	77.00
New Upside Regret Point	85.50

Figure 10.7 shows the risk/reward for the original position and the risk/reward for the position after it has been rolled up.

FIGURE 10.7 Original Covered Call and Rolled Up



Rolling Down

Since smart covered call writers only write calls on stocks that they already own and therefore like, having the stock drop after selling the call is likely to be a bit of a surprise. They expected the stock to trade sideways for some time, at least until option expiration. If they'd thought the stock was likely to head lower, they would have sold the stock and/or established a bearish option position.

When the stock does head lower the subsequent decrease in the value of the call option will cushion some of the loss, but since we don't sell covered calls for their insurance virtues, this is small comfort. So, if the stock drops should the option trader take follow-up action?

The initial covered call position had a range in which it realized a profit. That range was from the regret point of $83.00 down to the breakeven point of $74.50. Above the regret point it starts to forgo additional profit. Below the breakeven point it is a net loser. This being the case, limited return potential and risk all the way down to a stock price of zero, it's important to not let a covered call position experience a huge loss.

A covered call position has the added complication in that traders can't simply sell the stock if it drops. This would leave them naked short the call, a position that has to be avoided. This means that covered call sellers need to examine alternatives if the stock drops. They don't have to do anything, but they should examine what strategies they might use to make a better, more informed trade.

Covered call sellers have more information than they had when they initially executed their call sale. They have to use this information; they can be assured that other market participants are using this information to inform their trades. Again, it doesn't mean that covered call sellers have to take any action, it simply means that the action they do take will be better informed than the original trade.

One follow-up trade if the stock has dropped is to roll the covered call down. In rolling down, traders buy back the call option they are short and sell an option with the same expiration, but with a lower strike price.

For example, our covered call seller is long 100 shares of PQR Corporation, which is trading at $77.50, and has sold the 80 call option for $3. The downside breakeven is $74.50. The regret point is $83.00. Table 10.17 shows the initial PQR covered call and the result of rolling down.

Table 10.17 Rolling Down

Initial Covered Call	
PQR Price	77.50
Call Strike Price	80
Call Premium Received	3.00
Downside Breakeven	74.50
Upside Regret Point	83.00
After PQR Falls to 73.00	
Follow-Up Trade	Sell 75/80 Call Spread to Roll Down
Additional Premium Received	2.00
Total Premium Received	5.00
New Downside Breakeven	72.50
New Upside Regret Point	80.00

If PQR falls to $73.00 with two weeks to expiration, our trader is facing a loss of $1.50. Traders in this situation might use this new information along with any other data gleaned during this period and decide that they're less certain of PQR's prospects going forward. As such, they might demand an additional call premium and might be more willing to have their stock called away. This being the case, they decide to roll down the 80 call.

With PQR now at $73.00, the 80 call might be worth $0.50 (implied volatility has likely increased, as the entire skew curve has ridden the volatility slope higher; if it hadn't this call would be worth even less). The 75 call might now be worth $2.50. In order to roll down, traders would buy back the 80 call they're short and sell a 75 call. This trade, selling the 75/80 call spread, which should be executed as a spread for the reasons discussed in Part Two, would generate a premium credit of $2.00 ($2.50 − $0.50). Rolling down will always generate a credit, since the call option sold will cost more than the call option bought back.

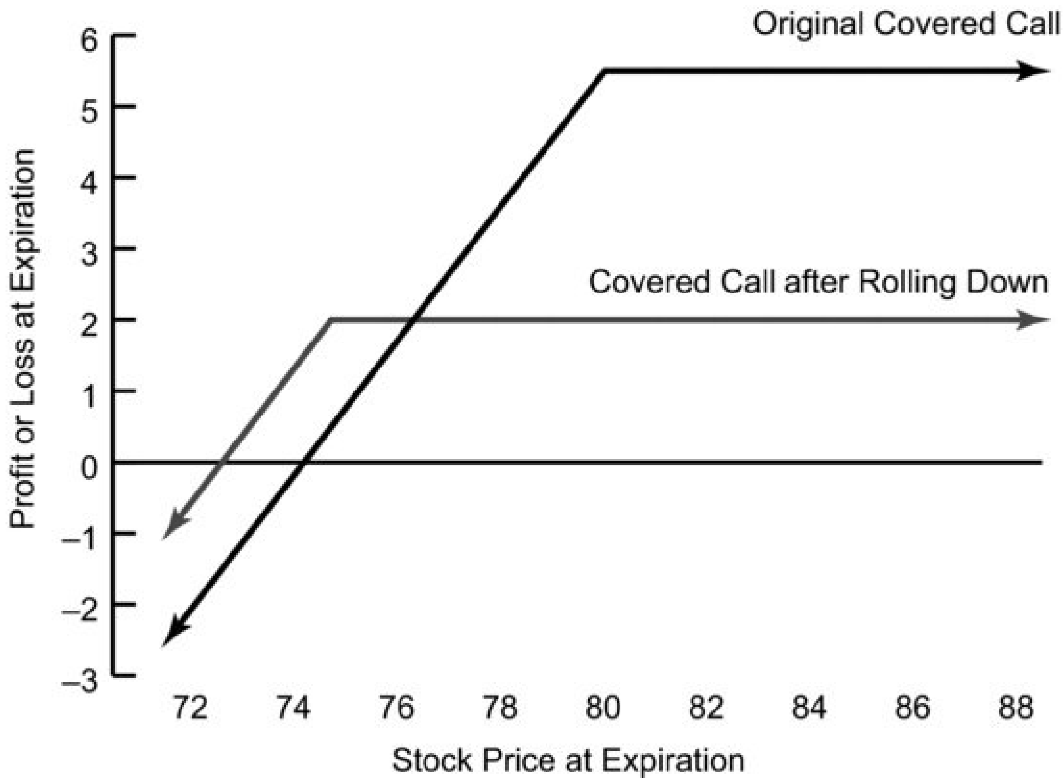
The breakeven point for this trade is now $72.50, which is below the current stock price. The new breakeven point for a rolled down covered call is always the original breakeven point minus the additional premium received.

The new regret point is $80.00.

The new maximum profit now occurs at $75.00, again we see the maximum profit occur with the stock price at the short strike At this point the maximum profit is $2.50, which represents the $5.00 in total option premium received less the $2.50 loss on PQR stock as it fell from $77.50 to $75.00. Rolling down has lowered the breakeven point, but it has also lowered the regret point.

Figure 10.8 shows the profit profile for the original trade as well as the trade after it's been rolled down.

FIGURE 10.8 Original Covered Call and Rolled Down Covered Call



Rolling down may be the right solution, but it subjects the trader to being constantly whipsawed and drastically increases the likelihood of getting called away. This may be okay for traders if the drop in price has made them reconsider ownership of this stock, but it may simply result in selling a good stock near a temporary low.

Locking In a Loser

If a stock has dropped enough, rolling down will reduce the maximum profit so much that the maximum profit is actually a loss. There will be no price for the underlying stock at option expiration that will generate a profit. The covered call seller would have locked in a loss.

For example, our covered call writer is long FED Incorporated, which is currently trading at $38.00, and might decide to sell the 40 strike call for $2.00. The downside breakeven point is 36.00 and the regret point is 42.00. Table 10.18 describes locking in a loser in FED.

Table 10.18 Locking in a Loser

Initial Covered Call	
FED Price	38.00
Call Strike Price	40

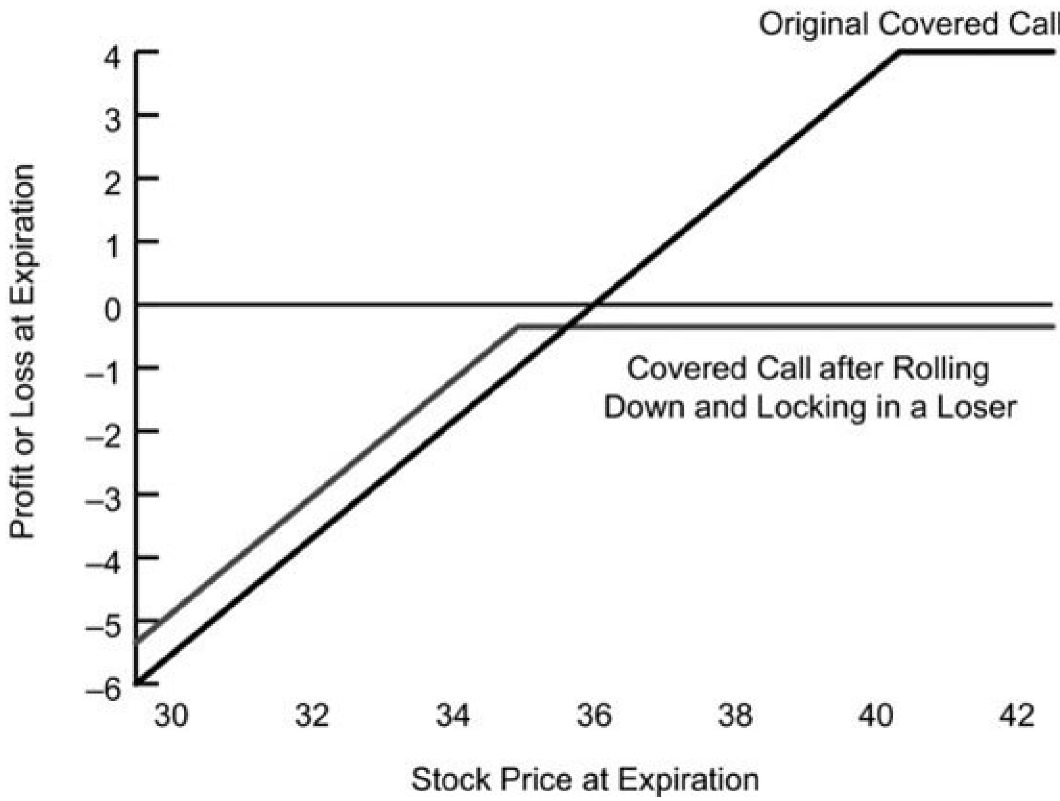
Call Premium Received	2.00
Downside Breakeven	36.00
Upside Regret Point	42.00
After FED Falls to 33.00	
Follow-Up Trade	Sell 35/40 Call Spread to Roll Down
Additional Premium Received	0.65
Total Premium Received	2.65
New Downside Breakeven	None—Locked-In Loss
New Upside Regret Point	37.65

If, after selling the covered call, FED drops to 33.00, our covered call seller might decide to roll down. In this case the 35 call might now be worth $0.75, while the 40 call might now be worth $0.10. If traders choose to roll down in this situation they will sell the 35/40 call spread by selling the 35 call at $0.75 and paying $0.10 to buy back the 40 call. They must buy back the 40 call; they can't simply sell the 35 call because that would leave them naked a call. These covered call sellers would receive an additional $0.65 for selling this 35/40 call spread.

But the result is that these traders have now guaranteed themselves a loss. If FED is at or above 35 at option expiration, they will have their stock called away at a loss of $3.00 ($38.00 − $35.00). This will only partially be offset by the $2.65 received in option premium ($2.00+$0.65). The very best these traders can do on this trade is a loss of $0.35. They have locked in a loser.

Figure 10.9 shows the initial trade and the position after the trader has locked in a loser.

FIGURE 10.9 Locking in a Loser



Locking in a loser sounds painful and it is, but that doesn't mean it's the wrong trade. If our trader has reevaluated FED Inc. and is determined not to own it any longer, then rolling down, even if it means locking in a loser, may be the best course of action. The traders rolling down because they don't want to own the stock any longer need to be mindful of two caveats.

Rolling down, even rolling down and locking in a loser, doesn't guarantee getting your stock called away. Don't think of rolling down as the same thing as selling your stock. Selling an at-the-money call certainly increases the likelihood of getting called away, but it's entirely possible for the stock to keep dropping and for it to be below the new strike price at expiration. If that happens covered call sellers will continue to own a stock they might not want to own. In these situations they might be better to simply buy back their call option and sell the stock outright.

Second, selling covered call options has limited utility as a vehicle for stock rehabilitation. If your stock is trading below your purchase price, then you might sell covered calls to make back the unrealized loss and hope to have the stock called away. This only works if the stock is within a reasonable distance of the initial purchase price. If you are deeply under water on the stock then the limited income generated by covered calls is unlikely to get you back to even. Again, there's no assurance that the stock won't continue to drop. In this case the loss compounds and you would have been better off buying back your covered call and selling the stock outright.

Rolling Up and Out

One reason that some traders hesitate to roll a covered call up is the requirement to pay premium to buy the call spread. Some hate to take premium they think they've already earned and pay it back out. This is the wrong outlook, as the premium isn't earned until the call has expired, but there is a way to reduce the likelihood of being called away without paying for a spread. The way to accomplish this is to roll up and out. In rolling up and out, traders buy back the call option they are short while simultaneously selling another call with a higher strike price and more time to expiration. The goal is generally to use the additional time to expiration of the call option being sold so that the spread can be done for no additional premium.

For example, in our rolling-up example in Table 10.16, PQR was trading at $77.50 and our covered call seller sold the 80 call for $3.00. The regret point was $83.00. PQR rallied to $80 with two weeks to option expiration. A trader wanting to roll up might pay $2.50 to buy the 80/85 call spread, but that $2.50 would reduce the potential profit if PQR didn't rally any further.

Another strategy would be to roll up and out in time by buying back the 80 call with 2 weeks to expiration and selling the 85 call with 6 weeks to expiration. You would be able to do this for no net premium if the 6-week 85 call is trading for the same $4.00 you have to pay for the 2-week 80 call. (See Table 10.19.)

Table 10.19 Rolling Up and Out

Initial Covered Call	
PQR Price	77.50
Call Strike Price	80
Call Premium Received	3.00
Downside Breakeven Point	74.50
Upside Regret Point	83.00
After PQR Rises to 80.00	
Follow-Up Trade	Buy 80 Call with 2 Weeks to Expiration / Sell 85 Call with 6 Weeks to Expiration
Premium Paid	0.00
Total Premium Received	3.00
New Downside Breakeven Point	74.50
New Upside Regret Point	88.00

Rolling up and out increases the regret point—it's now the new strike price plus the total premium received—but also extends the time the trader will be short the covered call. If the trader is rolling up and out because the stock is rallying, then it may simply delay the inevitable assignment.

Rolling up and out also resets the option math against the call seller. As we've seen, short-dated options like the original 2-week option erode more quickly than the new 6-week option. Despite having different strike prices, traders who roll up and out are paying more for each day in the option they're buying back than they're collecting for each day in the new option they're selling. This is the most convincing argument against rolling up and out, but that doesn't mean it should never be done, just that it should be done carefully.

In this example the call seller is able to roll up and out for no net premium, but the daily erosion of the new option is about half that of the old option. This is the cost for increasing the strike price at which the stock is called. Unfortunately, this also means we've raised the price at which the maximum profit occurs and we've increased the regret point. Table 10.20 shows data for the daily erosion (theta) after rolling up and out.

Table 10.20 Daily Erosion After Rolling Up and Out

	Option Price	Daily Erosion (Theta)
Stock Price 80.00		
80 Strike Call with 2 Weeks to Expiration	3.00	0.109
85 Strike Call with 6 Weeks to Expiration	3.00	0.059

Since our trader initially sold the covered call based on the thought that the underlying stock was stuck in neutral for some time, rolling up and out may make sense because it can allow the rally to run out of steam. But since traders often write covered calls on a stock they like to begin with, maybe a rally is simply a manifestation of all the reasons they liked the stock.

TAKEAWAYS

The best way to approach selling covered calls, which can be a great strategy and a fantastic way to harvest the volatility risk premium, is holistically.

Our savvy covered call sellers will think about all the issues we've discussed in this chapter including:

- Return if the underlying stock doesn't move during the term of the option.
- Return if the underlying stock is called away.

- The yield from selling the call.
- The option math and how successful option selling favors at-the-money, shorter-dated options (although that doesn’t require selling the short-dated, at-the-money option).
- Using the bid/ask spread to our advantage in illiquid options.
- Getting called away isn’t a defeat, particularly if we’ve sold our stock at a big profit.
- We’re trying to collect the volatility risk premium.
- We make our money when we sell the call, and we collect it through the daily price erosion, so try to sell shorter-dated options that maximize theta.
- We always have the right to execute a more informed follow-up trade.

CHAPTER 11

Selling Puts

Selling puts can be a great strategy: It collects premium and offers the potential to buy stock at a discount. Selling a put takes advantage of several of the phenomena we discussed in Part Two, mainly the volatility risk premium, and since we'll sell short-dated options, it will take maximum advantage of time decay.

As we discuss selling puts, it won't be for speculation and it won't be levered; rather it will be fully funded, meaning the put seller will have the cash set aside to pay for the stock if it's put to him.

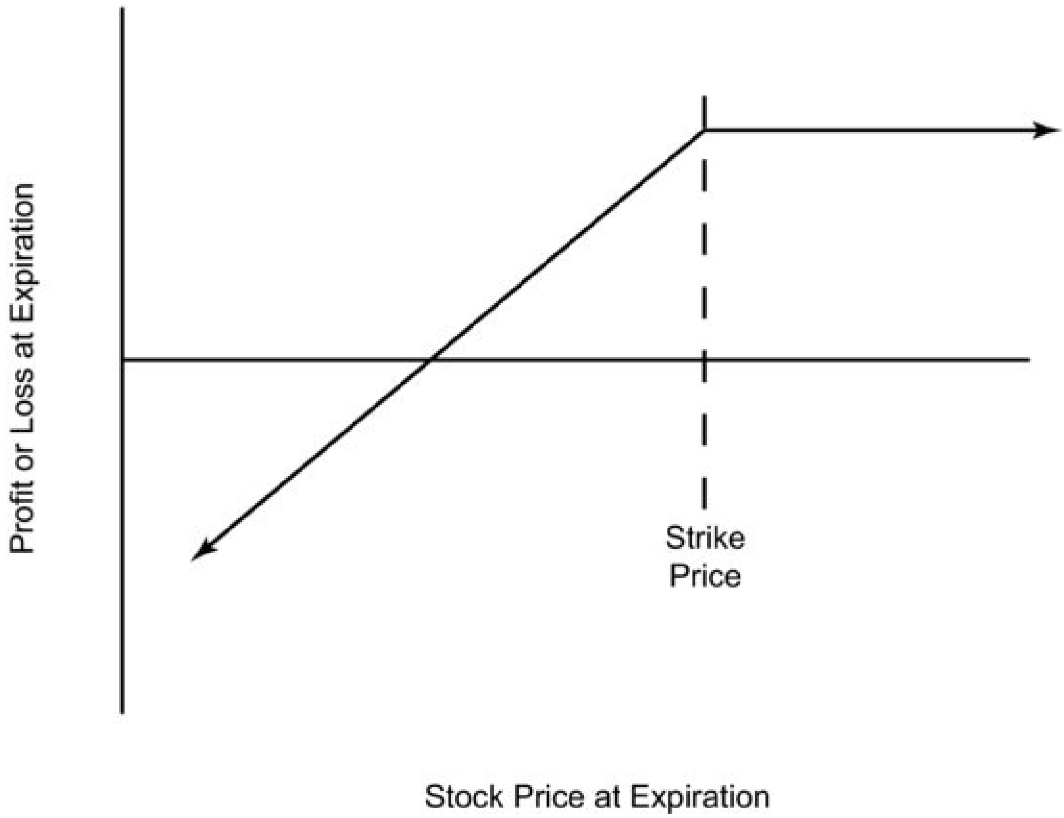
Almost every trader has entered a limit order to buy stock. It's a great way to buy stock at a discount, at a price that's more palatable then the current market price, which may have simply been too expensive. One of the problems with a limit order to buy stock is obviously the potential to never buy the stock and see it appreciate substantially.

The same problem exists for the option trader when selling puts with the added wrinkle that the stock has to be below our limit price (i.e., the put option strike price) at option expiration—so timing is an issue as well. If we've entered a limit order to buy shares then if the stock is below that limit price, for a month or a minute, we're going to get our buy order filled. When selling puts to buy stock it's not the amount of time the stock is below our strike price, it's when that occurs. It has to occur at expiration.

While this is a deterrent to selling puts if a trader's sole goal is to buy stock, by selling puts we're paid to wait to buy the stock and we're often paid very handsomely. Think of selling puts as a way to get paid for waiting to see our buy order filled, although it's entirely possible that we'll wait until expiration and never get filled.

In selling puts, we agree to buy the underlying stock at the strike price if the put option buyer exercises their option. We'll be paid the option premium for agreeing to do so. The maximum profit is that premium received. The breakeven point is the strike price minus the premium received. The maximum loss occurs if the stock goes to zero at expiration. Figure 11.1 shows the typical risk and reward for a short put at expiration.

FIGURE 11.1 Short Put Risk and Reward



SELLING PUTS IS BEST FOR STOCKS YOU WANT TO OWN AT A DISCOUNT

Selling puts to buy stock that you want to own at a discount is a wonderful strategy for great stocks that you think aren't likely to fall or appreciate significantly during the term of the option. If you thought that the stock was going to fall, you certainly wouldn't sell a put. In that situation you'd be better off buying a put. If you thought the stock was going to appreciate sharply, selling puts isn't the optimal strategy. In that situation you'd be better off buying call options or buying the stock outright. However, on some occasions great stocks get stuck in neutral.

Selling puts should only be done on great "names" that you want to own at a discount. Don't get into the habit of selling expensive puts on bad stocks just because the options are expensive and you think you'd be willing to buy anything at a 15 percent discount. When that bad stock falls, as they tend to do, you might end up buying something you don't like at an effective price higher than its current market price. The discount from the initial price isn't so attractive now, since you own a bad stock at a higher price. In that instance you should be looking to puke it (sell it at a loss) just as soon as you get it put to you.

Selling puts should be done on stocks that you don't currently own or on stocks that you'd like to own more of. Be careful in this second case. It potentially violates a cardinal rule of trading by adding to a loser, and getting long more stock through a put sale generally means the stock is at least slightly lower than it was.

We'll always consider selling puts as a great way to buy stock at a discount. As such you'll always have the cash ready to go in order to buy the stock, and it will preferably be in the same account you're selling the put option in. Don't sell naked puts, that is, don't plan to rely on margin to buy the stock if it gets put to you. We're getting paid to wait to buy the stock, not to dodge a bullet.

As in a covered call, we get to keep the premium received whether the put option we're short gets assigned, meaning the stock is put to us and we're required to buy it at the strike price, or not. Keeping this premium means that we might buy the stock at an effective price (strike price minus premium received) lower than the stock ever traded.

When selling puts to buy stock at a discount, or to at least get paid for trying to, there are four possible outcomes, as shown in Table 11.1. One is good, one is less good, one is great, and one is less bad.

Table 11.1 Relative Outcome from Selling Puts

Stock Price Action	Position Result	Relative Outcome
Stock Rallies Slightly	Keep Premium, Don't Buy Stock, Gain Greater Than Buying Stock	Good
Stock Rallies Sharply	Keep Premium, Don't Buy Stock, Regret Not Buying Stock	Less Good
Stock Falls Slightly	Keep Premium, Don't Buy Stock, Maximum Profit Achieved	Great
Stock Falls Sharply	Keep Premium, Buy Stock, Premium Cushions Loss	Less Bad

Having the stock rally slightly means we get to keep the premium received for selling the put, and since the stock is near its original price, we're money ahead.

If the stock rallies sharply the outcome is good, we get to keep the premium received, but it's less good than simply buying the stock would have been.

The stock falling slightly is the best possible outcome assuming it stays above the strike price. This is because the put will expire worthless and the put seller will get to keep the premium received, but the stock we like will cost slightly less than it did. The next trade can be to sell the same strike price in the next expiration and probably receive more in premium than the initial put sale, or to sell a lower strike put while collecting a reasonable amount of premium.

Having the stock fall sharply, enough so that it's below the strike price, is less bad than simply buying the stock would have been. The effective purchase price will certainly be lower than the market price for the stock when we sold the put. The current stock price may be below our effect purchase price, meaning we're facing a loss, which is bad, but it will be a smaller loss than if we'd just bought the stock outright.

THE PHENOMENA

Of all the phenomena we discussed in Part Two, the volatility risk premium is the most important for selling puts. Over time, put sellers are receiving more (implied volatility) than they're giving (realized volatility). It's this excess that generates additional return and can make selling puts superior to simply buying stocks on the offer price. Table 11.2 shows the volatility risk premium for some S&P put options going back to 1989. These are the SPX options we discussed in Part Two.

Table 11.2 Volatility Risk Premium for SPX Put Options

Put Option	Average Implied Volatility	Average Realized Volatility, S&P 500 During Opt Term	Average Volatility Risk Premium in Volatility Terms
At-the-Money 30-Day Put	18.31%	16.29%	2.02%
5% Out-of-the-Money 30-Day Put	25.37%	16.29%	9.08%

The difference in volatility risk premium for the two puts is a result of skew. Out-of-the-money put options tend to be relatively more expensive than at-the-money options due to hedgers buying out-of-the-money puts as we discussed in Part Two. Skew can help a put sale at initiation; it obviously helps the seller of that 5 percent out-of-the-money SPX put option. Skew is likely to be less obvious and less steep in individual equities. You can use the implied volatility calculator at OptionMath.com to calculate the implied volatilities for the puts you're considering selling.

Time decay is the way put sellers collect their premium. Since daily time decay is greater for short-dated options, those are the put options that a put seller should focus on. As we saw in Part Two, the put seller is better off selling a series of three 30-day put options rather than selling a single 90-day option. The accelerating time decay from short-term puts is a great way to get the option math working in your favor.

The bid/ask spread can make very little difference in the profitability of very liquid options with tight bid/ask spreads. Again, in this case, it generally makes sense to simply sell the put option at the bid. The tiny amount of edge (the difference between the option's fair value and the realized selling price) given up isn't likely to impact the outcome of the trade. When bid/ask spreads are wide but the options are fairly active and liquid, getting the put sale executed at a reasonable price can be more difficult. The midpoint of the bid/ask spread is a reasonable proxy for fair value, but that doesn't mean the market will want to buy your put there. Illiquid options, which almost always have wide bid/ask spreads, are an opportunity to use the spread to your advantage. The fair value is likely to be closer to the bid than the offer, and this is an opportunity to offer your put for sale at higher than fair value by offering it for sale at the midpoint of the bid/ask. If a market maker needs to buy options to offset some he has already sold, then he's likely to buy your offer. The guide to execution of covered calls in Chapter 10 applies to selling puts as well.

Volatility slope can help in closing out the trade early if the stock moves higher. If that happens the volatility slope will bring implied volatility, and option prices, down for all strike prices. Volatility slope can make closing out the trade early more difficult if the stock moves lower. All implied volatilities will increase, so delta (the increase in the put price as the underlying price falls), as well as vega (the increase in the put price as implied volatility increases), both work against the put seller.

SELLING PUTS IS IDENTICAL TO A BUYWRITE

Observant readers will have noticed that selling a put results in a position that seems a lot like the hybrid position that resulted from selling a covered call. The payoff chart for a short put, Figure 11.1, looks very similar to the covered call hybrid charts we saw in Chapter 10. The outcome for a short put is affected by the same phenomena, which tend to have the same sort of impact. While we sold covered calls on stock we already owned, if we made it a point to buy stock just so we could sell covered calls on it, the similarities would be even more striking.

That's because selling a put and doing a buywrite (simultaneously buying stock and selling covered calls) are identical positions. Assuming the strike price and expiration date of the put and covered call are the same, the maximum potential profit is the same, the maximum potential loss is the same, and the breakeven and regret points are the same.

Scenarios

Buywrite

Buy 100 shares of ABC Corp at $100.00

Sell 30-day 100 strike call at $5.00

Total capital required = $9500.00 ($10,000 to buy stock minus $500 in option premium received)

Breakeven point is 95.00

Regret point is 105.00

Selling a Put

Sell 30-day 100 strike put at $5.00

Total capital required = $9,500 ($10,000 to buy stock if assigned minus $500 in option premium received)

Breakeven point is 95.00

Regret point is 105.00

Outcomes

With ABC Corp at $120.00 at option expiration, both strategies return $5.00.

The buywrite paid $100.00 for ABC shares and got called away at $100, recognizing no gain or loss. The buywrite gets to keep the $5.00 in call premium received.

The short put sees the put expire worthless and gets to keep the $5.00 in put premium received.

With ABC Corp at $100.00 at option expiration, both strategies return $5.00. The buywrite paid $100.00 for ABC shares, which are still worth just $100.00, and the call expires worthless. The buywrite gets to keep the $5.00 in call premium received. The short put sees the put expire worthless and gets to keep the $5.00 in put premium received.

The buywrite still owns the stock while the short put does not, but since the stock is at $100 and could be bought or sold there, continued ownership is neither an advantage nor disadvantage, however the buywrite had to pay two commissions to initiate the position and will be left paying another commission to sell the shares. This is a decided disadvantage.

With ABC Corp at $80 at option expiration, both strategies lose $15.00.

The buywrite loses $20.00 on the stock bought but gets to keep the $5.00 received for selling the call. The buywrite still owns the stock.

The short put is assigned and buys the stock at $100.00. The short put loses

$20.00 on the stock but gets to keep the $5.00 received for selling the put. The covered call seller and the put seller both own the stock.

As long as the covered call and short put have the same strike price and the same expiration, the outcome from a buywrite (buying the stock to sell the covered call) will be identical to selling a put because the time value for the covered call and the put will be equal. This ignores the two commissions that the buywriter would pay. The first is to buy the stock; the second is to sell the covered call. Compare this to the single commission the put seller pays. This is why it doesn't make sense to buy stock just to sell calls against it. Selling the same strike put is a better way of getting exactly the same payout.

SELLING PUTS TO BUY STOCK AT A DISCOUNT

Selling puts is a great way to collect premium while waiting to buy a good stock at a discount if it drops. One risk is that the stock will rally and we'll never get ownership. Another risk is that we're forced to buy the stock (i.e., we have it put to us) when the stock has dropped substantially such that it's well below our breakeven point. The put seller has to be ready and able to buy the stock, but should think it's stuck in neutral for a while.

Table 11.3 shows some SPY puts we might consider selling in order to buy SPY at a discount.

Table 11.3 Selling Puts to Buy SPY at a Discount

	Bid	Offer	Breakeven Point	Regret Point
SPY	140.40	140.41		
30-Day 130 Strike Put	0.35	0.36	129.65	140.76
30-Day 140 Strike Put	1.99	2.00	138.01	142.40
30-Day 150 Strike Put	9.50	9.78	140.50	150.05

The breakeven point is similar to the one we discussed in selling covered calls. If the underlying stock is below this point at expiration, then we'll have been better off not having sold the put option. We will have lost money. The regret point is also similar to that discussed in the covered call chapter. Above this regret point we would have been better off simply buying the stock.

At the regret point the stock is above the strike price of our put option at expiration, so the owner of the put option won't exercise and the put seller won't buy the stock. The premium received is now equal to the profit we would have enjoyed from buying the stock. Above this point we regret not buying the stock outright.

The put seller should always look at shorter-term options like these 30-day options since longer-term options don't erode as quickly. If we sold the 130 strike put we'd likely sell it at $0.35. That's a 0.25 percent yield for the 30 days, or about 3.00 percent annualized. If we sold the 140 strike put we'd likely sell it at $1.99. That's a 1.4 percent yield, or about 17 percent annualized. The 150 strike put is a little different. Since it's in-the-money we can't calculate the yield in the traditional way because so much of its value is inherent. If we sold the 150 put at the midpoint of the bid/ask spread, the time value would be 0.04 and the *additional* yield would be very small, about 0.025 percent monthly or about 0.3 percent annually.

We know that a put seller is trying to capture the volatility risk premium and will be paid through the daily erosion but the goal of selling a put option is to buy a stock at a discount and to get paid for waiting to see if we get filled. What is the likelihood that these SPY options will be exercised meaning that we buy SPY at the strike price? That would be the delta of each option. How much would we be paid today for waiting to see if we get our order filled to buy SPY? That would be the daily erosion (theta) for each option. Table 11.4 details each of these variables.

Table 11.4 Selling Puts and the Greeks

Option	Implied Volatility	Delta	Daily Erosion (Theta)
30-Day 130 Strike Put	20.58%	-9	0.023
30-Day 140 Strike Put	13.62%	-46	0.037
30-Day 150 Strike Put	11.91%	-97	0.005

At-the-Money

The at-the-money put (in the SPY example it's the 140 put), will always have the greatest amount of time value, as we saw in Part Two. As such, it will also have the highest daily time decay.

The at-the-money put will also have a so-called fair implied volatility, meaning that skew will have little impact on the price of the option. Since the at-the-money put is likely to actually be somewhat out-of-the-money (as the SPY 140 put is in this example), there may be a tiny bit of skew included in the implied volatility, but this effect will be very minor.

If there's a problem with selling the at-the-money put, it's that actually buying the stock usually occurs less than 50 percent of the time. This likelihood is the delta we discussed in Part Two. For the SPY 140 put the delta was about 46, meaning there's about a 46 percent chance of being in-the-money at expiration. If this likelihood isn't sufficient for the trader considering a put sale, then this isn't the best strategy—although selling a slightly in-the-money put is also a possibility, since the time value of that option is likely to be close to that of the at-the-money option. In this SPY example the in-the-money put would be the 141 put, which was trading at $2.42. The inherent value is about $0.60 and the time value is $1.82 versus time value for the 140 put of $1.99. The delta of the 141 put was 54, meaning there was a 54 percent chance it would be in-the-money at expiration. Moving to more in-the-money options will increase the likelihood of being in-the-money at expiration but will do so at the cost of time value, which will decrease fairly quickly.

In-the-Money

An in-the-money put will have a strike price that is above the current market price for the underlying stock. The implied volatility for an in-the-money put will generally be lower than for the at-the-money or out-of-the-money puts, meaning that they are *relatively* less expensive (although in absolute terms they'll be more expensive due to the inherent value) and will have relatively less time value; time value is what the put seller wants more of. Selling the in-the-money put can drastically increase the likelihood of buying the stock: In the SPY example the delta of the 150 strike put was 97, meaning there's a 97 percent chance of it being in-the-money at expiration. However, the bid price for this option is actually below parity. With SPY at $140.40/$140.41, the 150 put should be worth at least $9.60 but the issues surrounding the bid/ask spread for deeply in-the-money options discussed in Part Two result in a bid price lower than $9.60. Selling this 150 put option at $9.50 may be a lot like just buying SPY shares outright, but it's a lot like paying $140.50 for them.

Even if we would sell the midpoint of the $9.50 bid/$9.78 ask for the 150 put ($9.64) we're only collecting $0.04 of time value. We're not being paid very much to wait. In-the-money puts aren't usually a great sale and skew is a big reason why.

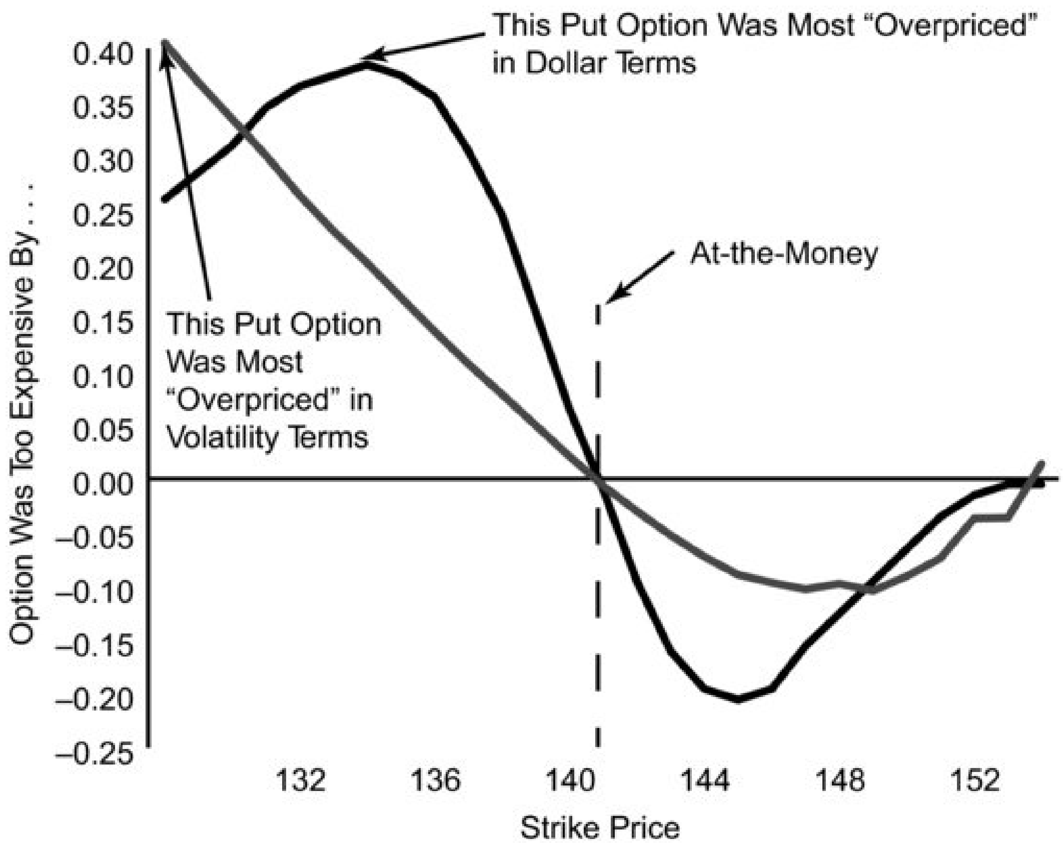
Out-of-the-Money

Selling out-of-the-money puts offers the best (lowest) effective purchase price, but the likelihood of actually getting the stock bought is pretty small. In the SPY example the effective purchase price (if we sold that 130 put) would be $129.65 ($130 – $0.35) but the 130 put has a delta of 9, meaning the likelihood of actually having the stock put to you is only 9 percent. Add the fact that the premium received is only $0.35, and the fact that we're tying up the capital needed to pay for the stock if it's put to us, and the yield from selling that put is only about 3.2 percent annually. That's not terrible, but there's the potential for loss if SPY is below the breakeven point at option expiration. Since so little premium is generated, the difference between the strike price and the breakeven point is very small. If we get the stock put to us it's likely to be below the breakeven price, and our put sale would be facing a loss. Clearly selling deep out-of-the-money puts faces some problems. Remember also that an out-of-the-money option may have seen the majority of its time value already eroded away. At some point an option is so far out-of-the-money that erosion will actually slow down as expiration approaches as we discussed in Chapter 7 and saw in Figure 7.4.

As for the phenomena, skew will be a huge help to out-of-the-money puts, as we discussed in Part Two. They'll be more expensive in the manner that counts, (i.e., in implied volatility terms), as they'll be "rich" to the at-the-money implied volatility, but in real-dollar terms put options that are substantially out-of-the-money still end up being pretty cheap.

For this SPY 130 put, the effect of skew in volatility terms is about 5.90 volatility points, so if the 130 put had the same implied volatility as the 140 put it would trade for about $0.06, the option price error is $0.29. This means skew adds about $0.29 to the price of the 130 put. The most expensive SPY put in terms of implied volatility terms would be the 128 put, as shown in Figure 11.2, but the observed price was only $0.27, and that's not much premium. The most overpriced put in dollar terms would be the 134 put which was "too expensive" by $0.39.

FIGURE 11.2 SPY Put Price Error



The volatility risk premium for out-of-the-money puts in volatility terms is gigantic, but in real-dollar terms it trails off pretty quickly as we get further out-of-the-money.

Follow-Up Action

As with covered calls and any other option position, you always have the right and the opportunity to make better informed trades that can lock in a profit, increase the potential profit, or reduce the risk from any existing trade. Not only do you have this right, you have an obligation to yourself to always make the best possible trade, even if it means taking a loss.

No option trade requires that you take it to expiration. Some generally work out best that way, and this is especially true for short option positions, but if the better informed trade is to buy back your short put, then do so.

Follow-up action for a short put usually takes one of two forms, buying back the put or rolling. Rolling a short put is a little like the rolling of a covered call that we discussed in Chapter 10, with a few differences. In rolling our short put option down we'll buy back the strike price we're short and sell a put with a lower strike price. This will cost additional premium. In rolling down and out we’ll buy back the put option we’re short and sell a put option with a lower strike price and more time to expiration. This may either cost or generate premium. The goal is to keep the net paid or received close to zero. In rolling up we’ll buy back the put option we’re short and sell a put option with a higher strike price. This will generate additional premium received.

Buying Back a Short Put Option

If most of the time value has come out of a short put, particularly if there is still a significant amount of time to expiration and the underlying stock is above the strike price, it generally makes sense to buy back the put if it can be done cheaply. Cheaply usually means for less than $0.10.

It might also make sense to buy back the short put, even if it has a significant amount of time value left, if the fundamental story for the underlying stock has changed dramatically. If this is the case then the option will usually be in-the-money and buying the option back will usually result in realizing a loss. But traders like to say that “your first loss is your best loss,” meaning that taking the loss if the picture has changed is much better than hoping that the trade works out while running the risk of greater losses while you are continuing to allocate capital and devote time to a losing trade as well. If the fundamental picture has indeed changed, then we’re no longer short a put on a great name that we want to own at a discount; we’re short a put on a name that we don’t particularly like and don’t want to own at anything like the current price.

Buying back a short put if the stock has dropped significantly is likely to be expensive. The option will be more costly because it’s now in-the-money. This is the impact of delta on the option price. Implied volatility is also likely to be higher, making the put more costly than it would be otherwise. This is the impact of vega and the volatility slope on the option’s price. Implied volatility is higher because the stock is seen as being riskier and because the entire volatility skew has ridden the volatility slope higher.

This doesn’t mean that we should lose our nerve just because the stock is lower and is going to be put to us. Unless something fundamental has changed this is what we wanted; we wanted to buy a good stock at a discount. It’s possible that three months from now the stock will be higher and the price we paid will be seen as a great entry point; that fleeting buying opportunity will have vanished. If as option traders we are disciplined enough to only sell puts on good stocks that we want to own at a discount, then this is an opportunity for us to discipline our fear. If something fundamental has changed, then the smart option trader will use the opportunity to reevaluate the stock and make a better informed trade. Simply having the price of the stock drop, absent some other issue, isn't a fundamental change.

One thing not to do in the situation where the short put is now in-the-money and likely to be exercised, which would leave you long the stock at the strike price, is to sell a call option. You don't own the stock yet and will never own it if the stock rallies back above the put strike price at expiration. This means the call would be uncovered or naked. This isn't the time for stock rehabilitation via call selling. Not yet anyway.

ROLLING

While a buywrite is identical to a short put of the same strike price and expiration, when rolling the directions are reversed: Rolling up for a covered call becomes rolling down. For a short put we'll discuss rolling down, rolling down and out and rolling up.

Rolling Down

Sellers of a put option expect the underlying stock to trade sideways to slightly higher or lower. If they thought it was going to move substantially in either direction they'd use a different strategy. Rather, they're willing to sell a put in an effort to buy the stock at a discount while getting paid for waiting. If the stock has fallen, put sellers might very well think it's still a good stock but that short-term circumstances are temporarily depressing the share price. In this situation they might want to reduce the effective price they're willing to pay for the stock. This is a little like lowering the limit bid price if they were using a limit order to buy the stock.

Trying to buy stock at a discount by selling a put is a great strategy and we don't want to lose our nerve just because the price of the stock has dropped, but that doesn't mean we have to be sitting ducks.

In this situation put sellers can roll the strike price of the put option down. In rolling down the put sellers repurchase the put option they are short and sell another put option with the same expiration date but with a lower strike price.

Rolling the short put down will always cost the trader money, since the put being repurchased is always going to be more expensive than the lower strike put sold. This net premium paid will reduce the maximum potential profit from the trade, which was originally the put premium received. It's possible for the net premium paid to roll down to exceed the initial premium received, making the best potential outcome a loss. The result is that the effective price potentially paid for the stock will be lower than the effective price would have been if the put hadn't been rolled down but the net premium collected will be reduced by the cost of the put spread bought to roll down. The effective purchase price of the stock is lower but the profit if the new put option expires worthless is reduced.

For example, if put sellers think very highly of STU Inc., which is trading at $125.00, they might think that current price is reasonable given the company's prospects, but they'd like to buy it at a discount if they can. If they can't buy it at a lower price, they'd be willing to forgo buying the stock at all, but they'd like to get paid while waiting to see if their order is going to get filled, as shown in Table 11.5.

Table 11.5 Rolling Down

Initial Short Put	
STU Price	125.00
Put Strike Price	120
Put Premium Received	7.00
Downside Breakeven	113.00
Upside Regret Point	132.00
After STU Falls to 120.00	
Follow-Up Trade	Buy 115/120 Put Spread to Roll Down
Premium Paid	2.50
Total Premium Received	4.50
New Downside Breakeven	110.50
New Upside Regret Point	129.50

In this case put sellers can sell the 120 strike put at $7.00. That $7.00 would be the maximum profit from the put sale and would be realized with STU at or above $120 at option expiration. The downside breakeven would be $113.00 and this would also be the effective price paid for STU stock if it's put to them. The regret point, the price at which buying the stock outright would be just as profitable as selling the put, is $132.00.

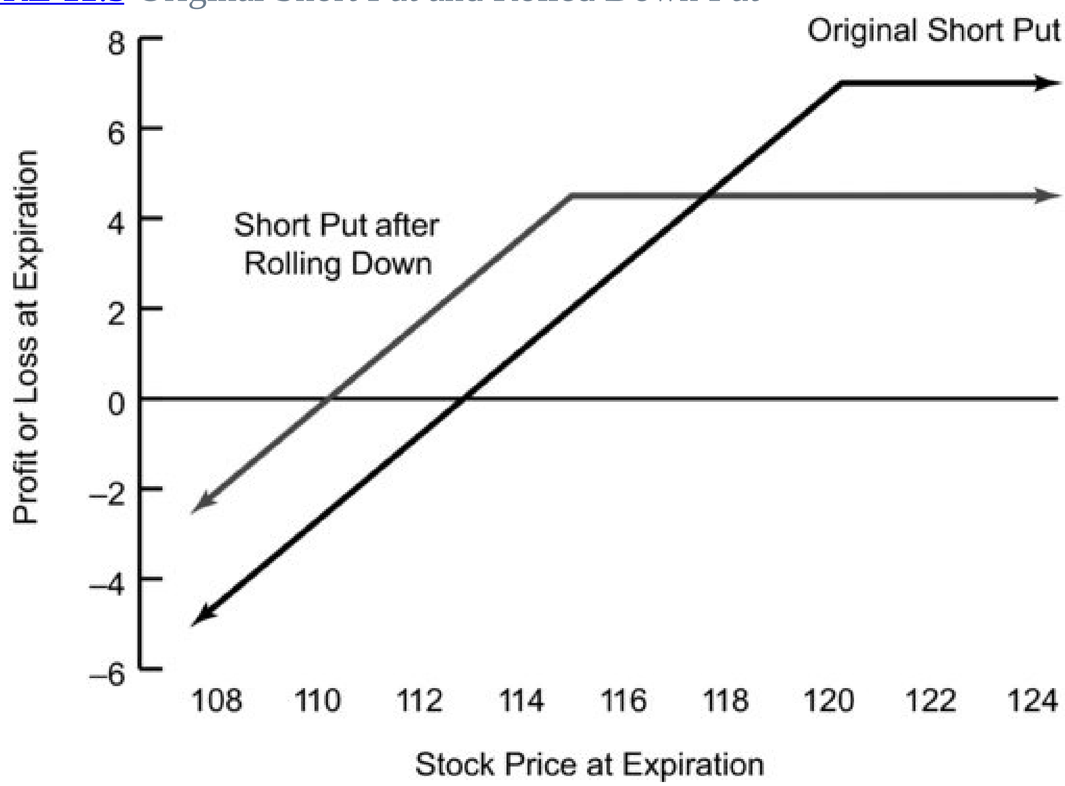
If STU has fallen slightly and is trading at $120.00 with two weeks to expiration, our put sellers can reexamine the trade and the prospects for STU with the goal of making a better informed trade if one is available. If they realize that the cause of the drop in STU's stock price is transient trouble for another company in the same space, our put sellers might decide that the possibility exists to buy STU for even less than they had originally been willing to pay. They've done analysis of fear versus greed and determine that rolling the short put down slightly is the better informed trade.

STU is now at $120.00 and the 120 strike put might now cost $8.00 while the 115 strike put might now cost $5.50. The put seller can roll down by buying the 120 strike put back at $8.00 while simultaneously selling the 115 put at $5.50. The trade should be executed as a spread for the reasons we've already discussed. The net premium paid for this spread is $2.50. This reduces the maximum potential profit on the trade to $4.50 but has reduced the effective purchase price, if assigned, to $110.50.

If STU is below this new strike price of 115 at expiration, then the put seller will be put the stock at an effective price of $110.50 regardless of the stock price at the time. If STU is above $115 at expiration then the new maximum profit of $4.50 will be realized, but the put seller won't buy the stock. If STU is between $115, the new strike price, and $120, the original strike price, the put seller will have missed the chance to buy the stock and will have paid out $2.50 adding insult to injury.

Figure 11.3 shows the payoff chart for the original trade and for the rolled down trade.

FIGURE 11.3 Original Short Put and Rolled Down Put



Rolling a short put down generally takes advantage of skew since the implied volatility of the new strike should be higher than that of the original strike, but implied volatility in general is likely to be higher making the spread more expensive than it would be otherwise. The daily erosion for the new put is likely to be less than for the original put.

Rolling down will always decrease the maximum potential profit and will cost money to execute, but rolling down generates a lower (better) breakeven point and a lower effective purchase price if the short put is assigned.

Rolling Up

A put seller should be thinking that the underlying stock isn't going to rally substantially during the term of the option. As we've said before, if a rally is your thesis then there are better strategies than selling a put. However, as a put seller you will focus on good companies that you want to own at a discount, so it shouldn't be too surprising if the underlying stock does rally.

When the stock rallies, the effect of the delta on the option price means the put option price should drop. The effect of vega and the volatility slope will also likely drive down the cost of the option, but even the combined effect might not be enough to make up for a missed opportunity. As you reexamine the landscape for this stock you may decide that a potential headwind hasn't become the problem you thought it might, or that the market has discounted some other problem. If this is the case you might be willing to pay more than your original effective purchase price but don't want to simply buy the stock at the current market price.

One follow-up strategy that would work in these circumstances would be to roll the short put up to a higher strike price. In rolling up a short put, the trader buys back the original put and sells a higher strike put with the same expiration. The trade should be executed as a spread and will generate additional premium since the new, higher strike price put option sold will cost more than the original lower strike price put.

In our STU example, the stock was at $125.00 when our put seller sold the 120 put for $7.00. If we had the stock put to us in this situation the effective price would be $113.00. This is the downside breakeven point. The upside regret point is $132.00. Above this point we'd regret not buying the stock outright.

If STU rallies to $135 it is now above the original regret point of $132. The original 120 put might now be worth only $1.00. As put sellers we may digest the new information and decide that the potential problem that we thought would keep STU from appreciating is not being viewed as a problem by the market. We may decide that we're willing to pay a higher effective price but don't want to pay $135.00. If the 130 put is now trading at $4.00 we can roll up by buying back the 120 put at $1.00 and selling a new 130 put at $4.00. We're collecting an additional $3.00 in premium to add to the original $7.00 received. We have raised the effective price we would pay for the stock if it is put to us. That effective price is now $120.00, the 130 strike price minus the $10.00 in total premium received. We've also increased our maximum potential profit to $10.00, but at the cost of increasing our maximum potential loss and raising our breakeven point from $113.00 to $120.00. Table 11.6 shows the initial short put and the result of rolling up.

Table 11.6 Rolling Up

Initial Short Put	
STU Price	125.00
Put Strike Price	120
Put Premium Received	7.00
Downside Breakeven	113.00
Upside Regret Point	132.00
After STU Rallies to 135.00	
Follow-Up Trade	Sell 120/130 Put Spread to Roll Up
Premium Received	3.00
Total Premium Received	10.00
New Downside Breakeven	120.00
New Upside Regret Point	140.00

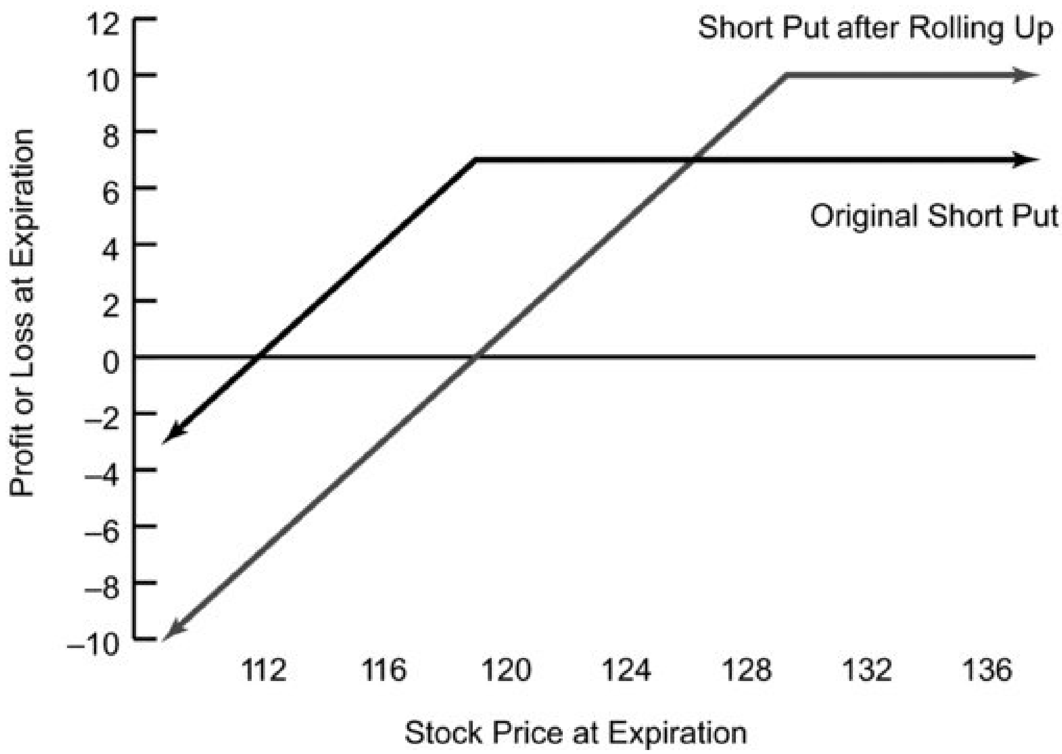
Rolling a short put up is generally hurt by skew; the implied volatility of the old put repurchased is greater than the implied volatility of the new put sold.

Rolling up a short put is also likely to be hurt by volatility slope as the entire volatility curve is likely to have fallen to lower implied volatilities as the stock has rallied. Rolling up leaves us short a put option that is closer to at-the-money so the daily erosion will be greater as we'd expect since our new short put has the same expiration date but has more time value to erode away.

Rolling a short put up will always increase the maximum profit, and does so by increasing the breakeven point and the effective price paid for the stock if assigned.

Figure 11.4 shows the payout graph for the original short put and the position after rolling up.

FIGURE 11.4 Original Short Put and Rolled Up Put



Rolling Down and Out

Rolling a short put down eats into the potential profit of the trade, so the put seller may hesitate to do so, particularly if the underlying stock decreased only slightly in price. This is the sort of scenario the put seller was hoping for, buying the stock at a discount. But if the stock has fallen more than expected or if the price action was troubling, the put seller may not want to give up on the trade but may like to decrease the breakeven point, and the effective purchase price, without spending the premium required to roll down. The way to decrease the breakeven point and the effective purchase price without spending premium is to roll down and out.

In rolling down and out the trader buys back the short put and sells a put that is further out-of-the-money and with more time to expiration. The additional life of the new option should compensate for the lower strike price, resulting in a spread that can be done for little or no net premium.

In our STU rolling down example, STU was trading at $125 and our put seller sold the 30-day 120 strike put option for $7.00. After STU fell to $120.00, the 120 put, now with two weeks to expiration, was trading at $8.00. Instead of rolling down to the 115 strike put of the same expiration and spending $2.50 to do so, the put seller could roll down and out by buying back the 120 strike put at

$8.00 and selling a new 6-week 115 strike put for $8.00. There is no net premium spent so the maximum potential profit is still $7.00. The breakeven point has now been lowered to $108.00, which would be the effective purchase price if STU is below $115 at the new expiration, meaning the stock is put to the put seller.

Rolling down and out will always lower the breakeven point and the effective purchase price, but does so by decreasing the daily erosion from the short put. It also can result in buying back the option with the greatest time value remaining, if the original short put is now at-the-money. As our put seller originally wanted to buy the underlying stock at a discount, that's now more difficult because the stock now has to be below the new lower strike price at expiration.

The smart put seller treats a short put position as a great way to potentially buy a good stock at a discount while getting paid to wait. It's entirely possible to never get long the stock and that can lead to some big misses but, over time, selling puts will be a great strategy and can be a wonderful way to build a portfolio of stocks for the long term.

TAKEAWAYS

Some of the issues put sellers should be considering include:

- The phenomena and how they impact the initial put option sale and any follow-up action.
- The return from selling the put versus the amount of capital set aside to buy the underlying stock if assigned.
- The effective purchase price and the discount from the existing stock price if assigned.
- The option math generally favors selling shorter-dated, at-the-money puts. We earn our money when we sell the put; we get paid via the daily erosion or theta.
- Getting assigned to buy the stock isn't necessarily something to fear. It's a great stock, right? We want to get it put to us but we're fine collecting and keeping the premium as an alternative.
- Short puts should collect the volatility risk premium.
- Skew helps at initiation if selling out-of-the-money puts.

CHAPTER 12

Calendar Spreads

Calendar spreads, sometimes called time spreads or horizontal spreads, are the most versatile option strategy available in that they can be bullish, bearish, or neutral, but option traders tend to use them less than they should. Calendar spreads can be neutral, meaning they maximize profit if the underlying goes nowhere; they can be mildly bullish, making money if the underlying appreciates slightly; they can be very bullish, losing money if the underlying sits but generating significant profits if the underlying rallies; they can also be bearish in the same way they can be bullish, mildly so or aggressively.

Calendar spreads are underused, particularly by newer option traders, because the risk/return or payoff chart is a little more difficult to understand and additional action is generally required when the first option expires. However, there are few option structures that take advantage of option math and the phenomena we've discussed as well and as clearly as calendar spreads.

In executing a calendar spread, you buy a longer-dated option and sell an otherwise identical option that expires sooner. Since you are long the longer-dated, more expensive option and short the shorter-dated, less expensive option, you are long the calendar spread. Selling the longer-dated and buying the shorter dated would be a short calendar spread.

Buying a calendar spread requires payment of net premium, since the longer-dated option is always going to be more expensive than the shorter-dated option. Selling a calendar spread generates net premium for the same reason.

The XYZ 100 strike put calendar spread, as shown in Table 12.1, would consist of being long the XYZ August 100 strike put option, which had 60 days to expiration, at a cost of \$4.85 and short the XYZ July 100 strike put option, which had 30 days to expiration, generating \$3.43. The net cost of buying the calendar spread would be \$1.42 (\$4.85 – \$3.43). The net daily erosion received, assuming XYZ didn't move, on the first day would be expected to be \$0.017 (\$0.057 – \$0.040).

Table 12.1 XYZ Calendar Spread as of June Expiration

	Price	Daily Erosion
XYZ Stock	100.00	

XYZ July 100 Strike Put	3.43	0.057
XYZ August 100 Strike Put	4.85	0.040

Buying a calendar spread is a fantastic way to get the difference in option erosion by time to expiration working in our favor. The short-dated option will nearly always have greater daily erosion than the otherwise identical longer-dated option. The one exception is if the strike price is too far from at-the-money and much of the time value has already come out of the short-dated option. We saw how this happens in Part One.

Since buying calendar spreads gets this math of erosion working in the trader's favor we'll only discuss buying calendar spreads. There are very few reasons to sell calendar spreads. Why would you want to get the option math working against you?

In the scope of the equity options discussed in this book it's nearly impossible to buy a calendar spread for a credit, but for options on futures it's occasionally possible because different option expirations have different underlying assets. In the futures world the March option might have the March futures contract as its underlying, while the September option might have the September futures contract as its underlying. In this situation the difference in price between the futures contracts might generate a net premium to the buyer of the option calendar spread, but that's illusory. It's driven by the difference in price between the two futures contracts, a difference that can be substantial, particularly in agriculture commodities where the two futures contracts might represent different harvests.

MAXIMUM PROFIT AND LOSS

The maximum potential loss for a long calendar spread is the net premium paid for the spread, assuming the remaining option is closed when the front option expires. In the XYZ example that maximum potential loss would be the $1.42 paid for the calendar spread. Again, this assumes that the August put was closed (sold) at the time the July put expired. This maximum loss would be realized if there was no time value remaining in the August put at the expiration of the July put. This could occur in two ways, either XYZ has rallied significantly so that the August 100 put is worthless at the July expiration, or XYZ has fallen sharply so that the August put has no time value and the entirety of its price was inherent value. In the first case both of the options would be worthless at July expiration. In the second case, both of the options would be worth the inherent value at July expiration. If XYZ was at 50 at July expiration, both the July and August 100 puts would be worth $50.00. The calendar spread would be worth zero.

The maximum potential profit at the expiration of the short option depends on the price of the long option at that time. This price is affected by the underlying price as well as the implied volatility of the back option. Thus, it's not possible to precisely know the maximum potential profit at the time of the front-month expiration, even if the underlying has not moved.

The generally expected profit for an at-the-money calendar spread, assuming the underlying has not moved, is the amount by which the longer-dated option is discounted from the shorter-dated option when the trade is initiated. This discount is really equal to the sum of the differences in daily erosion between the two options for each day of the term of the option sold.

In the previous XYZ example, if XYZ did not move for the term of the July option and implied volatility was unchanged, then the August put would cost $3.43 at the July expiration since it is now a 30-day option, just as the July put was when it was initiated. The profit for the calendar spread, assuming the August put was closed by selling, would be $2.01. Our trader would have pocketed the entire $3.43 received for selling the July put and the loss on the August put would be $1.42 (the $4.85 initially paid minus the $3.43 current value). It's no accident that this $2.01 profit is equal to the discount seen in the August put at initiation. The 30-day July put cost $3.43. If daily erosion were linear the August put, with exactly twice the time to expiration, would cost exactly twice as much, or $6.86. Instead it cost $4.85. This difference of $2.01 ($6.86 – $4.85), as shown in Table 12.2, is the expected profit for an at-the-money calendar spread if nothing (price of the underlying, implied volatility, interest rates, etc.) changes over the life of the front option.

Table 12.2 XYZ Calendar Spread as of July Expiration

	Original Price	Current Price	Profit (Loss)
XYZ Stock	100.00	100.00	
XYZ July 100 Strike Put	3.43	0.00	3.43
XYZ August 100 Strike Put	4.85	3.43	(1.42)
Net Profit (Loss)			2.01

This discount is the expected profit for any at-the-money calendar spread assuming nothing changes. The profit ultimately is the front-month premium received and kept, minus the reduction in value of the back month option. Table 12.3 shows this discount and the resulting profit and profit components, for a variety of option prices.

Table 12.3 The Long Option Discount and "Expected" Profit

30-Day Option Price	60-Day Option Price	60-Day Option Price if It Were 2 Times the 30-Day Price	Discount	Profit if No Changes During Term of Front Option
2	3	4	1	1 (+2, −1)
8	11	16	5	5 (+8, −3)
20	30	40	10	10 (+20, −10)
22	28	44	16	16 (+22, −6)
2	4	4	0	0 (+2, −2)

How likely is it that nothing will have changed during the term of the front option? Not very. These aren't really the expected profits because we'd expect something to change during the term of the first option. Either the underlying would move or the implied volatility would change; implied volatility would likely drop if the underlying price didn't change. Though these numbers are not really the expected profit, they highlight the theory of calendar spreads. These examples also work because the back month has exactly twice the time to expiration as the front month. When the timing isn't this neatly arranged it's easier to use OptionMath.com to calculate the expected price of the back month at the front month's expiration, then the math is simple. The expected profit on the calendar spread (if the underlying doesn't move and nothing else changes) is the price of the front month minus the loss in value of the back month.

If the price of the underlying has not moved but implied volatility has increased, then the profit will have increased. Because a higher implied volatility means the remaining option, the option our trader is long, is worth more. If implied volatility has decreased, then the profit will have decreased because a lower implied volatility means the remaining option, the option our trader is long, is worth less.

Unlike the other strategies that we've discussed, covered call and short put, it's not possible to know the ultimate profit for a calendar spread by simply knowing where the underlying is at either expiration. It's possible to know the profit or loss at the first expiration given certain assumptions (underlying price and implied volatility, for example). It's possible to know the profit or loss at the second expiration given other assumptions such as underlying price, for example, and the answer to some other questions (was the front option in-the-money at expiration, and what action did the trader take at the first expiration, for example). As such, the traditional payoff charts we used in Chapters 10 and 11 won't work for a calendar spread.

THE PHENOMENA

Time decay is one phenomenon that overwhelmingly places the option math of long calendar spreads on the side of the option trader. The difference in expected daily erosion should theoretically show up in the trader's account at the end of every day. While this effect is often camouflaged by the impact of changes in the underlying price and implied volatility (which impacts the two legs of a calendar spread differently), this difference in erosion and the apparent discount generated in the longer-dated option, is the expected profit.

As we saw in Part Two, the expected daily erosion increases as the time to expiration decreases, and since this expected daily erosion increases exponentially the net expected erosion, the erosion received from the short option minus the erosion paid for the long option, also increases as the time to expiration decreases. In Table 12.4, the net daily erosion for the very shortest calendar, the 10-day/20-day calendar, is $0.029 or nearly double that of the 30-day/60-day spread and nearly triple that of the 90-day/180-day spread, even though in all instances the back-month option has precisely twice the time to expiration as the front-month option. While the theoretical discount for the 120-day/360-day calendar is $8.71, this isn't the expected profit since the 360-day option has 3 times the amount of time to expiration. In this case the expected profit is $4.63. After 120 days the front option has expired, resulting in a profit of $6.85, and the back-month option how has 240 days to expiration. Given that its value would be $9.67, meaning the loss on this option would be $2.17 ($11.84 – $9.67) the net profit would be $4.68 ($6.85 – $2.17).

Table 12.4 The Impact of Time to Expiration on Calendar Spreads

Front-Month Time To Expiration	10 Days	30 Days	90 Days	120 Days
Back-Month Time to Expiration	20 Days	60 Days	180 Days	360 Days
Front Option Price	1.98	3.43	5.94	6.85
Front Option Daily Erosion	0.099	0.057	0.033	0.028
Back Option Price	2.80	4.85	8.39	11.84
Back Option Daily Erosion	0.070	0.040	0.023	0.016
Difference in Daily Erosion	0.029	0.017	0.010	0.012
Calendar Spread Price	0.82	1.42	2.45	4.99
Theoretical Discount	1.16	2.01	3.49	8.71

Skew has very little impact on calendar spreads. It usually has some minor impact on out-of-the-money put calendar spreads, however, since skew tends to be more pronounced in shorter-dated options as each strike of a shorter-dated option serves less well as a hedge for the other strikes of the same shorter-dated expiration.

The volatility risk premium is generally about equal in volatility terms for both expiration months of a calendar spread. It's not likely to have much impact on the ultimate profitability of a calendar spread.

Any calendar spread should be executed as a spread, that is as a single trade, rather than as two separate trades, for the reasons we discussed in Part Two. In some underlying stocks the bid/ask spread might be wide, particularly in the longer-dated expiration. In these situations the impact of the bid/ask spread can materially impact the price realized for the calendar spread.

There's one sensitivity the calendar spread buyer should be particularly aware of. Changes in implied volatility impact longer-dated options to a much greater degree than shorter-dated options. Thus, a long calendar spread wants implied volatility to increase during the term of the first option, as shown in Table 12.5.

Table 12.5 XYZ Calendar Spread and Changes in Implied Volatility

Implied Volatility	10%	30%	60%
XYZ July 100 Strike Put	1.14	3.43	6.85
XYZ August 100 Strike Put	1.61	4.85	9.68
Net Cost	0.47	1.42	2.83
Longer-Dated Option Discount	0.67	2.01	4.02
Net Daily Erosion	0.006	0.017	0.034
Net Sensitivity to Changes in Implied Volatility	0.047	0.047	0.048

LONG CALENDAR SPREADS AND IMPLIED VOLATILITY

Long calendar spreads benefit from a higher implied volatility when it is initiated and is hurt by lower implied volatility. While a higher implied volatility makes the calendar spread more expensive it increases the discount for the longer-dated option. Just before expiration of the front option the impact of changes in implied volatility on that option is minuscule so it is at this point that changes in implied volatility have the greatest impact on the profitability of a calendar spread. Table 12.6 uses the same XYZ Corp options with different levels of implied volatility.

Table 12.6 The Impact of Implied Volatility on Calendar Spread Prices

Implied Volatility	10%	25%	50%	100%
July Option Price	1.14	2.86	5.71	11.40
August Option Price	1.61	4.04	8.07	16.06
Calendar Spread Price	0.47	1.18	2.36	4.66
Theoretical Discount	0.67	1.68	3.35	6.74
Difference in Daily Erosion	0.006	0.014	0.028	0.057

The difference in sensitivity to changes in implied volatility also means that a calendar spread is helped by an increase in implied volatility after the trade is initiated and is hurt by a drop in implied volatility after the trade is initiated.

For example, our initial XYZ Corporation example assumed that implied volatility was 30 percent for both options and stayed at 30 percent for the term of the July put. If that was the case, and XYZ was still at 100.00 at the July expiration, the calendar would have generated a profit of $2.01. But if implied volatility had changed at the time the July put expired the value of the August put would have been affected.

The impact of a change in implied volatility is initially not linear as we see in Table 12.7. An increase in implied volatility helps the calendar spread just about as much as a decrease hurts. In this XYZ example implied volatility decreased from 30 percent to 10 percent, resulting in a loss of $0.28, $2.29 less than the $2.01 profit we'd expected if implied volatility hadn't changed, and an increase from 30 percent to 50 percent generated a profit of $4.29, an increase of $2.28 over the $2.01 profit we'd expected.

Table 12.7 The Impact of Changes in Implied Volatility

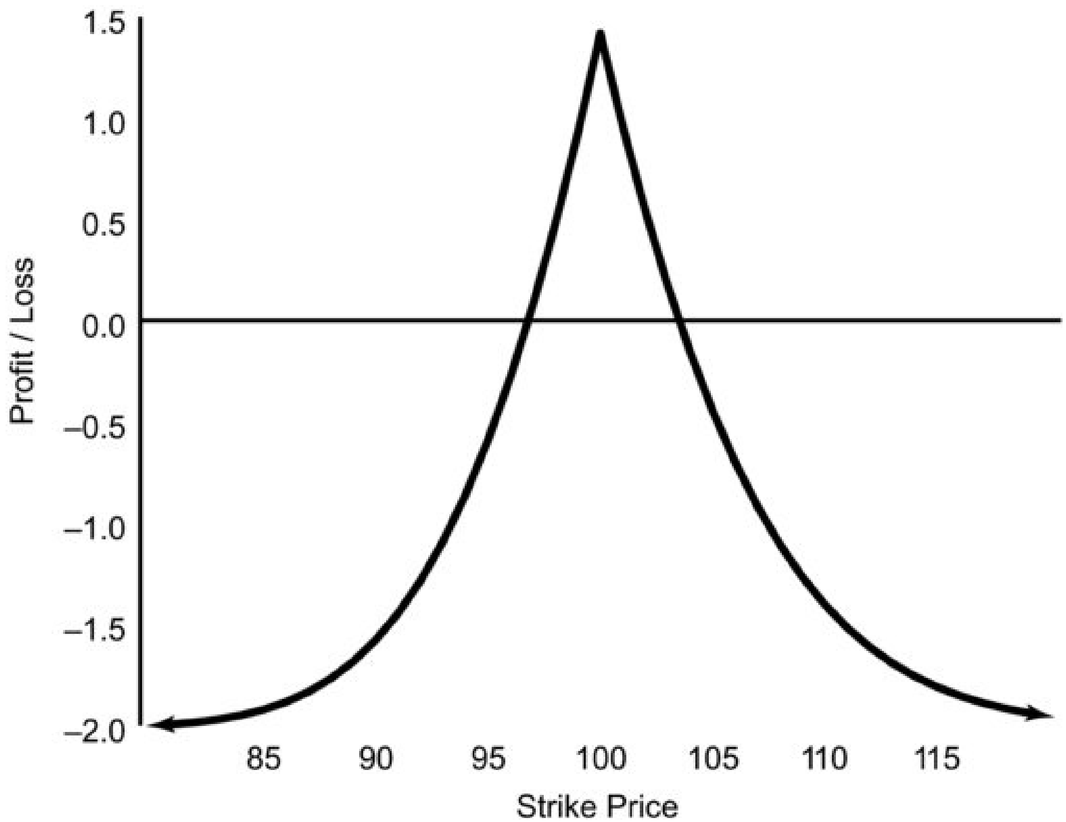
Implied Volatility at July Expiration	10%	25%	50%	100%
August Option Price at July Expiration	1.14	2.86	5.71	11.40
Calendar Spread Profit/Loss at July Expiration	−0.28	1.44	4.29	9.98

Since an increase in implied volatility helps a long calendar spread after it's been initiated, we'd say a long calendar spread is a long implied volatility trade.

CALENDAR SPREAD PAYOFF AT FRONT-MONTH EXPIRATION

Assuming nothing changes from the time the at-the-money calendar spread is initiated to the time the front-month option expires, the payoff chart for a long calendar spread like the XYZ example would look like Figure 12.1.

FIGURE 12.1 Put Calendar Spread Assumed Profit/Loss at First Expiration



The payoff chart makes many assumptions so it should only be used as a rule of thumb, but it can highlight several interesting aspects of the calendar spread. First, although it's difficult to tell, the payoff is not symmetrical. It's got a slight bias, too slight to be of value, but the bias comes from the time value remaining in the back month option at expiration.

NEUTRAL, BULLISH, AND BEARISH CALENDAR SPREADS

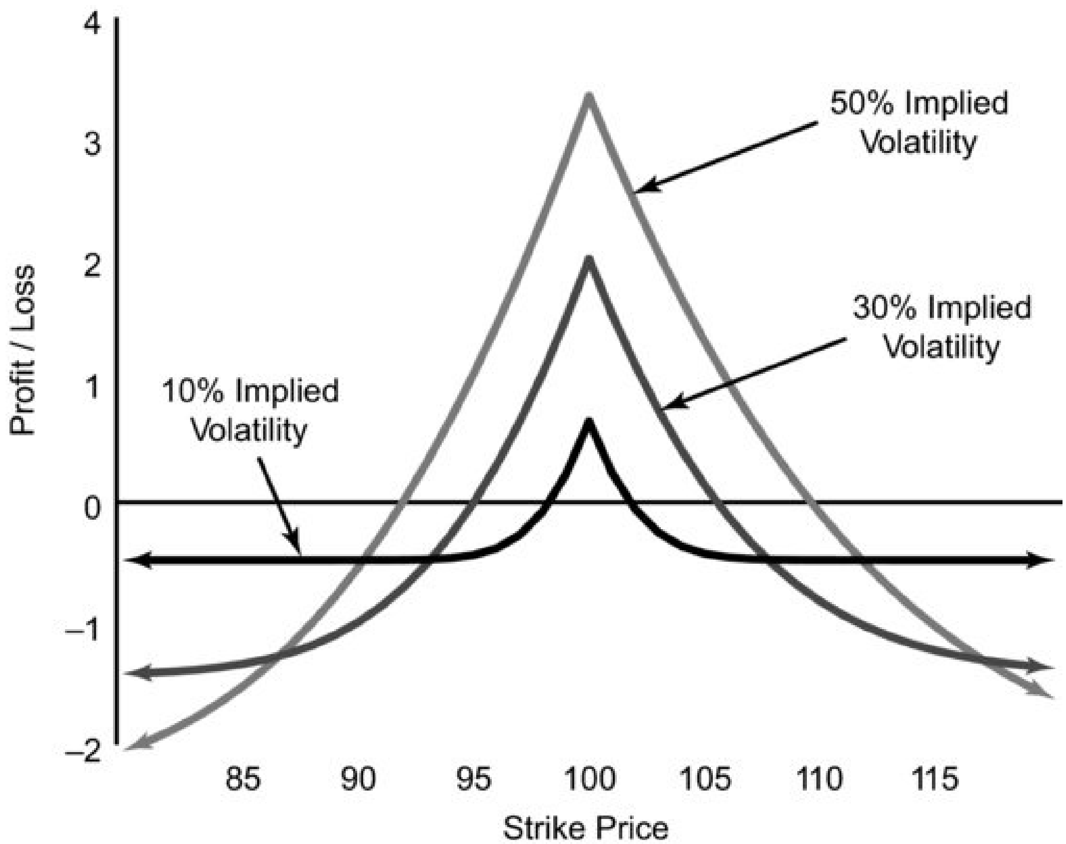
Calendar spreads are the most versatile option structures available since they can be neutral, somewhat bullish, very bullish, somewhat bearish, or very bearish. All long calendar spreads want the underlying to be at the strike price at the expiration of the front-month option, but since traders can select any strike price they can always buy a calendar spread that conforms to their outlook for the stock. For instance, traders can select a strike price that is currently at-the-money, resulting in a calendar spread that does best with no movement; an out-of-the-money call calendar spread that does best with an increase in the underlying price; or an out-of-the-money put calendar spread that does best with a decrease in the underlying price. It is possible to select a calendar spread that is too aggressive, in either direction, and end up selling a short-dated option that has very little time value left. In this situation the option math is no longer working in our favor, since the net daily erosion might be negative. We'll discuss this more fully when discussing bullish and bearish calendar spreads.

Neutral Calendar Spreads

Neutral calendar spreads begin with selecting a strike price that is close to the current price of the underlying stock. Neutral calendar spreads need the underlying stock to stay within a fairly narrow range around this strike price at expiration. As we saw in Figure 12.1, the profit decreases as the underlying gets further away from the strike price at expiration and eventually reaches its maximum loss of the amount paid for the calendar spread if the stock price is sufficiently far from the strike price at the front-month expiration.

As implied volatility increases the width of the profitable zone increases as well. (Again, we're assuming that the implied volatility of both legs is equal at initiation. This is unlikely to be exactly so, but the difference should be small so we'll continue to make this assumption since it simplifies the math and highlights the theoretical issues at play.) This comes at the cost of greater total risk since the increased implied volatility increases the total cost of the calendar spread. Figure 12.2 shows the payoff for an at-the-money call calendar spread for varying implied volatilities. These payoff charts assume that implied volatility was equal and unchanging for the options and that the underlying did not move for the term of the first option.

FIGURE 12.2 Neutral Calendar Spread Payoffs for Varying Implied Volatilities



These payoff charts are curved because the August expiration still has time value remaining, as we saw in the time value to expiration charts in Part One.

The XYZ example we discussed previously was a neutral calendar spread. It used the 100 strike puts in July and August expirations with the underlying price at $100.00. This is the 30 percent implied volatility example in Figure 12.2.

The assumption that we would liquidate the remaining option once the front option in a neutral calendar spread has expired is logical. We put on a neutral calendar spread because we didn't think the underlying was going to move during the term of the first option. (See Table 12.8.) There's no reason to believe that the underlying is now going to magically start moving in the direction we desire simply because the front option has expired. We used a calendar spread because it put the option math on our side. Staying long the August put, which is now a 30-day option, makes option math, particularly the volatility risk premium and time decay, our mortal enemy. This means that while all calendar spreads have limited risk, specifically the amount paid for the spread (assuming the remaining option is closed once the front option expires), it also means that a neutral calendar spread essentially has a limited return as well. It's possible that the underlying doesn't move until the front option has expired and then moves drastically in the direction that generates the most profit for us, but it's unlikely and isn't the sort of price action an option-math-savvy trader will expect or even hope for.

Table 12.8 Neutral Calendar Put Spread

Maximum Loss	1.42
Maximum Profit (assuming no changes in underlying or implied volatility)	2.01
Theoretical Downside Breakeven Point	95.00
Theoretical Upside Breakeven Point	106.14

The goal of this at-the-money calendar spread is to capture the difference in daily erosion, ultimately capturing the entire discount in the price of the August put relative to the July put at initiation. In this case that's $2.01.

Bullish Calendar Spread

The bullish calendar spread is constructed using call options with a common strike price that is above the current price of the underlying asset. Again, a long call calendar spread is accomplished by buying the longer-dated call option and selling the shorter-dated call option.

One difference between the neutral calendar spread and the bullish calendar spread is that a very aggressive bullish spread, one that uses a strike price that is substantially above at-the-money and that expects the underlying stock to appreciate substantially by the time of the front-month expiration, can actually lose money if the underlying doesn't move by this first expiration. In this case it is unlike the neutral calendar spread, which will be profitable if the underlying stock doesn't move.

A mildly bullish calendar spread can generate a profit if the stock does not move at all before the initial expiration, but it will realize its maximum profit if the underlying stock does rally and is precisely at the strike price at the first expiration—so in this way it is like every other calendar spread, it generates its maximum potential profit with the underlying at the strike price at the first expiration.

Assume we were considering buying a call calendar spread. The November calls have 30 days to expiration and the December calls have 60 days to expiration. What would the profit or loss be at the November expiration if the underlying stock hadn't moved? How aggressive can we be, that is, how high a strike price could we select, and still have our calendar spread be profitable, assuming nothing else had changed, at the November expiration? Table 12.9 shows the profitability of various call calendar spreads. They differ by strike price, with more aggressive calendar spreads having the highest strike prices, but all assume the underlying stock does not move before November expiration.

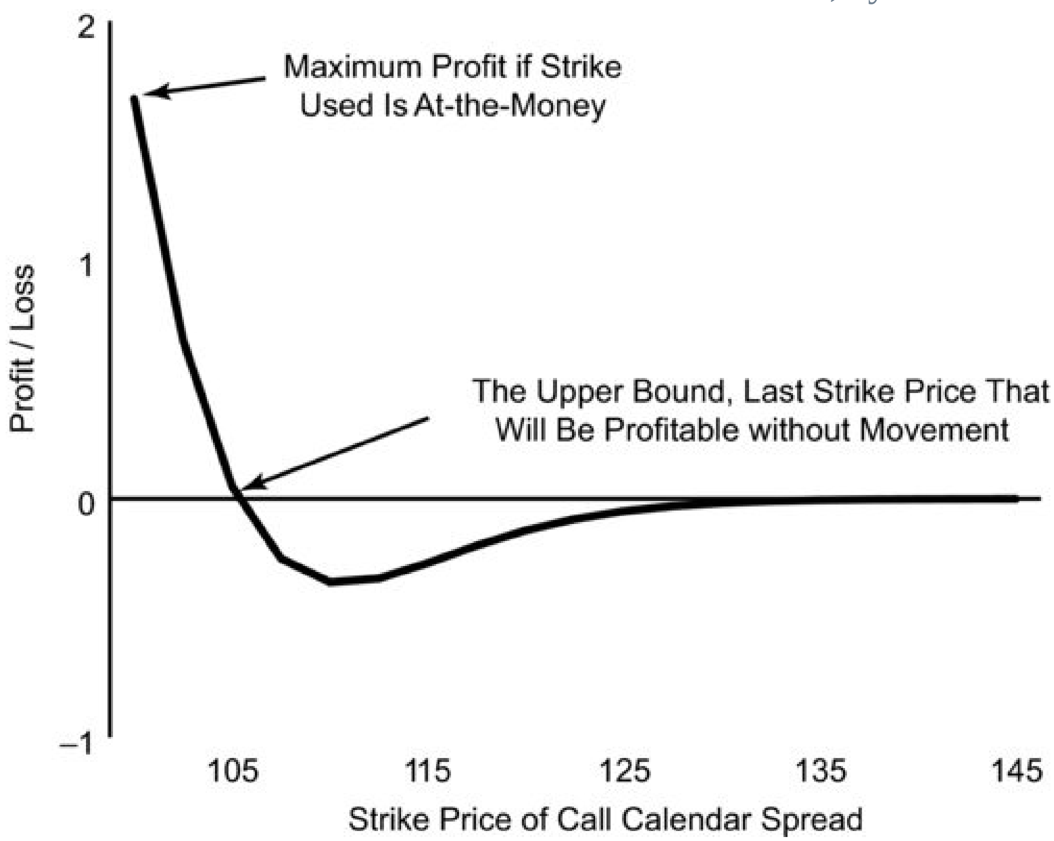
Table 12.9 Calendar Spread Profitability if Underlying Doesn't Move

Strike Price	Initial November Call Price	November Call Price at Expiration	Initial December Call Price	December Call Price at Expiration	Total Profit
100	2.86	0.00	4.04	2.86	1.68
102.50	1.81	0.00	2.96	1.81	0.66
105	1.08	0.00	2.11	1.08	0.05
107.50	0.61	0.00	1.47	0.61	−0.25
110	0.32	0.00	0.99	0.32	−0.35

For these calendar spreads the most aggressive (highest) strike price that will still return a profit if the underlying doesn't move is the 105 strike. This is the *upper bound* for November/December call calendar strike prices. If we construct a call calendar spread with a strike price higher than $105, then we have to see the underlying rally prior to November expiration or we will lose money.

Figure 12.3 shows the profitability of bullish call calendar spreads if the underlying doesn't move during the term of the first option. The horizontal axis shows the strike price of the calendar spread increasing from at-the-money.

FIGURE 12.3 Bullish Call Calendar Profit if No Movement, by Strike Price



The goal of any bullish calendar spread is to have the stock rally during the term of the front month yet be just equal to the strike price at that expiration. In that situation the front month will expire worthless and the back month is now worth more; actually it's achieved its maximum amount of time value since it's now at-the-money, as the underlying rose in price this call option likely rose in price.

Which of the call calendar spreads we examined previously would be most profitable if we were correct and the underlying rallied to the respective strike price? Table 12.10 shows the profitability of each of these call calendar spreads at the first expiration, assuming volatility hasn't changed (which is a big assumption), with the underlying price at the respective strike price.

Table 12.10 Calendar Spread Profitability by Moneyness

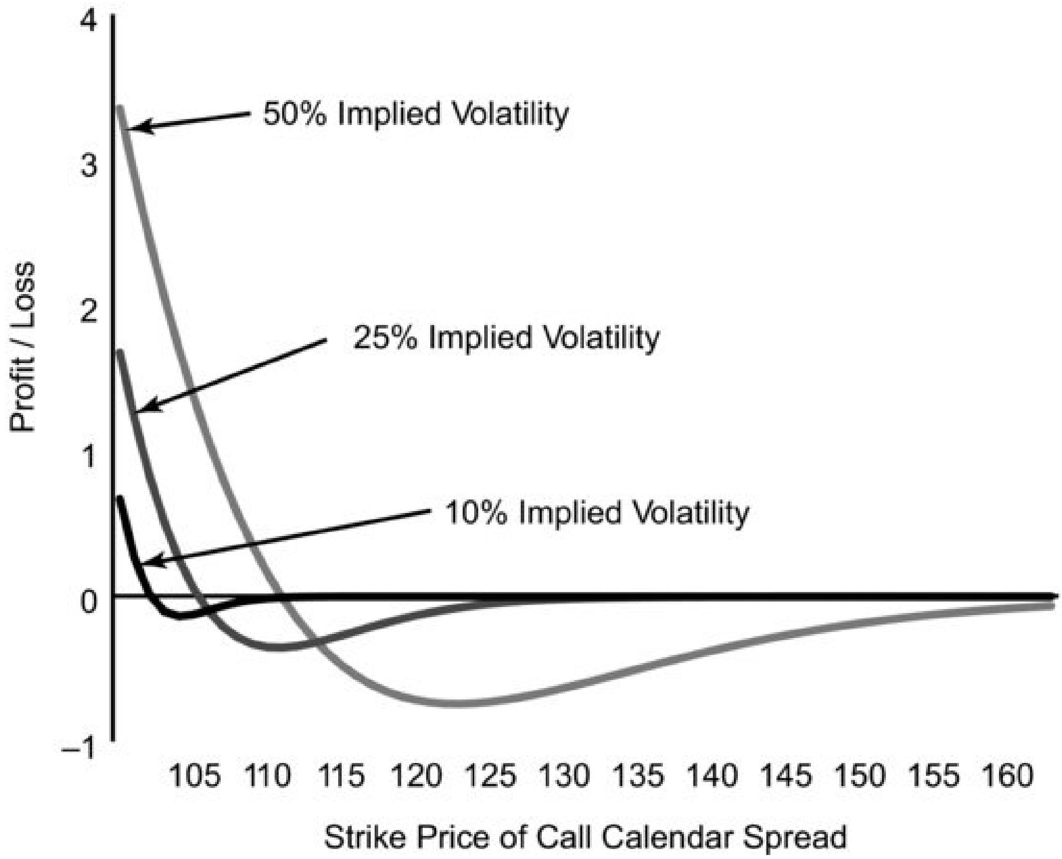
Strike Price/ Stock Price at November Expiration	Initial November Call Price	November Call Price at Expiration	Initial December Call Price	December Call Price at Expiration	Total Profit
100	2.86	0.00	4.04	2.86	1.68
102.50	1.81	0.00	2.96	2.93	1.78
105	1.08	0.00	2.11	3.00	1.97
107.50	0.61	0.00	1.47	3.07	2.21
110	0.32	0.00	0.99	3.14	2.47

The potential profitability of a bullish call calendar spread increases as the strike price selected, and then achieved, increases. This is logical since the initial cost of the calendar decreased as the strike price selected got further from at-the-money at initiation. Also, the likelihood of the underlying stock rallying to the strike price decreased as the strike price increased. We would expect to make a greater profit if the risk was increased. However, is the potential additional profit from selecting a far out-of-the-money strike price worth the additional risk? Probably not, given that the likelihood of a 10 percent move in the one-month term of our November call option is pretty remote but this is why we say that the calendar spread gets more aggressive as the strike price gets further from at-the-money.

CALENDAR SPREAD PROFITABILITY WITHOUT MOVEMENT

The goal of any bullish (bearish) calendar spread is to have the underlying rally (fall) to the strike price at the front-month expiration. However, since the daily erosion for a far out-of-the-money option is limited, it's possible to go too far out-of-the-money and get into a situation where the underlying has to rally (fall) or the trade will be unprofitable. Figure 12.4 shows the general shape of the payoff curve for a call calendar by strike price if the underlying doesn't move. This general shape applies regardless of the implied volatilities of the options (we've assumed the implied volatility of both options was equal and unchanging during the term of the first option), but the bump at the bottom of the chart will move to the right, that is, it will cover higher strike prices, as implied volatility increases. Figure 12.4 shows this payoff chart for 10 percent implied volatility, 25 percent implied volatility, and 50 percent implied volatility.

FIGURE 12.4 Bullish Call Calendar Profit if No Movement, by Strike Price for Three Implied Volatilities



As you can see, the potential loss increases as implied volatility increases but the upper bound, the highest strike price that is profitable without any movement in the underlying, increases and is pushed further to the right on Figure 12.4, as implied volatility increases.

Bearish Calendar Spread

Bearish calendar spreads use put options with a strike price that is lower than the current market price of the underlying stock. The further out-of-the-money the strike price is at initiation, the more aggressive the spread is and the more movement it needs to reach its point of maximum profit. As we saw with a bullish call calendar, it's possible for a bearish put calendar spread to lose money if the underlying doesn't move prior to the initial expiration, and if the strike price selected is sufficiently out-of-the-money. The further out-of-the-money the strike is at initiation the further the underlying has to move in order for the calendar spread to break even.(See Table 12.11.) **Table 12.11** How Much Does the Underlying Need to Move?

January/February Put Calendar Spread, Underlying at 100.00 at Initiation	
Strike Price of Calendar	Breakeven at First Expiration
95	Profitable without Movement
92.50	98.92
90	97.31
87.50	95.93

The goal of a bearish put calendar spread, as with nearly all spreads, is to have the underlying at the strike price of the short option (in the case of a calendar spread it just happens to also be the strike price of the long option) when the short option expires. A mildly bearish put calendar will be profitable if there is no movement. A more aggressive bearish put calendar requires the underlying price to fall some prior to the initial expiration.

CALENDAR SPREAD SENSITIVITIES

Differing times to expiration often have a profound impact on options' sensitivities to changes in underlying price, time to expiration, and implied volatility. For a calendar spread these sensitivities are often distilled to their core, since issues affecting other spreads (such as differing strike prices) aren't a factor with a calendar spread.

A neutral calendar spread wants little market movement. Mildly bullish and bearish calendar spreads also generally want little market bumpiness, but would do best with a very slow, methodical march to the strike price, getting there just as the front option expires worthless. Very bullish and very bearish calendar spreads generally need a fair amount of volatility in the underlying stock, as that's the only way the underlying is going to end up moving to the strike price by the front-month expiration.

Again, the main goal of a calendar spread is to collect the difference in daily erosion while, for the bullish and bearish versions, incorporating assumptions about the direction and magnitude of the movement of the underlying stock. Figure 12.5 shows the sensitivities of a neutral calendar spread, as well as for mildly bullish and bearish calendar spreads.

FIGURE 12.5 Calendar Option Sensitivities

	ATM Calendar	OTM Call Calendar	OTM Put Calendar
If the Price of the Underlying Asset Increases . . .	Calendar Value Will Decrease	Calendar Value Will Increase	Calendar Value Will Decrease
If the Price of the Underlying Asset Decreases . . .	Calendar Value Will Decrease	Calendar Value Will Decrease	Calendar Value Will Increase
If Volatility Increases . . .	Calendar Value Will Increase	Calendar Value Will Increase	Calendar Value Will Increase
If Volatility Decreases . . .	Calendar Value Will Decrease	Calendar Value Will Decrease	Calendar Value Will Decrease
As Time Passes . . .	Calendar Value Will Increase	Mild Calendar Value Will Increase	Mild Calendar Value Will Increase

FOLLOW-UP

The follow-up action for a neutral calendar spread is pretty easy if the spread achieved the majority of the profit goal. The trade was put on because we thought that the underlying stock wasn't going to move very much for the term of the front option and we wanted to collect the difference in daily erosion and the discount seen in the back-month option. Now that the front option has expired worthless, there's no reason to think that the underlying is suddenly going to move in the direction we need it to move. It's just as likely to move in the opposite direction, and since it's an at-the-money option, and thus will see its price change by 50 percent of the change in price of the underlying stock, just a little movement in the wrong direction will wipe out all of the profit made.

The correct follow-up action for a neutral calendar that has realized most of the profit potential is to close out the remaining option. The trade has been profitable, now the job is to not screw it up.

As we've discussed, the neutral calendar spread, either using call options or put options, needs the underlying asset to stay very close to the strike price. What if it doesn't?

If we initiated a neutral call calendar only to see the underlying stock move dramatically, we need to evaluate how much time value exists in the remaining option. If the underlying stock has fallen substantially, the front option will expire worthless and we will get to keep that premium. Unfortunately, the remaining option, the leg we're long, will have fallen in value to a point that makes the trade a loser. If there is still a reasonable amount of time value remaining in the long option, it's probably time to take the loss and move on. Table 12.12 shows the results of taking a small loss based on a 100 call calendar spread.

Table 12.12 Taking a Small Loss

November/December 100 Call Calendar Spread	
At Initiation	
Stock	100.00
November 100 Call	2.86
December 100 Call	4.04
Spread Value	1.18
At November Expiration	
Stock	95.00
November 100 Call	0.00
December 100 Call	0.98
Spread Value	0.98

In this situation the December call has $0.98 of time value remaining, so the net effect of selling there would be a loss of $0.20 ($1.18 – $0.98) on the calendar spread. The expectation was for little movement and instead the underlying stock fell by 5 percent over the 30-day term of the November option. A $0.20 loss given the magnitude of the miss is not too bad. Such a relatively small loss is due to the phenomena we've discussed and that were at work on this calendar spread.

But what if there's no time value remaining? Table 12.13 shows such a scenario.

Table 12.13 Follow-Up after Getting It Wrong

November/December 100 Call Calendar Spread

At Initiation	
Stock	100.00
November 100 Call	2.86
December 100 Call	4.04
Spread Value	1.18
At November Expiration	
Stock	75.00
November 100 Call	0.00
December 100 Call	0.05
Spread Value	0.05

If there's no time value remaining, or very little time value remaining, then there's no additional risk from holding the option. In this example the loss can't really get any larger than the $1.13 already sustained, and while it might be comforting to simply take the loss by selling the remaining option for whatever can be had for it, $0.05 in this case, it makes sense to do nothing now. The commission cost to collect that $0.05 would surely make selling the December call even less worthwhile.

It almost never makes sense to sell teenie options---options that are very cheap in absolute terms, about $0.10 and less. It certainly never makes sense to sell these options to create a new short position. Options that are inexpensive in absolute terms are called *teenies* from the days when stock and option prices were quoted in eighths ($0.125) and sixteenths ($0.0625) of a dollar. A price of 1/16 of a point was called a *teenie*. The term is now generally used for any cheap option, particularly options costing less than $0.10 and certainly for options costing less than $0.05.

The best strategy in this situation is to just stay long that out-of-the-money call option and hope the stock rallies back. In a situation like this it's often a very good idea to place a good-till-cancelled (GTC) order to sell the call option at a small price, but one that's high enough to be worth selling. A GTC order isn't automatically canceled at the end of the trading day if it's not filled. It will automatically be reentered each day until it's filled or the option expires.

It depends on other variables, but leaving such a good-till-canceled order to sell the call option at $0.50 is often a good way to be able to move on to the next trade and not worry about how or whether to close the position. If the sell order is executed then we are out of the position and have mitigated some of the damage. If the order isn't executed then we're no worse off.

Smart option traders don't get in the habit of saying, "it's only $0.50, why bother?" First, those traders are probably selling that option for more than it's worth, even if they're only selling it for $0.50. Second, $0.50 here, $0.50 there, and pretty soon they've collected enough to deploy in another trade. This doesn't mean a smart trader will sell options at $0.10. That's a very different trade and not one the smart option trader will make very often. So what's the difference between $0.10 and $0.50? It's more than $0.40; it's the difference between an option that has some time value and an option that's really just a lottery ticket for someone else.

If the stock has rallied above the strike price of the call calendar such that both of the options are trading at parity, then the follow-up action is also fairly straightforward. In this situation the short call, the November 100 call in our example shown in Table 12.14, will be exercised by the holder and we will be forced to deliver 100 shares. This can be done by borrowing the shares and delivering them such that we are short the shares. However, since we're long the back-month call option, the December 100 call in our example, which is trading at parity, we have no additional risk to the upside. If the price of the stock increases, the value of the long call option will increase by an equal amount.

Table 12.14 Follow-Up after Being Assigned

November/December 100 Call Calendar Spread	
At Initiation	
Stock	100.00
November 100 Call	2.86
December 100 Call	4.04
Spread Value	1.18
At November Expiration	
Stock	110.00
November 100 Call	10.00
December 100 Call	10.00
Spread Value	0.00
Position after November Expiration	
Stock	Short 100 shares
December 100 Call Option	Long 1 option

This short stock, long in-the-money call option position is really like being long a put option. Why? Because this position makes money as the stock drops. In fact, this new position, which can't lose any more than the $1.18 the calendar has already lost, would do best if the price of the stock dropped to zero at December expiration. With the stock at zero at December expiration, we can buy our stock back for zero and the December call option we're long expires worthless. We would have made $100.00 on the stock we're short and would have lost $10.00 on the December call, as $10.00 was its value when we shorted the stock to satisfy our obligation at the November expiration.

Immediately after the November expiration the logical follow-up activity is to do nothing. There's no time value in the remaining December call option. There's no additional risk from keeping the position as it exists. There's only potential profit, and that occurs if the price of the stock drops. If it drops to a point that results in time value coming back into the call option, then we might close the entire position at a smaller loss, as we can see in Table 12.15.

Table 12.15 Further Follow-Up After Being Assigned

Position with 15 Days to December Expiration	
Stock	102.50
December 100 Call	3.54
Option Time Value	1.04

With 15 days to expiration we can close the position by buying back the shares we are short at $102.50 and selling the December 100 call at $3.54. That $3.54 includes $1.04 of time value, which will reduce the loss on the entire trade. With the options trading at parity that loss was the $1.18 paid for the spread. By selling the December call with $1.04 of time value, the loss has been reduced to $0.14 ($1.18 – $1.04).

What do we do if we've initiated a bullish or bearish calendar spread and the market has moved toward our strike? Table 12.16 shows the follow-up for a successful directional calendar spread; we discuss the ramifications of certain actions that result in an unrealized profit of $1.30.

Table 12.16 Follow-Up for a Successful Directional Calendar

November/December 95 Put Calendar Spread	
At Initiation	
Stock	100.00
November 95 Put	0.98
December 95 Put	1.94
Spread Value	0.96
At November Expiration	
Stock	96.00
November 95 Put	0.00
December 95 Put	2.26
Spread Value	2.26
Unrealized Profit	1.30

Now we have a choice. We can close the back-month put option position for a profit of $1.30 or we can stay long the back-month put option. This is unlike the neutral calendar spread at front-month expiration. In the neutral calendar spread we have correctly predicted that the stock would not move for the term of the front option. In that situation there's no reason to believe the stock will magically begin to move in the optimal direction for us. The bearish put calendar is different. In this situation we have correctly predicted that the stock would fall toward the strike price. Again, there's no reason to believe that the stock will change behavior simply because the front-month option has expired. We can stay long the December 95 put option—after all, we've gotten the direction correct—but that sets the option math working against us. We're long an option for which the price is likely higher than its value, and since it now has only 30 days to expiration the daily erosion is going to pick up rapidly. In this case no one would blame us for staying long that put for a short period to see if the stock continues to move lower, but no one would blame us for closing the position and taking our profit. If we chose to stay long the December 95 put, it would make sense to enter a GTC order to sell it at a price currently above the market. We might enter a GTC limit order to sell this option at $3.00 as a way to exit the trade. We might also enter a contingent order to sell the December 95 put at the market price if the underlying stock trades at $95.00. This would be the point when time value is maximized although the total value of the put option will continue to increase if the stock continues to drop. One important note: We don't want to have both orders in the market simultaneously such that they might both get filled.

Another alternative that maintains downside exposure while mitigating some of the phenomena is to turn the long put into a long put spread. By selling the December 90 put at $1.05 the effect of daily erosion is reduced and we have put option skew working for us. Since we only paid $0.96 for the original calendar spread and will receive $1.05 for selling the December 90 put, we have gotten ourselves into a situation where the worst we can do is make $0.09 ($1.05 – $0.96). This is probably not the best way to look at the trade, however, since we currently have an unrealized profit of $1.30. But we now have a vertical spread on. We'll discuss vertical spreads later in Part Three.

The Super Calendar

One of the very best follow-up trades for a profitable calendar spread is to turn it into a super calendar as shown in Table 12.17. This is done after the front option has expired by selling another option with the same strike price but with an expiration date that's shorter than the remaining long option. If the original calendar spread sold a 30-day option and bought a 90-day option, then at the front-month expiration the remaining option would have 60 days to expiration. We could turn this into a super calendar by selling a new 30-day option of the same type (put or call) and the same strike price. The result is that we reload the phenomena in our favor. As weekly options become more common, selling a weekly to create a super calendar is also possible for some underlying stocks and ETFs.

Table 12.17 The Super Calendar Spread

November/December 95 Put Calendar Spread	
At Initiation	
Stock	100.00
November 95 Put	0.98
December 95 Put	1.94
Spread Value	0.96
At November Expiration	
Stock	96.00
November 95 Put	0.00
December 95 Put	2.26
Spread Value	2.26
Unrealized Profit	1.30
After Selling Weekly 95 Put to Create a Super Calendar	
Stock	96.00
December Weekly 95 Put	0.88
December Standard 95 Put	2.26
Spread Value	1.38
Total Profit with Stock at 96.00 at Weekly Option Expiration	1.84

A super calendar is a great way to add to a winner. The initial calendar spread was a winner; we had the direction right and the phenomena worked in our favor. In this case it's often a great idea to believe the stock is going to maintain its recent trend and to put the phenomena back on our favor.

BULLISH BECOMES BEARISH…

If the market overshoots a bullish or bearish calendar spread the nature of the spread changes. A calendar spread that was originally bullish only to see the underlying stock rally over the strike price, now needs the stock to drop back in order realize the maximum potential profit. Likewise, a put calendar spread that was originally bearish only to have the stock drop below the strike price needs the stock to rally back to the strike price in order to realize the maximum potential profit. Calendar spreads are one of the few option structures that experience this sort of change.

For example, with ABC at $150.00, as shown in Table 12.18a, a bullish call calendar needs ABC to rally to the strike price to recognize the maximum profit.

Table 12.18a A Bullish Calendar Spread Becomes Bearish

September/October 160 Call Calendar Spread	
at Initiation	
ABC	150.00
September 160 Call	3.18
October 160 Call	5.80
Spread Cost	2.62
September 160 Call with ABC at 160 at Expiration	0.00
October 160 Call with ABC at 160 at Sept. Expiration	7.31
Expected Profit with ABC at 160 at Expiration	4.69

But if ABC rallies past $160.00 then the expected profit will be reduced, and if ABC rallies enough that both options are trading at parity (i.e., at their inherent values without any time value), then the hoped-for profit has become a loss of $2.62. In these cases the spread has become bearish in that it needs ABC to fall in price.

If ABC rallies substantially, say to $190, the calendar spread, as shown in Table 12.18b, is now worth less than our trader paid for it and he now needs ABC to drop back toward the 160 strike price of the calendar spread. Our calendar spread was originally bullish in that it did best if ABC stock rallied from $150 to $160, at $160 the calendar spread achieved its maximum profit. But since ABC has overshot the $160 level this trade is no longer bullish; it is now bearish because it does best if ABC drops. Specifically, we want ABC to drop from $190 back to $160.

Table 12.18b A Bullish Calendar Spread Becomes Bearish

September/October 160 Call Calendar Spread	
with 2 Weeks to September Expiration	
ABC	190.00
September 160 Call	30.09
October 160 Call	31.31
Spread Value	1.22

CATALYSTS

The major caveat a calendar spread buyer has to be aware of is the timing of catalysts such as dividend payments and earnings reports. Given the nature of calendar spreads and the differing expiration dates, it's possible to have a catalyst affect the longer-dated option but not the shorter-dated option. Since these events are knowable they will impact the prices at which we can initiate our calendar spread.

In the case of an earnings report, having the catalyst affect the back month, meaning the option we're buying, and not the front month, the option we're selling, generally makes the calendar spread more expensive to buy and reduces the amount of the discount in the back-month option. In some cases the discount disappears totally. For example, Starbucks was due to report earnings on April 26. This meant that the April options would expire before the report was public, but the July options would catch the resulting price action. At the March option expiration, as shown in Table 12.19, the April options had about 30 days to expiration and the July options had about 120 days to expiration. How much of a discount was the July 55 call trading at when compared to the April 55 call option?

Table 12.19 Starbucks 55 Call Calendar at March Expiration

April 55 Call Option Price	July 55 Call Option Price	July Call Price if It Were 4 Times the April Price	July Option Discount (Premium)
0.48	1.97	1.92	(0.05)

In this situation the July option is trading at a small premium due to the fact that it catches the price action of the earnings release, while the April option does not. The back-month option, which catches a catalyst that the front-month option misses, will always be more expensive than expected, which will tend to make buying a calendar spread less attractive.

In the case of a dividend payment, longer-dated puts will look more expensive relative to shorter-dated puts and longer-dated calls will look less expensive relative to shorter-dated calls. This is due to the fact that the market price of the stock will drop by the amount of the dividend on the day the dividend is payable. For example, the Royal Bank of Canada was due to pay a dividend of $0.58 on April 22. This date would be after the April options had expired but before the July options expired. At the March option expiration the April options had about 30 days to expiration and the July options had about 120 days to expiration. How much of a discount was the July 55 put trading at when compared to the April 55 put option?

The premium shown in Table 12.20 is due to the dividend payment and subsequent drop in the price of the stock on April 22. If we were to factor this in, the July option would actually be trading at a discount to the April option, just as we would normally expect.

Table 12.20 Royal Bank of Canada 55 Put Calendar at March Expiration

April 55 Put Option Price	July 55 Put Option Price	July Put Price if It Were 4 Times the April Price	Discount (Premium)
0.27	1.40	1.08	(0.32)

So a dividend payment will make a put calendar spread appear less attractive than it would otherwise. What would happen to a call calendar spread in Royal Bank of Canada? (See Table 12.21.)

Table 12.21 Royal Bank of Canada 60 Call Calendar at March Expiration

April 60 Call Option Price	July 60 Call Option Price	July Put Price if It Were 4 Times the April Price	Discount (Premium)
0.50	1.52	2.00	0.48

While it seems that the April/July 60 call calendar is showing the sort of discount in the July option that we'd expect, it's important to remember that Royal Bank of Canada stock will drop by the $0.58 amount of the dividend on April 22, and will drag the price of the July 60 call with it. Dividends make call calendar spreads look more attractive than they actually are.

TAKEAWAYS

- Long calendar spreads put the difference in daily erosion to work.
- The maximum loss from a long calendar spread is the amount paid for the spread, assuming the remaining leg is closed at the expiration of the front leg.
- The maximum profit from a long calendar spread is similarly limited, but the actual profit at expiration of the front month is not knowable given the potential change in implied volatility (and option prices) during the term of the spread.
- The goal of a calendar spread is to collect the discount in the price of the back-month option. This discount is really the cumulative difference in expected daily erosion.
- Calendar spreads can serve every market outlook—bullish, bearish (very much so or mildly so), and neutral.

- Bullish calendar spreads can become bearish and vice versa.
- Since a calendar spread has two different expiration dates, catalysts can play havoc with the outcome.

CHAPTER 13

Risk Reversal

Just as calendar spreads isolate the benefit of differences in time decay, risk reversals isolate the phenomena of skew to the option trader's advantage. With a risk reversal, option traders get to sell expensive options while buying cheap options, usually get to pocket some premium, and get long exposure to a stock they think is going to appreciate—all while generating a potentially significant margin of error in which the worst thing that happens is the risk reversal expires worthless and they keep any premium received. While it's possible to establish a risk reversal at a debit, and we'll discuss that later, it's generally best for a risk reversal to generate a net credit, even if it's small. Likewise, any net debit should be relatively small.

A risk reversal is constructed by selling a put option and buying a call option of the same expiration, but with a higher strike price. The premium received for selling the put option is generally greater than the premium paid in buying the call option. This difference is due to skew and results in the standard risk reversal generating a net credit to the option trader, even if the call is the same distance from at-the-money as the put. If the risk reversal were done for zero net premium, we would expect the call option bought to be closer to at-the-money than the put option sold.

The XYZ 95/105 risk reversal shown in Table 13.1 would consist of being long the XYZ 105 strike call option at a cost of $2.50 and short the XYZ 95 strike put option, generating $2.75. The net credit from doing the risk reversal would be $0.25 ($2.75 – $2.50).

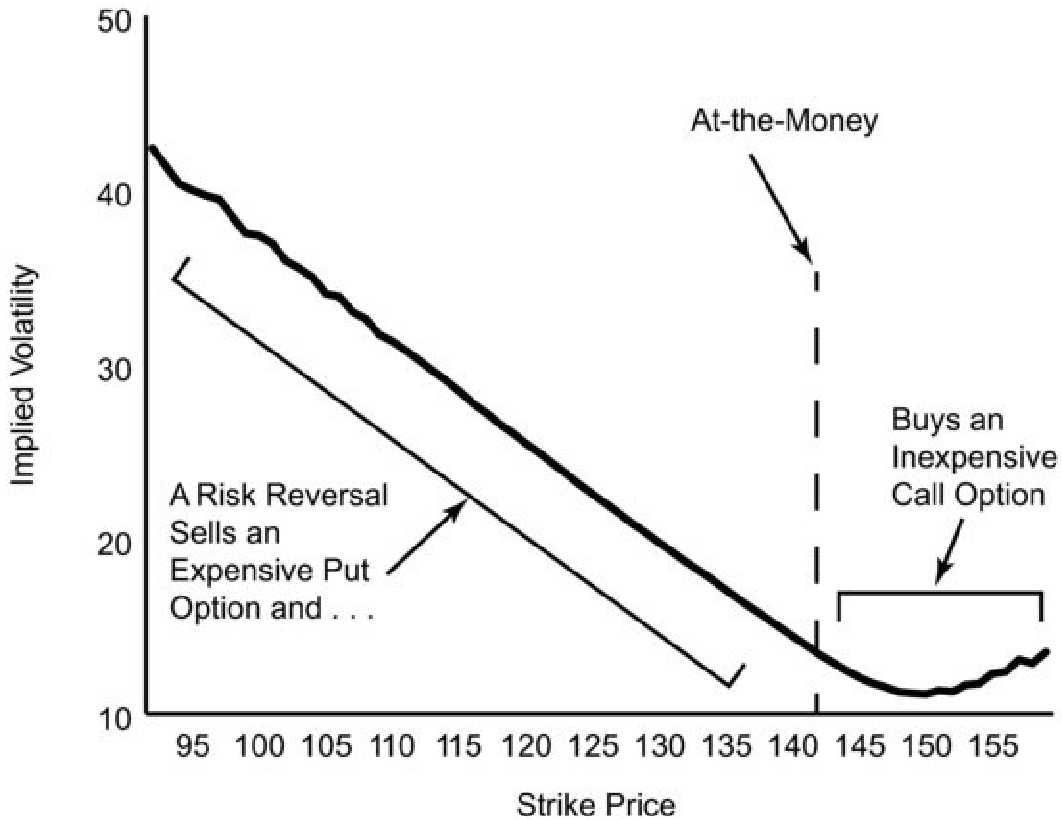
Table 13.1 A Risk Reversal

	Price
XYZ Stock	100.00
Buy XYZ 30-Day 105 Strike Call	2.50
Sell XYZ 30-Day 95 Strike Put	2.75
Net Credit	0.25

A RISK REVERSAL AND SKEW

Skew is one of the phenomena discussed in Part Two. Due to several factors, including the flawed assumptions of option pricing models and the tendency for investors to insure their stock holdings via put purchases, options with strike prices below at-the-money (i.e., put options) generally display implied volatilities that are higher than the implied volatilities of options with strike prices that are above at-the-money, even if the put and call are equidistant from at-the-money. If the implied volatility for every strike price in an expiration cycle were plotted, it would show the curve that we've called skew. Figure 13.1 shows implied volatility plotted for SPY, the S&P 500 ETF, and how it is used to construct a risk reversal.

FIGURE 13.1 Skew Chart



A risk reversal generates a long position in the underlying stock by selling the left side of the skew chart (which is the higher side in terms of implied volatility) in the form of a put and buying the right side of the skew chart (which is the lower side in terms of implied volatility) in the form of a call option.

A risk reversal is always a bullish strategy since both legs of the trade are bullish. (See Table 13.2.) Selling a put is mildly bullish and using that premium generated to buy a call option adds to the bullishness. The total bullishness of the position, expressed as the total delta of the two legs, depends on how far each is from at-the-money. The closer each leg is to at-the-money, assuming both legs are still out-of-the-money, the higher the total delta of the risk reversal and the greater the bullishness of the position.

Table 13.2 XYZ Risk Reversal Bullishness with Underlying at 102.50

Option	Delta
90 Strike Put	−12
95 Strike Put	−22
100 Strike Put	−40
105 Strike Call	38
110 Strike Call	20
115 Strike Call	8
Total Delta	
90/115 Risk Reversal	20
95/110 Risk Reversal	42
100/105 Risk Reversal	78

Let's say the underlying stock is below the put strike price at expiration; we, by using a risk reversal, are going to have the stock put to us and must pay the strike price of the put option. If the underlying stock is above the call strike price at expiration we're going to choose to exercise the call option we're long and will pay the call strike price for the stock.

If the stock falls inside the range between the strike prices at expiration, above the put strike price and below the call strike price, then risk reversal users do not buy the stock. Both options will expire worthless and we will keep (lose) whatever net premium we received (paid) when executing the risk reversal.

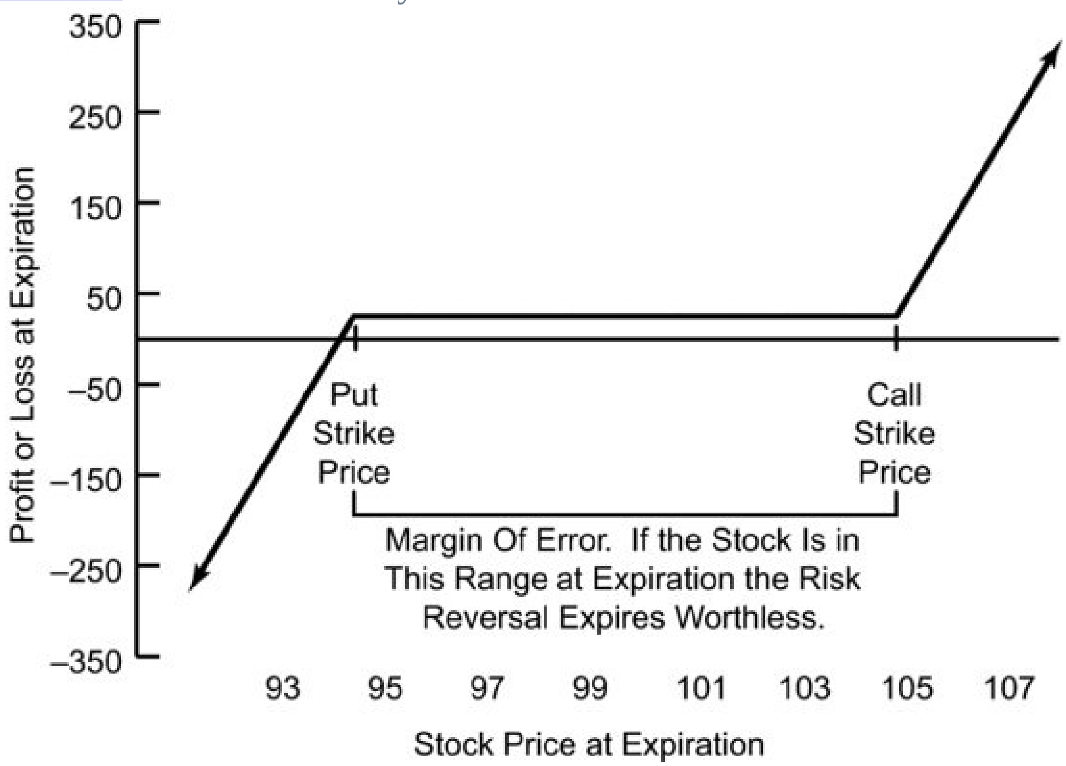
What is the profitability of the XYZ 95/105 risk reversal we looked at previously? See Table 13.3, which shows that, if we bought the 105 call at $2.50 and financed it by selling the 95 put at $2.75, we'd generate a net credit of $0.25. Table 13.3 shows the profitability across a range of prices.

Table 13.3 Profit and Loss From the XYZ 95/105 Risk Reversal

XYZ Price at Option Expiration	Profit or Loss on 105 Call Option	Profit or Loss on 95 Put Option	Total Profit or Loss
92	−250	−25	−275
93	−250	75	−175
94	−250	175	−75
95	−250	275	25
96	−250	275	25
97	−250	275	25
98	−250	275	25
99	−250	275	25
100	−250	275	25
101	−250	275	25
102	−250	275	25
103	−250	275	25
104	−250	275	25
105	−250	275	25
106	−150	275	125
107	−50	275	225
108	50	275	325

Figure 13.2 shows the payoff chart for this risk reversal including the area between the strike prices, which generates a small profit.

FIGURE 13.2 Risk Reversal Payoff



WHEN TO USE A RISK REVERSAL

Since a risk reversal is always a bullish strategy it is best used on underlying stocks that we are bullish on. If we were very bullish then we'd want to use another strategy, such as an outright purchase of the stock or the purchase of an at-the-money call option.

If we thought the underlying stock would likely head higher but might be stuck in neutral, then we'd sell a put option as we discussed in Chapter 11, but wouldn't buy a call option. By simply selling a put, we make money if the stock goes nowhere but underperform if the stock rallies enough. By adding a long call option to the put sale, a trader adds significant upside to the trade if the stock rallies. A trader using a risk reversal should be more bullish than a put seller.

As with any strategy that involves selling a put option, a risk reversal should only be used on underlying stocks that a trader is willing to own. Since the net premium received for using a risk reversal is usually relatively small and might be slightly negative, the discount if the stock drops below the put strike price at expiration is also relatively small; in our XYZ example the discount would only be the $0.25 credit received. If the stock dropped below the put strike price the effective purchase price would be $94.75. If the risk reversal were initiated at a debit, the stock would be put to the trader at an effective price slightly above the put strike price. As such, a risk reversal isn't a good way to buy a stock at a discount. Rather, it's a good way to get long exposure to a stock while creating a margin of error in the form of a range between the strike prices where nothing happens. Inside that margin of error the entire trade expires worthless.

Since using a risk reversal results in being short a put option, your broker will require you to leave cash or margin availability in your account to pay for the stock if it's put to you. While your broker will be satisfied with margin capability in your account, we won't consider using margin, and all the payoff charts and profit and loss calculations will ignore the effects of margin.

USING A RISK REVERSAL

Since skew is most prevalent and obvious in equity index products let's examine SPY for a risk reversal example, as seen in Table 13.4. SPY was at $140.71 when these prices were observed.

Table 13.4 Skew and Delta for a SPY Risk Reversal

Option	Price	Option Delta	What Would Option Price Be with No Skew	Option Is Overvalued (Undervalued) By?
120 Put	0.20	−4	0.01	0.19
125 Put	0.35	−7	0.02	0.33
130 Put	0.65	−13	0.17	0.48
135 Put	1.27	−24	0.80	0.47
140 Put	2.57	−45	2.48	0.09
145 Call	0.94	26	1.21	(0.27)
150 Call	0.15	6	0.35	(0.20)
155 Call	0.04	2	0.08	(0.04)
160 Call	0.02	1	0.01	0.01

If we were simply interested in maximizing the positive impact of skew on option prices we would select the 130/145 risk reversal. We would sell the 130 put at $0.65, $0.48 more than it would be worth if it weren't for skew, and we would use the proceeds to buy the 145 call at $0.94, about $0.27 less than the option would be worth if it weren't for skew. Since the 145 call costs more than we will receive for selling the 130 put, we will have to pay $0.29 ($0.94 – $0.65) to execute this trade.

There is no downside breakeven for this trade because it cost money to put on. There's no price to which the stock could break that would result in a profit on the option trade. That doesn't mean it's necessarily a bad trade, it just means the stock has to rally for a risk reversal executed at a net debit to be profitable. For this risk reversal the upside breakeven is $145.29. At that point, at expiration, the risk reversal will result in buying the shares at $145.00 and the gain will be equal to the $0.29 paid initially. Above that breakeven level at expiration the trade makes $1 for each $1 the underlying rallies; above this level it's essentially a long position in the stock.

SPY was at $140.71 when these prices were observed. That means that the breakeven point ($145.29) required only a 3.25 percent increase in the price of the underlying stock. There is no downside breakeven but since the entire trade cost only $0.29 we can compare the rally required to get to breakeven to the drop that would result in having the stock put to us. That happens with SPY below $130 at expiration and would require a drop of 7.61 percent, as we see in Table 13.5. We could consider the $0.29 paid for the risk reversal as the price paid to have good things happen with only a 3.25 percent increase while keeping bad things from happening unless we experience a drop of 7.61 percent.

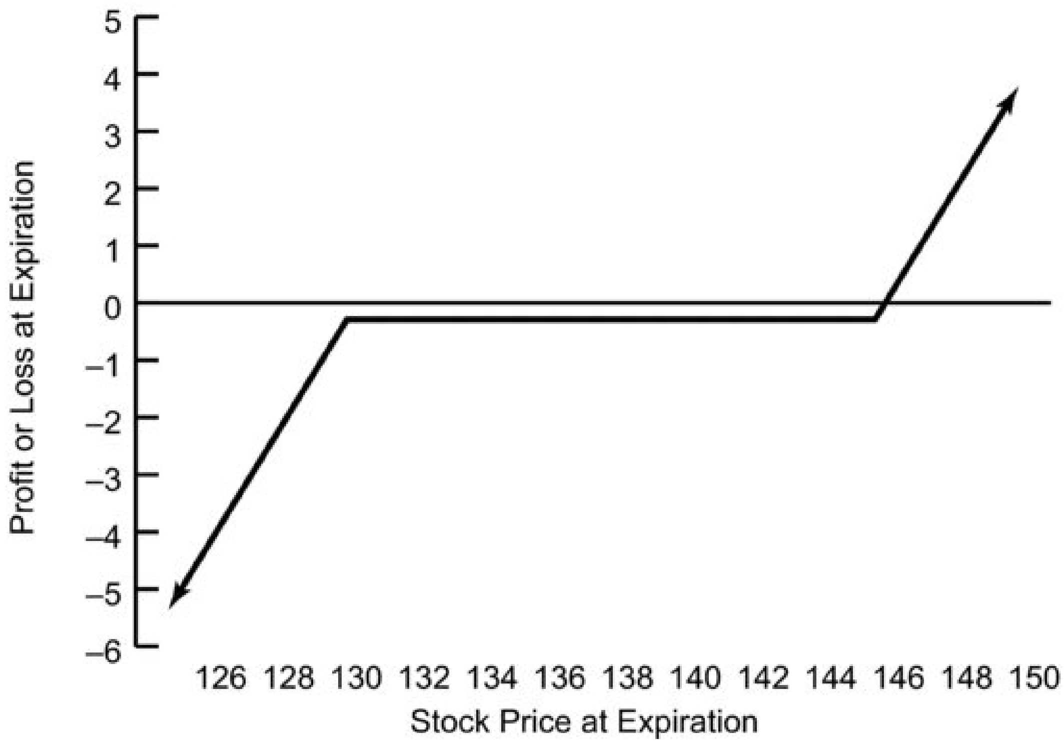
Table 13.5 SPY Risk Reversal

Buy 145 Call	0.94
Sell 130 Put	0.65

Net Premium Paid	0.29
Total Delta	39
Downside Breakeven Point	None
Upside Breakeven Point	145.29
Drop in Stock Required to Have Stock Put to Trader	7.61%
Rally Required to Achieve Upside Breakeven	3.25%

This trade highlights the danger of being locked into the idea that a risk reversal (or its opposite trade, a collar) needs to be done at no cost or for a credit. Sometimes, the expenditure of a little bit of premium will result in strike prices and a payoff chart that are superior to those generated from a risk reversal that is done at a credit. Figure 13.3 shows the payoff chart for this risk reversal.

FIGURE 13.3 SPY Risk Reversal #1 Payoff



How much long exposure does this risk reversal generate? The delta of the put sold is –13 and the delta of the call option bought is 26. The total delta is 39 (the impact of selling a put which has negative delta is to gain positive exposure or positive delta).

This total delta of 39 doesn't really give us much exposure in the case of a small movement. Remember from Part One that a delta of 39 means that if SPY rallies by $1 we'd expect our risk reversal to increase in value by $0.39. As SPY rallied this delta would gradually increase, and since the 145 call is the lowest call strike price that is out-of-the-money among those strike prices we looked at, our trader may be very happy to use this combination of strike prices.

However, our trader may want more exposure meaning he wants a higher total delta. Is there another risk reversal that would generate a net credit as well as a higher delta? The 135/145 risk reversal offers almost as much positive effect of skew and offers much more market exposure since the delta is higher. In executing the 135/145 risk reversal our trader would sell the 135 put at $1.27, $0.47 more than the option would be worth if it weren't for skew, and would use part of the proceeds to buy the 145 call at $0.94. The result is a net credit of $0.33.

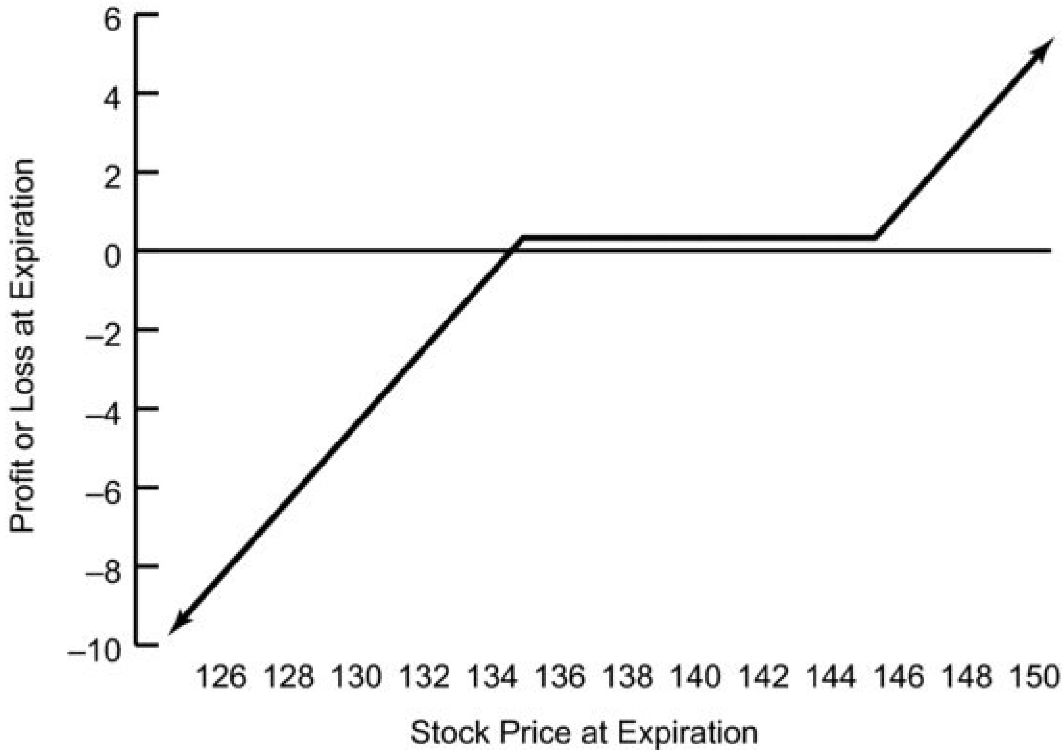
This risk reversal offers more exposure to price changes in the underlying stock because the put option sold is closer to at-the-money. The delta of the 135 put was –24, meaning the delta of the second risk reversal was 50 (selling the 135 put generates positive delta of 24 while buying the 145 call generates positive delta of 26) as you can see in Table 13.6. Over short distances, this risk reversal will change in price by about half of the change in SPY. Our trader has accomplished the goal of getting more exposure to changes in the price of SPY and has also put the risk reversal on for a net credit.

Table 13.6 New SPY Risk Reversal

Buy 145 Call	0.94
Sell 135 Put	1.27
Net Premium Received	0.33
Total Delta	50
Downside Breakeven Point	134.67
Upside Breakeven Point	None
Drop in Stock Required to Achieve Downside Breakeven	4.29%
Rally Required to Achieve Call Strike Price	3.05%

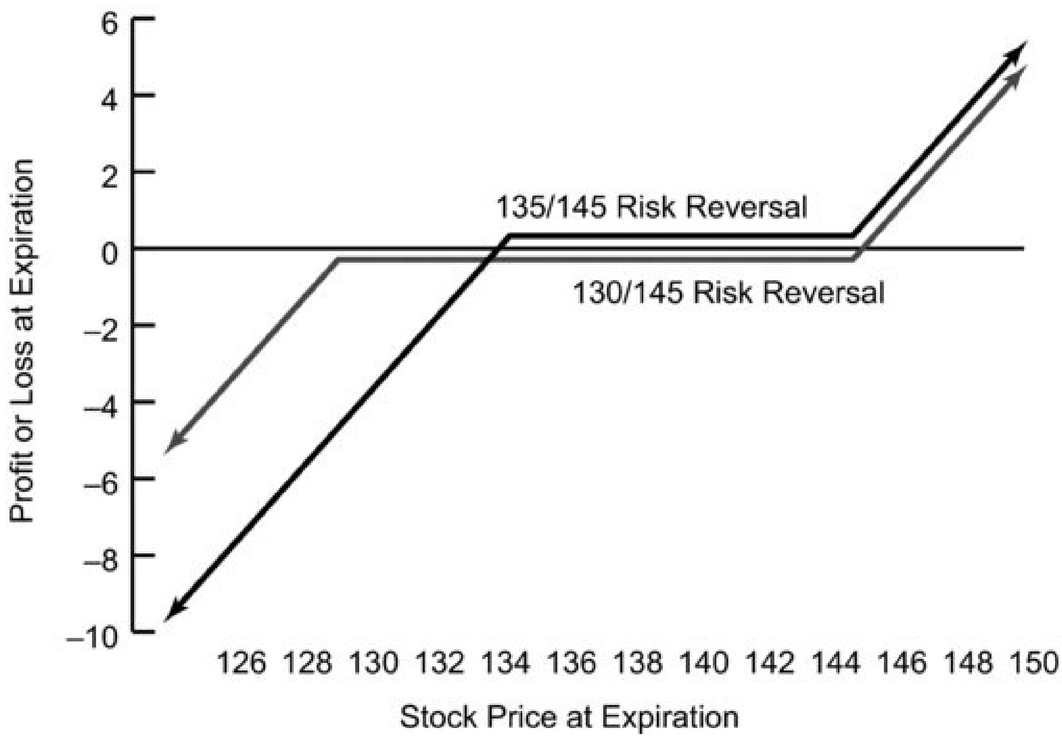
The downside breakeven for this trade, the 135/145 risk reversal, is $134.67. This trade has a downside breakeven because it was done at a net credit; there is no upside breakeven. If the stock were to rally it would simply add to profits. Figure 13.4 shows the payoff chart for this risk reversal.

FIGURE 13.4 SPY Risk Reversal #2 Payoff



This second risk reversal, the 135/145, was executed for a credit. At what cost? First, since it has a higher delta it has increased exposure to changes in the price of SPY. That might be good or bad. If SPY falls in price, then the value of the 135/145 risk reversal will fall faster than will the value of the 130/145 risk reversal. Second, exposure on the downside will happen sooner because the strike price of the put is now higher. If the SPY were at 130 at option expiration, the first risk reversal (the 130/145) would expire worthless and the net outcome would be the loss of the $0.29 initially paid. However, if SPY dropped to 130, the second risk reversal (the 135/145) would result in a loss because the 135 is now in-the-money. The loss from this second risk reversal would be $4.67, a $5.00 loss on the 135 put our trader is short less the $0.33 credit received at initiation. Figure 13.5 compares the payoff charts for both risk reversals.

FIGURE 13.5 Both Risk Reversals



RISK REVERSALS PRIOR TO EXPIRATION

The delta effect we've discussed results in market exposure from the time we put the trade on. Since the delta for a risk reversal can be fairly large, often representing 50 percent or more of the move in the underlying stock, a risk reversal can be a proxy for a long position in the stock in a way that other option strategies can't. Simply selling a put option, as we discussed in Chapter 11, doesn't generate a delta of 50 or greater unless the put option sold is at-the-money or in-the-money. A calendar spread can be bullish but it can go too far and become bearish. Covered calls and short puts need less movement, not more.

This delta effect means that a risk reversal doesn't require the stock to rally above the call strike price in order to be profitable. Rather the risk reversal will increase in value as the underlying stock rallies even if it doesn't get above the call strike price. While an outright long call will increase in value as the underlying rallies, an outright call is always fighting erosion. For a risk reversal the negative effect of erosion on the call option is balanced by the positive effect of erosion on the put option. However, eventually time decay becomes a problem as the long call option begins to erode more quickly once it's at-the-money.

There are several good ways to mitigate the impact of erosion if the underlying rallies and the call becomes at-the-money. We'll explain these later when we discuss follow-up action.

It's impossible to know what a risk reversal will be worth given a specific price for the underlying until expiration, but if we make some assumptions about skew (always a very dangerous thing) it is possible to approximate what a risk reversal would be worth before expiration. This exercise, as shown in Table 13.7, is done only so that readers can see a possible outcome prior to expiration. It requires assumptions about skew, implied volatility, the passage of time, and how all of those interact. The example assumes an at-the-money price of $100.00, the at-the-money implied volatility was 14.25 percent, and there were 50 days to expiration.

Table 13.7 Risk Reversal Alternatives

Option	Implied Volatility	OTM Option Price	Delta	Option Price Without Skew	Skew Effect
80 Put	28.00	0.05	−1	0.00	0.05
85 Put	24.25	0.11	−3	0.00	0.11
90 Put	20.75	0.30	−8	0.04	0.26
95 Put	17.50	0.82	−21	0.43	0.39
100 Call and Put	14.25	2.06	50	2.06	0.00
105 Call	11.75	0.32	14	0.49	(0.17)
110 Call	11.25	0.01	1	0.07	(0.06)
115 Call	13.25	0.00	0	0.00	0.00
120 Call	13.50	0.00	0	0.00	0.00

There are several risk reversals we could select from among these options. If we wanted to maximize the positive effect of skew on option prices and simultaneously get the maximum delta exposure while using out-of-the-money options, we would execute the 95/105 risk reversal for a $0.50 credit. We would do this by selling the 95 strike put at $0.82 and buying the 105 strike call for $0.32. Due to skew the 95 put is "overpriced" by $0.39 and the 105 call is "underpriced" by $0.17; the risk reversal is worth $0.56 more than it would be if there were no skew. The delta of this 95/105 risk reversal is 35 (selling the put with a negative delta of 21 and buying the call with a positive delta of 14 generates a positive delta of 35).

It is not always possible to simultaneously maximize the skew effect and delta, as we've seen in the SPY example in Table 13.4.

What would this 95/105 risk reversal be worth if just after initiation the underlying moved to 105? Using an option pricing model like the one available at OptionMath.com it's possible to estimate. In that case, using the same *relative* implied volatilities the risk reversal would look like the one in Table 13.8.

Table 13.8 The 95/105 Risk Reversal After a Rally to 105

	Original Price	New Value	Profit (Loss)
95 Put Option	0.82	0.30	0.52
105 Call Option	0.32	2.06	1.74

The total unrealized profit from the risk reversal is $2.26 ($0.52+ $1.74). Observant readers will notice this is more than would be expected from a 5 point move for a 35 delta option position. This is due to the fact that delta changes as the underlying moves. The originally observed delta of 35 is only valid over short distances. As the underlying rallies this delta increases (this is the effect of gamma). With the underlying at 105 the delta of this risk reversal would be 59.

What would the risk reversal be worth if the underlying had not moved but time had passed? What would the risk reversal be worth with 25 days to expiration with the underlying at $100.00? We see this scenario in Table 13.9.

Table 13.9 The 95/105 Risk Reversal After the Passage of Time

	Original Price	New Value	Profit (Loss)
95 Put Option	0.82	0.32	0.50
105 Call Option	0.32	0.08	(0.24)

In this situation the risk reversal has made $0.26 ($0.50 – $0.24) even though the risk reversal is bullish and the underlying hasn't moved. The only thing that has changed is that time has passed. You'd expect a risk reversal executed for a credit and with the strike prices equidistant from at-the-money to be profitable in this situation.

These examples are offered only with the caveat that we've tried to isolate a single variable so that we can see its impact on a risk reversal. The markets rarely act like this. Obviously markets tend to move, implied volatilities tend to change, and the shape of the skew curve evolves.

These examples show that a risk reversal doesn't require the underlying stock to be above the call strike price to be profitable, and the reason is the effect delta has on the risk reversal and the difference in the impact of time on the two options.

The value of the risk reversal will increase as the stock appreciates although eventually time decay becomes a problem. With the stock at the call strike price at expiration the worst thing has happened: You've been right but you've only made a tiny bit of money; you've made the amount of the credit the risk reversal generated, meaning that if you put the risk reversal on for a debit the whole thing ends up being a loser. This doesn't mean you should only initiate a risk reversal for a credit, it just means you should have a good reason for paying to put one on.

A risk reversal is optimal, meaning the relationship between how far the strikes are out-of-the-money and the net credit received or net debit paid is most advantageous, when the general investing public hates a particular stock and has bid up the price of put options and has sold down the price of call options.

WHEN A RISK REVERSAL DOESN'T WORK

Risk reversals work because of put skew, meaning they work because implied volatility and the subsequent price of put options is higher than for call options. If there were no skew, the call would cost as much as the put and the risk reversal user would have no advantage. What about those underlying assets or stocks we discussed in Chapter 6, the ones that don't exhibit put skew but rather exhibit call skew, meaning that calls are relatively more expensive than puts? Those assets included gold, crude oil, and some of the companies that produce these commodities, as well as companies that are seen as takeover candidates.

One example is GLD, the ETF that tracks gold prices. Table 13.10 draws on some recently observed prices for options on GLD.

Table 13.10 GLD Option Prices

Option	Price	Option Delta	What Would Option Price Be with No Skew	Option is Overvalued? (Undervalued) By?
30 Put	0.03	−2	0.00	0.03
32 Put	0.09	−5	0.02	0.07
34 Put	0.22	−10	0.10	0.12
36 Put	0.50	−21	0.37	0.13
38 Put	1.07	−39	0.99	0.08
40 Call	0.89	39	0.90	(0.01)
42 Call	0.40	21	0.38	0.02
44 Call	0.20	11	0.13	0.07
46 Call	0.12	7	0.04	0.01

In our first example, the SPY example, any combination of short put and long call would have demonstrated an advantage generated by skew. In GLD that's not the case. The 32/44 risk reversal would result in selling the 32 put for $0.07 more than it would be worth without skew and buying the 44 call for $0.07 more than it would be worth without skew. There's no advantage there. That's because gold tends to show either call skew or equal skew, which is what we see here. What about a stock that's a takeover candidate?

One recent example of a stock that's considered a takeover candidate is Yahoo! (YHOO). It, like many takeover candidates, shows call skew. What would a risk reversal in Yahoo! look like? First let's look at some of the options available to construct our risk reversal in Table 13.11.

Table 13.11 YHOO Option Prices

Option	Price	Option Delta	What Would Option Price Be with No Skew	Option is Overvalued? (Undervalued) By?
12 Put	0.04	−3	0.02	0.02
13 Put	0.13	−13	0.10	0.03
14 Put	0.36	−42	0.35	0.01
15 Call	0.41	44	0.36	0.05
16 Call	0.16	15	0.08	0.08
17 Call	0.07	3	0.03	0.04

In this situation the risk reversals we might pick all result in losing money to skew. Of the put options, the 13 put has the most additional value due to skew, so that might be the one we'd sell. However, every call is higher than it would be if not for skew, and each one is higher by more than that $0.03. The 13/16 risk reversal would result in paying $0.03 to put it on, and the net effect of skew would always be negative for this trade since the call bought is "overpriced" by more than the put sold. The 14/15 risk reversal would cost $0.05 to put on. Again, the net effect of skew would be negative.

In situations like this where call skew exists, it's best to think of a risk reversal as a way to get upside exposure for a very low cost, although the requirement to deposit margin should be taken into account. The benefit of a risk reversal in a situation like this is that if the stock is between the two strike prices at expiration, we don't have to worry about holding stock that isn't rallying as we expected. However, if an offer had been made to buy the company, then it would likely be for a price greater than the strike price of the call we're long. It shouldn't be forgotten that bad news could still come out leaving us short a put and ultimately long the stock when we don't want to own it. In a situation where call skew cancels out or overwhelms the benefit generated by put skew, there's no reason not to use a risk reversal if we recognize that what we expect to go up might go down. There's just no extra benefit generated by skew.

In the presence of put skew a risk reversal should usually be put on for a small credit, but if spending a small amount of premium generates a risk reversal with better risk/reward characteristics, we should spend the little bit of extra money.

This is also the case with underlying stocks exhibiting call skew. This is true particularly if the result of spending a little in premium is that we participate at a price that is an important technical level on the stock chart.

RISK REVERSALS AND LONGER-DATED EXPIRATIONS

Risk reversals are usually hurt by extending the expiration. This is because option pricing assumes the underlying is going to appreciate by the risk-free rate of interest resulting in the at-the-money strike for a call option being above the current price for the stock. This is also why a stock at $100.00 will often have 100 strike call options with deltas greater than 50.

The result is that what we might think of as the at-the-money call is really in-the-money if the expiration is distant enough and a slightly out-of-the-money call might actually be at-the-money. Since the call is at-the-money, it will be more expensive. Similarly, the put option will be further out-of-the-money than we really believe it is and will have less value. This all means our option trader will collect less for selling the put option and must pay more to buy the call option. The normal economics of a risk reversal are changed by the more distant expiration. Table 13.12 shows deltas for hypothetical options at 30 percent implied volatility, 100 strike price, and the underlying at $100.00.

Table 13.12 Risk Reversals and Time to Expiration

Time To Expiration	Delta
Calls	
1	50.7
5	51.5
15	52.6
30	53.6
90	56.3
180	58.9
360	62.4
Puts	
1	49.3
5	48.5
15	47.4
30	46.4
90	43.7

180	41.1
360	37.6

In some cases the call strike price can be significantly above the current price. This happens if interest rates are high and the options are particularly long-dated. What strike price, assuming $1 wide strike prices, would have a call (and put) delta closest to 50 for these expirations in Table 13.12? Table 13.13 shows the at-the-money strike price increases for calls as the number of days to expiration increases.

Table 13.13 Time to Expiration and Moneyness

Time To Expiration	At-the-Money Strike Price
Calls	
1	100
5	100
15	100
30	101
90	102
180	105
360	110

Time to Expiration and Risk Reversal Deltas

Let's look at some different hypothetical options and the potential risk reversals in Table 13.14. Note that because these are hypothetical there is no skew in order to isolate the impact of time to expiration.

Table 13.14 Risk Reversal Time and Delta

Time to Expiration	Price	Delta
105 Call Option		
15 Days	0.75	22
30 Days	1.57	30
180 Days	6.33	45
360 Days	9.80	49
95 Put Option		
15 Days	0.66	−19
30 Days	1.42	−26
180 Days	5.93	−36
360 Days	9.21	−37
95/105 Risk Reversals		

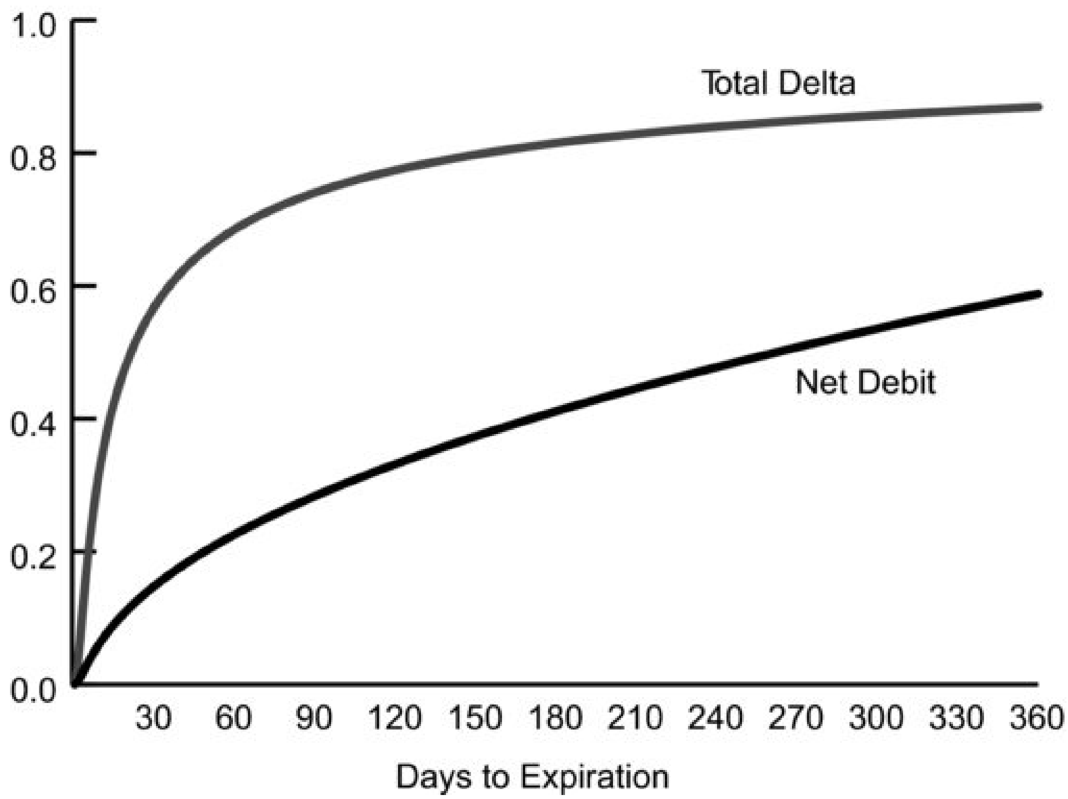
15 Days	0.09 Debit	41
30 Days	0.15 Debit	56
180 Days	0.40 Debit	81
360 Days	0.59 Debit	86

As time to expiration increases the call option gets more expensive relative to the put option. Thus, the risk reversal gets more expensive.

We also see that the delta of the risk reversal increases as time to expiration increases. This makes sense as the delta of each option increases as time to expiration increases. This is due to the idea that with more time to expiration; there's a greater possibility for a call option that is currently out-of-the-money to become in-the-money at expiration.

Figure 13.6 shows how this hypothetical cost and delta changes as time changes. Changes in the price of the risk reversal are fairly linear, but the real impact is on the delta. As time to expiration increases the delta initially increases very rapidly and eventually levels off. If your major goal is to get delta exposure rather than use the option math of skew, then you're better off using slightly longer dated options.

FIGURE 13.6 Risk Reversal Cost and Delta Across Time



FOLLOW-UP ACTION

Follow-up action for a risk reversal isn't as involved as it is for some of the other strategies we've discussed. In selling a put a trader may be most focused on collecting and keeping the premium received. This might result in rolling the position to keep from owning the stock. In a risk reversal the potential to get put the stock if it's below the strike price of the short put might result in our trader wanting to close the put or roll down or down and out.

Since the initial trade probably didn't generate much net premium, it's much tougher to roll the put and not have the trade end up a big loser. In this case rolling the put down and out (so that the net premium paid for the follow-up trade is very small) is likely the best idea. The problem is that by rolling down and out we have extended the period during which we're short a put option. If we think the issues that are weighing on the stock are transient then this may make sense, but we executed the trade in order to get long exposure to the underlying stock. We've been wrong. Rolling down and out will lower the strike price we're short but it may not be low enough. We should recognize that by using a risk reversal we likely had the option math working for us and, thanks to the delta being less than 100, probably lost less money than we would have if we'd simply bought the stock.

If the stock is below the put strike price, then it's probably best to recognize the trade for the loser it is and move on by closing the position and taking the loss. If the call option is worthless, or nearly so, there's no reason to sell it. This is much like the situation we discussed previously. We could leave a good-till-canceled (GTC) order to sell the call at a reasonable price, something like $0.50. If the short put still has substantial time value remaining then it may make sense to leave the trade as it is. We expected the underlying stock to rally, so it may be near a bottom.

If the stock isn't yet below the put strike price and there's very little time to expiration it probably makes sense to simply monitor the trade in the hope that the stock stays above the put strike price and stays within the margin of safety between the two strike prices.

Since a risk reversal generates so little premium, and might actually be executed at a debit, the goal needs to be long exposure to the underlying stock. That doesn't mean that we shouldn't take advantage of the opportunity to make a better, more informed trade, particularly if the stock has rallied to our call option strike price so that erosion is now working against our position.

For example, Table 13.15 shows QQQ, the ETF that tracks the NASDAQ 100 index, at $66.25 with about 30 days to expiration.

Table 13.15 QQQ Risk Reversal

Initial Risk Reversal	Price	Delta	Daily Erosion
68 Strike Call Option	0.65	31	−0.019
64 Strike Put Option	0.77	−28	0.023
64/68 Risk Reversal	0.12 Credit	59	0.004

This is about what we would expect for a risk reversal, particularly one on an equity index. There's significant put skew, as you can see from the fact that the put option is further from at-the-money ($66.25) than the call option but is still more expensive than the call. Since both options share an expiration, the expected daily erosion for the put option is greater since it's more expensive, however the net expected erosion is tiny. This trade clearly has the option math working for it, but what would happen if QQQ rallied, as expected, and was at $68.00? How would this effect the risk reversal? Would the option math still be working in our favor? While it's always difficult to assume what the trade would look like, Table 13.16 shows a reasonable estimate of what this trade would look like with QQQ at $68.00 and 10 days to expiration.

Table 13.16 QQQ Risk Reversal After a Rally

Risk Reversal After Move	Price	Delta	Daily Erosion
68 Strike Call Option	0.85	51	−0.044
64 Strike Put Option	0.07	−6	0.016
64/68 Risk Reversal	0.78 Credit	57	−0.028

The risk reversal shows a profit of $0.90 ($0.78 value now plus the $0.12 already collected) as we'd expect given that QQQ has rallied. What about the rest of the term of the trade? Is the option math still working in our favor? Daily erosion is now working against us; the value of the risk reversal will erode by nearly $0.03 today, and as expiration approaches that erosion penalty will increase. If QQQ doesn't move any further, the 68 strike call will expire worthless and the additional unrealized value of $0.78 will disappear. The entire profit will fall back to the $0.12 credit received for initiating the trade. Clearly, the passage of time and the option math are no longer working for this risk reversal, they're now working against it. So what's the right follow-up trade?

With 10 days left to expiration our trader needs to focus on the call side of this trade. It's certainly possible that QQQ could fall below the 64 level before expiration, and many traders would buy back that nearly worthless put or would bid $0.05 for it. Either makes sense, although that would eat into the credit of $0.12. Buying back the put would also free up all of the cash or margin that's currently being used. However, the call option is where the action is.

Our trader really has three alternatives: Leave the trade as it is, close the trade and take the profit, or roll the call.

Leave the Trade As It Is

Not every trade can always have the option math working in its favor and presumably our trader was bullish QQQ and put this risk reversal on for that reason. Right so far: There's no reason to think that the rally is going to stop simply because QQQ has reached the call strike price. From this point forward the risk reversal will increase in value by $1 for each $1 rally in the price of QQQ, although that $1 increase in value will require holding the trade until expiration. As long as traders in this situation recognize that QQQ has to reach $68.78 at expiration to be as well off as they are right now, they should leave the trade on if they think that is likely.

Close the Trade

If traders think QQQ going substantially higher is unlikely, they may very well choose to exit the trade and take the profit. In doing so they would sell the call at $0.85 and buy back the put at $0.07. Traders shouldn't get in the habit of taking off the call and staying short the teenie put option. Staying short this put option will usually work out since it will usually expire worthless but occasionally some unexpected news will come out and torpedo the stock or ETF, QQQ in this case, and the $0.07 they're hoping to collect will end up being pretty expensive.

Roll the Call

The final alternative is to roll this long call. Simply rolling the call up will generate net premium since the 68 call sold will be more expensive than the upside call bought. This will add additional premium to the $0.12 received when the trade was initiated, but at the cost of reduced exposure to a continued rally because the delta of the new call will be lower than the delta of the 68 call. Since the new call option will be cheaper than the 68 call, the net daily erosion paid will be reduced as well.

Rolling the call up and out will reduce the net premium received for selling the 68 call to the point that no net premium might be received. However, since the new call option is both longer-dated and has a higher strike price, the penalty of daily erosion will be reduced, as we discussed in Part Two.

TAKEAWAYS

- Risk reversals get skew (cheaper call options, more expensive put options) working in our favor.
- A risk reversal is a fairly bullish trade.
- Risk reversals should generally be initiated for a small credit.
- Don’t be afraid to initiate a risk reversal at a small debit if it results in much better strike prices.
- Risk reversals allow for a margin of error at expiration, where the risk reversal simply expires worthless.
- If the stock rallies to the call strike price the option math is now working against us.
- Longer expirations create problems for risk reversals.

CHAPTER 14

Vertical Spreads

Just as a risk reversal takes advantage of skew to get bullish exposure to the underlying stock, vertical spreads can take advantage of skew, and some of the other phenomena we've discussed, to get bearish exposure to the underlying.

A vertical spread is executed when you buy one option and sell another option of the same type (put or call) and the same expiration date but with a different strike price.

While vertical spreads, sometimes simply called verticals, can be either bearish or bullish, skew is generally working against a bullish vertical spread, whether it's a call spread or a put spread, so we'll focus on bearish vertical spreads.

Since we're focusing on bearish vertical spreads in order to take advantage of skew we'll look at buying a put spread (buying the strike price that is closer to at-the-money and selling the strike price that is further from at-the-money) and at selling a call spread (selling the strike price that is closer to at-the-money and buying the strike price that is further from at-the-money). Table 14.1 shows two bearish vertical spread examples for IBM stock.

Table 14.1 Bearish Put and Call Vertical Spread Examples

IBM	206.81
Put Spread	**Option Price**
Buy July 200 Put Option	4.30
Sell July 180 Put Option	1.00
Net Premium Paid	3.30
Call Spread	
Sell July 210 Call Option	4.80
Buy July 230 Call Option	0.50
Net Premium Received	4.30

In buying the July 180/200 put spread our trader would buy the July 200 put at \$4.30 and sell the July 180 put at \$1.00. The total paid for the spread is \$3.30.

In selling the July 210/230 call spread our trader would sell the July 210 call at \$4.80 and buy the July 230 call at \$0.50. The total received for selling the spread is $4.30. The benefit of selling a call spread is that the upper strike call, in this case the 230 call, caps the risk from what would otherwise be a naked call in selling the 210 call.

The minimum value of any vertical spread is zero; no vertical spread can have a negative value because no one would be willing to pay more for a lower strike put or more for a higher strike call. The minimum value of both of these IBM vertical spreads is zero.

The maximum value of any vertical spread is the distance between the strike prices. The maximum value of this IBM put spread is $20.00 because 200 minus 180 equals 20.00. The maximum value of this IBM call spread is $20.00 because 230 minus 210 equals 20.00.

BREAKEVENS

The breakeven point for a short call spread is very similar to the breakeven for a short call. The underlying stock can rally, at expiration, to a price equal to the strike price of the short call leg of the spread plus the amount of total premium received. At this point, the spread our trader is short is worth precisely the premium received.

The breakeven for a long put spread is likewise similar to the breakeven for a long put. At expiration the stock has to have fallen below the strike price of the long option portion of the spread by enough to pay for the spread. The breakeven point is that long strike price minus the total amount of premium paid. At this point, the spread our trader is long is worth precisely the price paid for it. (See Table 14.2.)

Table 14.2 Put and Call Vertical Spread Breakeven Points

Put Spread	
Buy July 180/200 Put Spread	3.30
Breakeven Point	196.70
Call Spread	
Sell July 210/230 Call Spread	4.30
Breakeven Point	214.30

SKEW AND VERTICAL SPREADS

Because skew can have such an impact on option prices and since there’s no reason to be swimming against the current, when using vertical spreads we’ll focus on buying put spreads or selling call spreads. Table 14.3 shows what our

IBM vertical spreads would be worth if it weren't for skew.

Table 14.3 Put and Call Vertical Spread Examples Without Skew

	Observed Price	What That Price Would Have Been without Skew
Put Spread		
Buy July 200 Put Option	4.30	4.05
Sell July 180 Put Option	1.00	0.32
Net Premium Paid	3.30	3.73
Net Benefit from Skew		0.43
Call Spread		
Sell July 210 Call Option	4.80	4.94
Buy July 230 Call Option	0.50	0.72
Net Premium Received	4.30	4.22
Net Benefit from Skew		0.08

In both the put spread bought and the call spread sold, skew generated a net benefit. There would certainly be other phenomena that would be helping or hurting these trades. The volatility risk premium would be helping the call spread since our trader would likely be selling the 210 strike call for more than it was worth, and that benefit would probably overwhelm the damage that the volatility risk premium would do to the profitability of the 230 strike call option bought. Time decay would also likely help the profitability of the call spread, since the daily erosion received from the call our trader is short (the 210 strike call) is going to be greater than the daily erosion paid on the option our trader is long (the 230 strike call).

The volatility risk premium is likely to hurt the profitability of the put spread bought, since the volatility risk premium paid in the 200 put is likely greater, in dollar terms, than the volatility risk premium received in the 180 put. Of course, it's not possible to know what the volatility risk premium will ultimately be for any of these options. That would require knowing what the realized volatility of IBM stock will be for the term of these options.

Time decay will also likely hurt the profitability of the put spread bought, since the daily erosion paid in the 200 put is going to be greater than the daily erosion received in the 180 put. Table 14.4 shows the daily erosion (theta) for each of these options and spreads.

Table 14.4 Daily Erosion of Vertical Spreads

	Daily Erosion
Put Spread	
Buy July 200 Put Option	0.039 Paid
Sell July 180 Put Option	0.021 Received

Net Daily Erosion	0.018 Paid
Call Spread	
Sell July 210 Call Option	0.038 Received
Buy July 230 Call Option	0.013 Paid
Net Daily Erosion	0.025 Received

A Word About Terminology

Many books refer to *bull call spreads* and *bear put spreads* and vice versa but option professionals rarely use these terms. Rather they buy or sell the spread and the spread is a put spread or a call spread. This is the terminology we'll use and that you can see in Table 14.5.

Table 14.5 Vertical Spread Terminology

Action	Market Outlook	Structure
Buy a Call Spread	Bullish	Buy Closer to At-the-Money Call, Sell More Out-of-the-Money Call
Sell a Call Spread	Bearish to Neutral	Sell Closer to At-the-Money Call, Buy More Out-of-the-Money Call
Buy a Put Spread	Bearish	Buy Closer to At-the-Money Put, Sell More Out-of-the-Money Put
Sell a Put Spread	Bullish to Neutral	Sell Closer to At-the-Money Put, Buy More Out-of-the-Money Put

The benefit of using this terminology is that it's aligned with that of buying or selling outright puts and calls.

VERTICAL SPREAD RISK AND REWARD

One reason the smart trader will use vertical spreads is that they define the potential risk of the trade. The maximum risk for any long vertical spread is the total paid for it. In our first IBM example, buying the July 180/200 put spread for $3.30, the maximum potential loss is the $3.30 paid.

The maximum potential loss for any short vertical spread is the distance between the strike prices, often referred to as the width of the spread, less the premium received. In the IBM call spread example, the maximum potential risk is $15.70, which is the $20.00 width of the spread minus the $4.30 in premium received.

In addition to getting some of the phenomena working to our advantage and mitigating the damage from those that are working against us, buying a vertical spread can significantly reduce the cost of a trade. For example, the IBM put spread only cost $3.30 or nearly 25 percent less than simply buying the July 200 put outright would have cost. The downside of this lower cost is that the potential profit is limited, just as the potential risk is limited. For a long vertical spread the maximum potential profit is the width of the spread minus the amount paid for the spread. (See Table 14.6.)

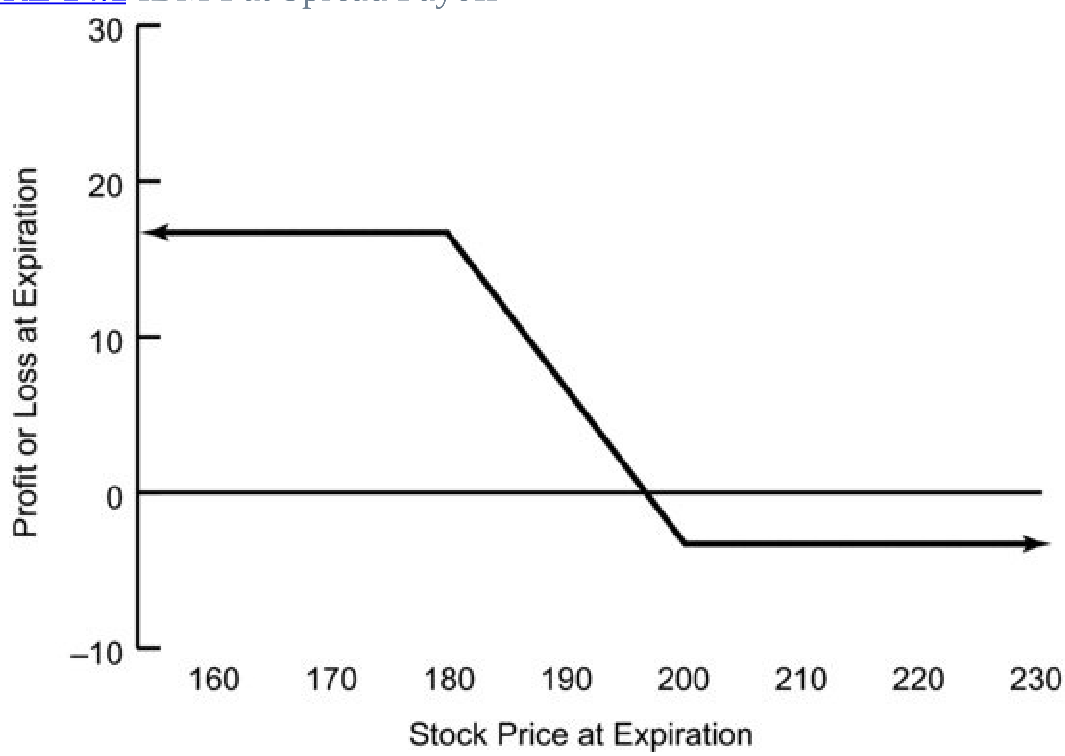
Table 14.6 Risk and Reward for Vertical Spreads

	Maximum Risk	Maximum Reward
Short Vertical Spread	Width of the Spread Minus the Net Premium Received	Net Premium Received
Long Vertical Spread	Net Premium Paid	Width of the Spread Minus the Net Premium Paid

In the IBM put spread example the maximum potential profit would be $16.70, which is the $20.00 width of the spread minus the $3.30 paid. For a short vertical spread the maximum potential profit is the net premium received for selling the spread. In this way a short spread is identical to a short outright option position, the maximum potential profit is the premium received.

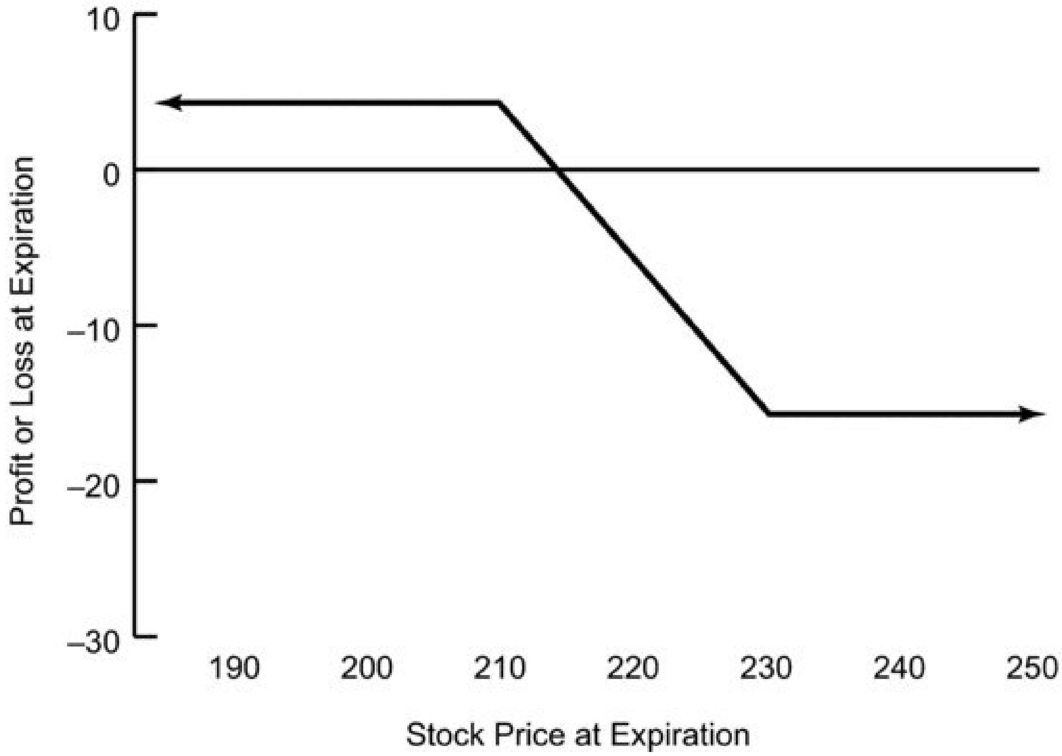
What would the risk and reward of buying this IBM put spread look like? Figure 14.1 shows the payoff chart for buying the IBM put spread.

FIGURE 14.1 IBM Put Spread Payoff



In the IBM call spread example, our trader sold the 210 call at $4.80 and bought the 230 call at $0.50. The net premium received was $4.30. That $4.30 would be the maximum potential profit. The maximum potential loss would be $20.00 (the width of the spread) minus $4.30 (the net premium received) or $15.70. Figure 14.2 shows the payoff chart for selling the IBM call spread.

FIGURE 14.2 IBM Call Spread Payoff



LONG PUT SPREADS AND SHORT CALLS SPREADS ARE ALIKE

Long put spreads and short call spreads are alike in many ways, but that doesn't mean they're identical. We've already seen how the risk and reward for each is different but they are alike in important ways such as market outlook and in ways that are a result of the phenomena we discussed in Part Two.

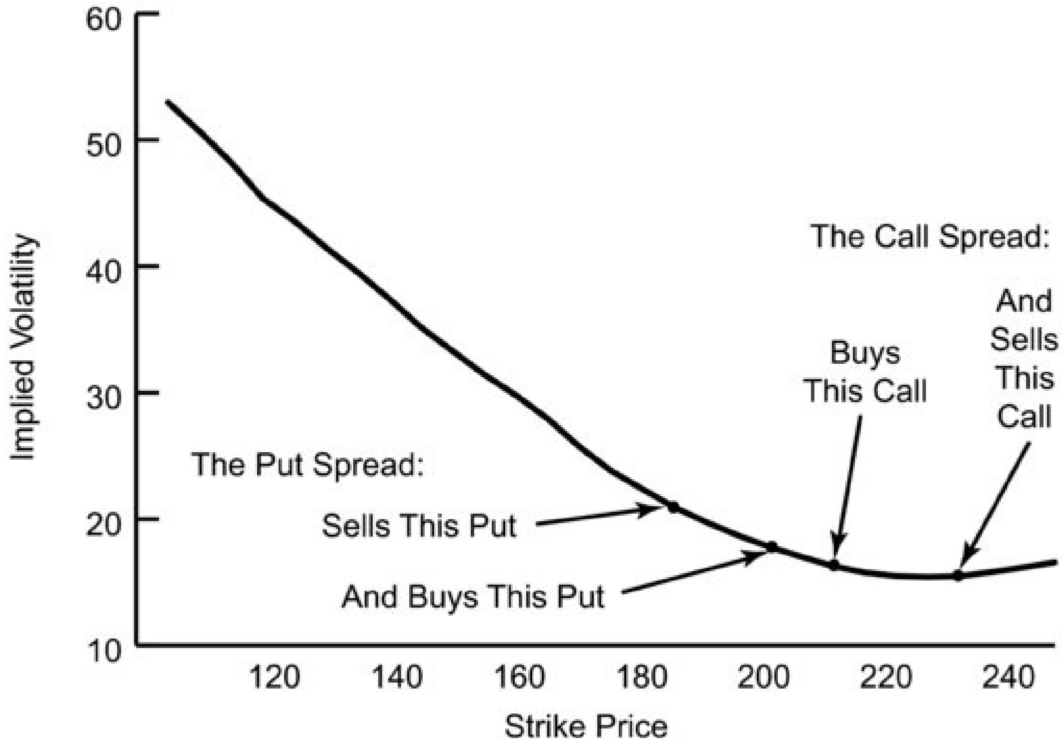
Both Are Bearish

Long put spreads and short call spreads are similar in that both are bearish. They both want the price of the underlying stock to drop, although a short call spread can also realize its maximum profit if the stock does not move, but both spreads lose money if the underlying rallies sufficiently. If the market rallies the long put spread will lose the amount of premium spent and the short call spread will lose the width of the spread minus the premium received.

Both Use Skew

Bearish verticals are also similar in that both can use skew. Nearly any long put spread will find that skew is advantageous because it's almost always the case that a put strike that is closer to at-the-money is going to have a lower implied volatility than a put strike that is more out-of-the-money. Figure 14.3 shows the skew curve for these IBM July options.

FIGURE 14.3 IBM Skew



The put spread is buying the 200 strike put at an implied volatility of 17.79 percent and selling the 180 strike put at an implied volatility of 22.34 percent. The call spread is selling the 210 strike call at an implied volatility of 16.28 percent and buying the 230 strike call at an implied volatility of 15.48 percent. Again, Table 14.3 quantified this impact in dollar terms.

Both Are Always Bearish

As we saw in calendar spreads, some directional positions can change their directionality. Bullish calendar spreads that originally need the underlying to rally can see the underlying go too far and find that their maximum profit is achieved if the underlying falls back. This isn't the case with bearish vertical spreads. They're both always bearish although, at some point, a bearish move in the underlying ceases to generate additional profit. This occurs if the spread is already at its point of maximum profit. For a long put spread it occurs if the underlying is below the bottom put strike price by an amount sufficient to wring all the time value out of both options. The same is true for a short call spread. Once this point has been reached by the underlying, any continued drop in price does no good. The put spread can't be worth more than the width between the strikes, and the call spread can't be worth less than zero.

LONG PUT SPREADS AND SHORT CALL SPREADS ARE DIFFERENT

A much as long put spreads and short call spreads are alike, they're also different in important ways. First, a short call spread is risking a lot to make relatively little but should expect to be profitable fairly frequently. On the other hand, a long put spread is risking a little to make a lot and, as such, we should expect it to be profitable much less often. We should expect it to realize its maximum profit potential even less often.

How often will a short call spread end up fully in-the-money with the underlying above the upper strike price at expiration? This question is important because it's at this point that the call spread realizes its maximum potential loss. That likelihood would be the delta of that upper call option. For the short IBM call spread that delta is 9, so the likelihood of sustaining the maximum potential loss is 9 percent.

How often will a long put spread end up fully out-of-the-money so that the underlying is above the top put strike at expiration? The delta of the top put strike is the likelihood it's in-the-money at expiration. We'd sustain the maximum loss if it's out-of-the-money at expiration. What would that number be? It's simply 1 minus the delta. The delta of that 200 put is 33. Thus, the likelihood of the put spread sustaining its maximum loss, with IBM above $200 at expiration, is 67 percent.

Table 14.7 shows the risk, the reward, and the likelihood of each.

Table 14.7 The Likelihood of Sustaining the Maximum Loss

	Maximum Profit	Maximum Loss	Likelihood of Realizing Maximum Loss
Short 210/230 Call Spread	4.30	15.70	9%
Long 180/200 Put Spread	16.70	3.30	67%

These likelihoods of realizing the maximum loss aren't the likelihood of sustaining *any* loss. While the likelihood of the short call spread sustaining the maximum loss is only 9 percent, that would require IBM to be at or above $230 at expiration. Since the breakeven for this trade is $214.30, what's the likelihood of IBM being above $214.30 at expiration? That's the likelihood of this trade sustaining any loss if our trader holds it to expiration. Obviously there's no option with a strike price precisely equal to $214.30 but we can put that strike price into the option pricing model at OptionMath.com and find out that the delta of a hypothetical $214.30 strike call option is about 37. That means the odds of this trade sustaining any loss is about 37 percent if we hold it to expiration. We'd certainly expect the odds to be in our favor since we're risking a relatively large loss ($15.70) in order to make a relatively small gain ($4.30).

The long put spread is a little different because we're risking relatively little ($3.30) to make a relatively large profit ($16.70). Given the difference between the risk and the potential payoff we'd expect to sustain a loss much more frequently than we would with the short call spread. The breakeven for the long put spread is $196.70, meaning IBM has to be at or below $196.70 at July expiration. Again, this probability is the delta of this $196.70 put option. The trade will sustain a loss if IBM is above $196.70 at expiration. The delta of the $196.70 put is 29, so the probability of IBM being above that price at expiration is 71 percent.

THE WIDTH OF THE SPREAD VERSUS THE COST

It's relatively easy to know whether an individual option is expensive or cheap: We simply look at the implied volatility. Things are a little more difficult for a vertical spread. If we look at the implied volatility of the option that's closer to at-the-money, then we'd only know whether options in general are expensive or cheap. We wouldn't know much about a spread because we don't know how wide the spread is, and we don't know what impact skew will have on the cost of the spread.

A better way of looking at the cost of a spread is to take into account the cost of the spread versus the width of the spread. The IBM put spread example cost $3.30 and the spread was $20.00 wide. That means the spread cost 16.50 percent of the width of the spread. The IBM call spread example cost $4.30 and again the spread was $20.00 wide, so the spread cost 21.5 percent of the width of the spread.

These ratios are pretty inexpensive given that one strike is so close to at-the-money. That is partly a function of implied volatility in IBM being pretty low. How close one strike price is to at-the-money is also a consideration. Obviously if we selected a spread that was significantly out-of- the-money we'd expect it to be pretty cheap. That means the relationship between cost and width would look significantly different for way out-of-the-money spreads than it does for at-the-money spreads as we see in Table 14.8.

Table 14.8 Moneyness and Cost versus Width

Spread	Cost	Cost as a Percentage of the Width of the Spread	Distance Out-Of-The-Money
July 130/150 Put Spread	0.13	0.65%	27.5%
July 260/280 Call Spread	0.04	0.20%	25.7%

This relationship makes sense, the spread costs less and less as a percentage of the width as it gets further from at-the-money and it's also less and less likely to be in-the-money at expiration as it gets further from at-the-money. Let's look at the same probabilities for loss we looked at before. If we bought the IBM July 130/150 put spread at $0.13 with IBM at $206.81 we wouldn't expect to pay very much, the breakeven is a long way from the current stock price; it's $149.87, or 27.5 percent below the current price for IBM. We're risking very little, $0.13, in order to make a great deal, $19.87, so the odds of doing so should be small. Since the delta of the $149.87 strike put would be 2, the probability of losing money is 98 percent. That doesn't necessarily mean this is a bad trade, it just means a trader buying this put spread needs to have reasonable expectations.

Similarly, selling the 260/280 call spread only generates $0.04 in premium and has a potential loss of $19.96. This is not a trade a sensible trader would make, despite the probability of losing money being very small, given the disparity between the risk and reward. The breakeven for selling this call spread is $260.04, the short strike price plus the net premium received. The delta of a theoretical 260.04 strike call option is very small, about 0.20, so the odds of sustaining a loss are 0.20 percent.

By the way, if we calculate the necessary potential profit to make the trade worthwhile we'd divide the potential profit, $0.04, by the odds of sustaining a loss, 0.20 percent. It's no accident that the result of 0.04/0.20 percent is 20, the width of the spread. This simply means there's no purely mathematical advantage to making or not making the trade. Rather, while no trader should make this trade, in a similar situation with a more appropriate payoff but the same lack of mathematical edge, traders will trade if they feel they have an information edge on the direction and magnitude of the trade.

THE GREEKS

Vega—The Effect of Changes in Implied Volatility

Several of the previous strategies we've examined are very dependent on changes in implied volatility during the term of the trade. For example, in a covered call or short put, a decrease in implied volatility can generate additional profit before expiration. In a calendar spread an increase in implied volatility will make the remaining option more valuable at the expiration of the short option.

Vertical spreads are generally much less susceptible to changes in implied volatility since any impact on one option is going to have a similar impact on the other leg of the spread. While both options will be impacted to different degrees, the impact will be similar and offsetting. If the spread is very narrow then the effect will be very small but as the spread gets wider the effect will increase.

For example, any change in implied volatility will have a relatively small impact on the IBM put spread we've been examining, as seen in Table 14.9.

Table 14.9 Implied Volatility and the Impact on Vertical Spreads

	Option Price	Vega (Change in Option Price Due to 1 Point Change in Implied Volatility)
July 200 Put Option	4.30	0.372
July 180 Put Option	1.00	0.158
Net Vega		0.214
July 210 Call Option	4.80	0.381
July 230 Call Option	0.50	0.140

Net Vega		0.241

A 1-point change in implied volatility will cause a change of $0.372 in the price of the July 200 put option. If implied volatility increased by 1.00 we'd expect the option price to increase to $4.67. If implied volatility decreased by 1.00 we'd expect the option price to decrease to $3.93. Similarly, the July 180 put would change in price by $0.158 for each one-point change in implied volatility. This means that the spread would only change in price by $0.214 for each 1-point change in implied volatility. The change in price of the spread is just more than half what it would be for the 200 put alone. Changes in implied volatility during the term of the spread will certainly change the value of the spread, but not in the major way that the value of a covered call or short put might change.

A 1-point change in implied volatility will cause a $0.381 change in the price of the 210 call option. It will also cause a change of $0.140 in the price of the 230 call option. The net effect on the call vertical spread of a 1-point change in implied volatility would be $0.241.

Delta

Just as the vega of one leg of any vertical spread will offset some of the vega exposure of the other leg, some of the directionality of one leg of a vertical spread will offset the directionality of the other leg. (See Table 14.10.) This directionality is the delta we discussed earlier. The result is that the delta, the sensitivity of an option's price to changes in the price of the underlying stock, for a vertical spread tends to be pretty small. In the IBM examples it is smaller than the delta of the outright, at-the-money, option.

Notice that the net delta for both spreads is negative, meaning that they're both bearish. This is what we were trying to accomplish as contrary trades to the bullish risk reversal. This net delta is the change we'd expect to see in the value of the spread if IBM changed in price by $1.00. We'd expect the put spread to change in value by $0.24 and the call spread to change by $0.36; if IBM rallied by $1 we'd expect to see the value of each spread change by that net delta (the put spread would fall, the call spread would rise). If IBM fell by $1 we'd expect to see the value of each spread change by that net delta (the put spread would rise, the call spread would fall). These deltas are only valid over short price ranges and only for today. The deltas will change as the underlying price changes just as they will change as expiration nears.

As vertical spreads get wider each option is a less effective hedge for the other option as we saw in Part Two. Each option will behave differently and the effect of changes in implied volatility and changes in the underlying stock price will be significantly different for each option. As a vertical spread gets wider, the option that is closer to at-the-money starts to act more like an outright option rather than as part of a spread. As the spread gets wider it takes on more directional characteristics becoming more bearish. (See Table 14.11.) We saw this earlier when discussing the angle of the spread and how it affected the ability of one option to hedge another.

The 180/200 put spread is slightly bearish. It makes money if IBM drops and IBM only has to drop 13 percent for this spread to realize its maximum profit. The 150/200 put spread is more bearish. It has a higher maximum profit but IBM has to drop 27 percent for this spread to realize that maximum profit. The 120/200 spread is very bearish. Its maximum profit is much higher but it needs IBM to drop much further, 42 percent, to realize this profit.

Selling the 210/230 call is somewhat bearish; it makes money if IBM doesn't move or drops but it also has a higher delta than any of the put spreads. The other two call spreads aren't really spreads at all. Those spreads are much more like selling the 210 call outright since the delta of the spreads is almost identical to that of the outright 210 call.

IMPLIED VOLATILITY AND THE COST OF VERTICAL SPREADS

We've already seen that IBM vertical spreads are relatively inexpensive because implied volatility in IBM options, in general, is relatively low. How does the general level of implied volatility change the price of vertical spreads? Table 14.12 shows several hypothetical options and spreads for varying levels of implied volatility. We've assumed no skew to remove one variable.

Table 14.10 Delta's Effect on Vertical Spreads

	Delta
Put Spread	
Long July 200 Put Option	−33
Short July 180 Put Option	9
Net Delta	−24
Call Spread	
Short July 210 Call Option	−45
Long July 230 Call Option	9

Net Delta	−36

Table 14.11 Bearishness Versus the Width of the Vertical Spread

	Net Cost	Net Delta	Maximum Profit	Where Maximum Profit Is Achieved
Put Spread				
Buy July 180/200 Put Spread	3.30	−24	16.70	180.00
Buy July 150/200 Put Spread	4.07	−31	45.93	150.00
Buy July 120/200 Put Spread	4.23	−32	75.77	120.00
Call Spread				
Sell July 210/230 Call Spread	4.30	−36	4.30	210.00
Sell July 210/260 Call Spread	4.78	−44	4.78	210.00
Sell July 210/290 Call Spread	4.79	−45	4.79	210.00

Table 14.12 Implied Volatility and the Cost of Vertical Spreads

Implied Volatility	105 Call Option	115 Call Option	105/115 Call Spread	Call Spread Delta	Call Spread Vega
10%	0.17	0.01	0.16	9	0.059
25%	1.80	0.28	1.52	25	0.064
50%	5.33	2.57	2.76	18	0.020
100%	12.70	9.37	3.33	10	−0.001
Implied Volatility	**95 Put Option**	**85 Put Option**	**85/95 Put Spread**	**Put Spread Delta**	**Put Spread Vega**
10%	0.14	0.01	0.13	−7	0.056
25%	1.64	0.14	1.50	−23	0.095
50%	4.97	1.79	3.18	−19	0.046
100%	11.96	7.36	4.60	−10	0.023

After a certain point, as implied volatility increases the likelihood that *both* options will expire in-the-money increases, meaning the delta for the spread decreases. The result is that with very high implied volatilities the value of the spread will not change very much given a change in the underlying asset price.

Likewise, after a certain point, as implied volatility increases the net effect of a change in implied volatility (vega) decreases. The result is that, in general, if implied volatility is high a trader is better off either selling outright options such as covered calls or puts to buy stock, or buying vertical spreads such as put spreads. This is also one of the times when buying a call spread, while not generally a way to get the advantage of the option math working in your favor, makes sense.

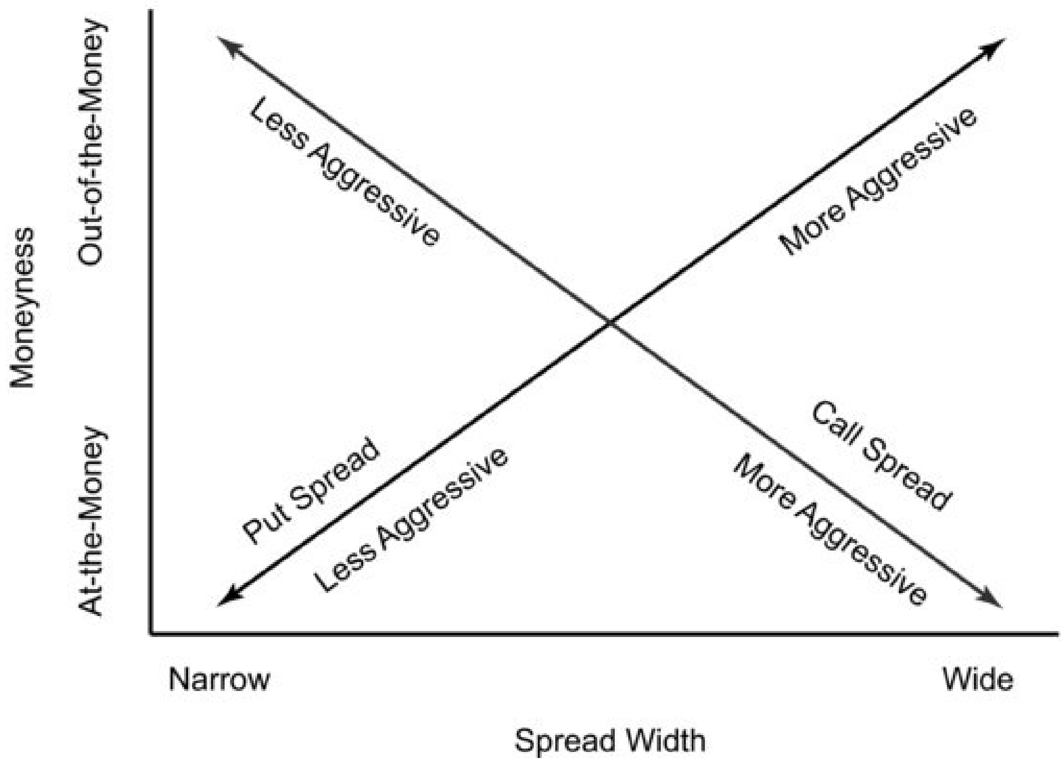
If our trader doesn't want to sell outright options in a high implied volatility environment, then he can sell a vertical spread with a short strike price that is very close to at-the-money. Selling a vertical spread with a short strike price that is further from at-the-money blunts the advantage of high implied volatility.

Similarly, if our trader is operating in a low implied volatility environment, it is generally advisable to buy outright options or sell vertical spreads. If our trader wants to buy vertical spreads in a low implied volatility environment, it's generally a superior strategy to buy a strike price that is closer to at-the-money. Buying a strike price that is further from at the money simply defeats the value of buying a vertical spread in a low implied volatility environment.

VERTICAL SPREADS—HOW AGGRESSIVE?

Like nearly all option strategies vertical spreads can be aggressive, moderate, mild, or downright bond-like. The strikes chosen result in spreads that are at-the-money or further out-of-the-money and spreads that are wide or narrow. Since we're focusing on buying put spreads and selling call spreads, the choices are naturally different. For a long put spread, the spread gets more aggressive as the long strike price gets further from at-the-money because the market has to drop substantially for the spread to go in-the-money, and the trade gets more aggressive as the spread gets wider because the market has to drop substantially before the put spread ceases to participate. For a short call spread the trade gets more aggressive as the short strike price gets closer to at-the-money because the likelihood of the spread going in-the-money increases as the delta of the short strike increases and gets more aggressive as the spread gets wider because the market has to rally substantially before the losses are capped, as Figure 14.4 illustrates.

FIGURE 14.4 How Aggressive?



CALL SPREADS, SKEW, AND THE PROBLEM OF THE "TROUGH"

Skew tends to generate a much smaller benefit for short call spreads than for long put spreads; the difference in implied volatility is lower for call spreads. Our original IBM examples demonstrate this. The benefit from skew for the put spread was 0.43 versus only 0.08 for the call skew. There's simply less difference in implied volatility for call strike prices than there is for put strike prices. There's also the possibility in selling a call spread to go out-of-the-money and sell the strike price that is in the bottom of the skew trough we saw in Figure 14.3. For the IBM options that strike price would be the 225 calls with an implied volatility of 15.42 percent. If the call spread we sell uses the 225 strike call as the short leg then skew will actually be working against the spread, as Table 14.13 shows.

Table 14.13 Call Vertical Spreads, Skew, and the Bottom of the "Trough"

Calls	Observed Price	Implied Volatility	What That Price Would Have Been without Skew
July 225 Call Option	0.96	15.42%	1.25
July 230 Call Option	0.52	15.48%	0.72
July 235 Call Option	0.31	15.81%	0.39
July 240 Call Option	0.18	16.17%	0.21
July 245 Call Option	0.10	16.58%	0.11
Short Call Spreads	**Observed Price**	**Difference in Implied Volatilities**	**Effect of Skew, The Spread Is:**
225/230 Call Spread	0.44	0.06%	0.09 Cheap
225/235 Call Spread	0.65	0.39%	0.21 Cheap
225/240 Call Spread	0.78	0.75%	0.26 Cheap
225/245 Call Spread	0.86	1.16%	0.28 Cheap

The result of selling the strike price that is in the "trough" of the skew curve is that every possible call spread using that strike as the short strike is worse off because of skew.

In selling call spreads it's generally wise to stick to selling a strike price that is very close to at-the-money. If implied volatility in general is low, low enough that our trader would rather not sell an at-the-money call strike price, then it's generally wise to look for another strategy altogether, or to recognize the inherent problem and sell a call spread simply because of the payoff profile and the defined risk versus the unlimited risk of selling a naked call option.

Selling the at-the-money call option as part of a short call vertical doesn't have everything stacked against it. As we've discussed, it will usually have the volatility risk premium working for it to some degree. Since the short call option will have greater daily price erosion, the net effect of erosion will also be a positive for a short call vertical.

FOLLOW-UP ACTION

Follow-up action for a vertical spread has, in many ways, already been taken care of. The nature of a spread, particularly a fairly narrow one, limits the potential damage and reduces the need to roll. If the spread is fairly wide then as expiration approaches, and as the strike prices' ability to hedge each other deteriorates, the need to close the trade or roll one of the strikes might increase. This is only the case if either strike is close to at-the-money, or if one strike is in-the-money and the other strike is out-of-the-money. In this situation the goal of follow-up action is to avoid having an unwanted position in the underlying stock due to exercise or assignment.

If both options will be in-the-money, or if both options will be out-of-the-money at expiration, then little follow-up action is needed. If the options are in-the-money, traders will exercise the option they are long and be assigned on the option they are short. Both spreads will close at their maximum value, the width of the spread. The short call spread will have sustained its maximum loss, but the trade will not generate any position in the underlying stock. The long put spread will recognize its maximum profit and again, there will be no resulting position in the underlying after expiration.

Follow-up action should focus on those instances when one leg of the spread is in-the-money and subject to exercise or assignment and the other leg is out-of-the-money and set to expire worthless. In this situation the spread is going to result in a position in the underlying asset. Given that our trader initiated a spread position, it's unlikely ending up with a stock position was the goal.

In this situation it's generally best to close out the trade. In the case of a long put spread that would mean the long put was in-the-money and would result in a short position in the underlying stock, while the short put would expire worthless. Since simply selling the long put would leave our trader naked short a put in an environment where the underlying stock has recently fallen, our trader should sell out the entire spread.

If the short leg of a short call spread is going to expire in-the-money and the long leg is going to expire worthless, our trader would end up with a short position in the stock. In this situation our trader might simply buy back the short call, leaving the worthless long out-of-the-money call to expire, rather than spend the commission to sell it. Since we're never in favor of selling really cheap options (i.e., worth less than $0.10) we wouldn't be in favor of selling this worthless, or nearly so, call option. In case of an unexpected development it's probably a good idea to offer this call for sale at a higher price via a good-till-canceled order as we discussed previously.

TAKEAWAYS

- Vertical spreads can be bullish or bearish, and all have their place, but in order to get the option math working in our favor we'll focus on bearish vertical spreads including long put spreads and short call spreads.

- Long put spreads and short call spreads are alike in that both use skew to their advantage, both are bearish, and are always so.
- Long put spreads and short call spreads are different in that a long put spread is risking relatively little to make a lot, while a short call spread is risking relatively more to make relatively less. The likelihood of those respective outcomes is also very different.
- The best measure of the cost of a vertical spread is often the price of the spread versus the width of the spread, taking into account the distance from at-the-money.
- The legs of a vertical spread are hedges for each other in terms of implied volatility and directionality. How good a hedge one is for the other is a function of the width of the angle, which changes over time.
- The net delta and net vega for vertical spreads decrease as implied volatility increases, meaning with implied volatility high it’s generally best to sell outright options or buy vertical spreads.
- The aggressiveness of a vertical spread depends on the moneyness (i.e., being at-the-money or out-of-the-money), and the width.
- Selling the skew trough can be particular problematic for call spreads. It’s generally better to stick with selling an at-the-money call as the short leg.
- Much of the follow-up for vertical spreads is already done. Our trader should focus on closing the position so that it doesn’t generate an unwanted position in the underlying stock.

Appendix

STANDARD DEVIATION

Standard deviation is a statistical measure of variability among a data set such as the daily percentage returns of an investment portfolio or equity index.

A low standard deviation indicates that the data points tend to be very close to the average of all the data points, while a high standard deviation indicates that the data points are spread out over a larger range from the average of all the data points.

As we've seen, standard deviation is often used to measure confidence in statistical results. We would be about 68 percent certain that any data point would be within 1 standard deviation of the average of all the data points. We'd be about 95 percent certain that the data point would be within 2 standard deviations of the average of all the data points.

The formula for standard deviation is:

$$Standard\ Deviation = \sqrt{\frac{\sum(Data\ Point - Avg\ of\ All\ Data\ Points)^2}{Number\ of\ Data\ Points - 1}}$$

Let's calculate the standard deviation for some daily index returns by hand to better understand the concepts. In real life there's no reason to do this as any spreadsheet can accomplish the calculation nearly instantaneously.

10 Days' Returns
0.56%
–0.22%
0.64%
0.45%
–0.81%
0.70%
–0.11%
1.01%
0.37%
–0.67%

Step 1: Calculate the average of all 10 data points.

$$0.192\% = \frac{1.92\%}{10}$$

Step 2: Calculate the deviation of each data point from the average and the square of that deviation.

Data Point	Average of All Data Points	Deviation from the Average (*Data Point – Average*)	Square of the Deviation (*Data Point – Average*)^2
0.56%	0.192%	0.368%	0.001354%
−0.22%	0.192%	−0.412%	0.001697%
0.64%	0.192%	0.448%	0.002007%
0.45%	0.192%	0.258%	0.000666%
−0.81%	0.192%	−1.002%	0.010040%
0.70%	0.192%	0.508%	0.002581%
−0.11%	0.192%	−0.302%	0.000912%
1.01%	0.192%	0.818%	0.006691%
0.37%	0.192%	0.178%	0.000317%
−0.67%	0.192%	−0.862%	0.007430%

Step 3: Calculate the sum of all the squared deviations. The sum of the squares of the deviations is 0.033696 percent.

Step 4: Divide the sum of the squares of the deviations by n – 1.

$$0.00003743956 = \frac{0.033696\%}{10 - 1}$$

Step 5: Find the square root of the solution in Step 4.

$$0.612\% = \sqrt{0.00003743956}$$

0.612 percent is the standard deviation of the daily returns for the 10 days we're examining.

REALIZED VOLATILITY

Every trader and investor knows realized volatility when they see it; prices bounce around significantly and demonstrate big moves.

How can we calculate realized volatility so that it is objective and in units that we can compare to the implied volatility that we see in an option pricing model at OptionMath.com?

Realized volatility is the standard deviation of the natural log of daily returns multiplied by the square root of 260 (the approximate number of trading days in a calendar year).

The natural log is the logarithm to the base *e*, *e* being the constant approximately equal to 2.718281828. The natural log of a number *x* is the power to which *e* would have to be raised to equal *x*, it is commonly written as ln(x). The natural log is commonly used in finance, most often in calculating rate of return and the time for asset growth.

Let's calculate the realized volatility of the 10 daily percentage changes we looked at in the discussion of standard deviation. To calculate the realized volatility, we need to start with the actual asset prices so that we can calculate the natural log daily returns. The natural log return for any day is:

$$LN\left(\frac{Closing\ Value_{Day\ T}}{Closing\ Value_{Day\ T-1}}\right)$$

Closing Price	Percentage Daily Return	Natural Log Daily Returns
100.000		
100.560	0.56%	0.0055844
100.339	−0.22%	−0.0022024
100.981	0.64%	0.0063796
101.435	0.45%	0.0044899
100.614	−0.81%	−0.0081330
101.318	0.70%	0.0069756
101.207	−0.11%	−0.0011006
102.229	1.01%	0.0100493
102.607	0.37%	0.0036932
101.920	−0.67%	−0.0067225

The standard deviation of these natural log daily returns is 0.0061154. Thus, the realized volatility for these prices is:

$$9.86\% = 0.0061154 * \sqrt{260}$$

VOLATILITY FOR DIFFERENT TIME PERIODS

The realized volatility we just calculated and the volatility input to any pricing model, including the implied volatility we might derive from observed prices, are expressed in terms of the expectations we have for change in the asset price. Since different assets have different absolute prices, the important measure of price change is the percentage price change.

By convention these volatilities apply to one calendar year so the volatility is the standard deviation of annual percentage price changes.

But what if we want to know what an annual volatility (standard deviation) of

20 percent says about the likely price change tomorrow or next month. How do you convert that volatility of 20 percent into a meaningful number for a shorter (or longer) time frame?

As we've already seen, standard deviation changes in proportion to the square root of time. So, volatility for a time frame other than a year is the annual volatility divided by the square root of the number of relevant time periods in a year.

How large a daily price change would we expect (with the 68.2 percent certainty we'd have given a range that's 1 standard deviation up and 1 standard deviation down) if the annual volatility was 20 percent?

$$1.24\% = \frac{20\%}{\sqrt{260}}$$

Any security displaying annual volatility of 20 percent would be expected 68.2 percent of the time to have a single day's percentage return to fall between +1.24 percent and –1.24 percent.

What does this 20 percent annual volatility say about the 68.2 percent expectations for a monthly move?

$$5.77\% = \frac{20\%}{\sqrt{12}}$$

Notice that the monthly move isn't 20 times the daily move despite there being approximately 20 trading days in a calendar month. Again, that's because changes in risk aren't linear with respect to time. Rather risk changes with the square root of time.

THE BLACK-SCHOLES FORMULA EXTENDED, PUTS AND THE GREEKS

The Black-Scholes formula for the value of a call option is:

$$\mathit{Call\ Price} = (S * N(d1)) - (SK * e^{(-rt)} * N(d2))$$

Where:

$$d1 = \frac{\left(\ln\left(\frac{S}{SK}\right)\right) + \left(\left(r + \left(\frac{Vol^2}{2}\right)\right) * t\right)}{Vol * \sqrt{t}}$$

$$d2 = d1 - (Vol * \sqrt{t})$$

And where:	S is the price of the underlying stock
	SK is the strike price of the call option

r is the annual risk-free interest rate

Vol is the annualized standard deviation of underlying stock returns

t is the time to expiration (in annual terms such that 6 months is 0.5)

e is the base of the natural log and is equal to 2.7183

ln is the natural logarithm

N represents the cumulative standard normal distribution. This cumulative distribution describes the probability of a random variable falling within a certain interval. The cumulative distribution value for any number can be found in online tables or can be calculated using a spreadsheet.

The Black-Scholes formula for the value of a put option is:

$$Put\ Price = (SK * e^{(-rt)} * N(-d2)) - (S * N(-d1))$$

Where:

$$d1 = \frac{\left(\ln\left(\frac{S}{SK}\right)\right) + \left(\left(r + \left(\frac{Vol^2}{2}\right)\right) * t\right)}{Vol * \sqrt{t}}$$

$$d2 = d1 - (Vol * \sqrt{t})$$

The Greeks—*delta*, *gamma*, *vega*, and *theta*—for a call option.

$$Delta = N(d1)$$

$$Gamma = \frac{\frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{S * Vol * \sqrt{t}}$$

$$Vega = \frac{S * \sqrt{t} * \frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{100}$$

$$Theta = \frac{S * Vol * \frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{2\sqrt{t}} + (SK * r * e^{(-rt)} * N(d2))$$

This theta formula is the generally accepted formula for theta but since time is measured in years in order to get a number that represents a single day's erosion, which is both more common in actual usage and more useful, divide by 365.

The Greeks—*delta*, *gamma*, *vega*, and *theta*—for a put option.

$$Delta = N(d1) - 1$$

$$Gamma = \frac{\frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{S * Vol * \sqrt{t}}$$

$$Vega = \frac{S * \sqrt{t} * \frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{100}$$

$$Theta = \frac{S * Vol * \frac{1}{\sqrt{2\pi}} * e^{\left(\frac{-(d1)^2}{2}\right)}}{2\sqrt{t}} - (SK * r * e^{(-rt)} * N(-d2))$$

This theta formula is the generally accepted formula for theta but since time is measured in years in order to get a number that represents a single day’s erosion, which is both more common in actual usage and more useful, divide by 365.

It’s no accident that the formula for gamma and vega are the same for call options and put options.

Delta, gamma, vega, and theta aren’t the only Greeks that professional options traders pay attention to. As we’ve discussed there are others include *rho*, an option’s sensitivity to changes in interest rates, *omega*, a measure of the change in an option’s price with respect to the percentage change in the underlying price, and *zomma*, the change in the gamma of an option due to changes in volatility. The list goes on.

Some practitioners express theta as a negative number to represent the daily price change due to the passage of time. However, I’ve always looked at as the daily erosion of an option price. As such, and for these purposes, it’s a positive number.

LINEAR INTERPOLATION

Linear interpolation is a handy method of describing a value using adjacent data points. For example, if a stock was trading at 72.34 and you wanted to estimate what a call option with a strike price exactly equal to 72.34 would cost you could do so using the 70 and 75 strike options.

The formula for linear interpolation is:

$$Y_2 = \frac{(X_2 - X_1)^*(Y_3 - Y_1)}{(X_3 - X_1)} + Y_1$$

In this example if the 70 strike call was trading at 3.60 and the 75 strike call was trading at 0.70 then we could approximate the value of a 72.34 strike call by:

$$2.2428 = \frac{(72.34 - 75)^* (3.60 - 0.70)}{(70 - 75)} + 0.70$$

ANNUALIZING YIELD

A quick way to annualize the yield from selling a covered call or the cost of buying a protective put—or for any other option strategy—is to simply multiply the yield by the number of relevant periods in one year. This generates an estimate, but the estimate doesn’t take compounding into account. If we want to be more precise and calculate an annualized number that takes compounding into account then we'll end up with a result that is more consistent with other measures of investment performance.

The formula for annualized investment performance is:

$$(1 + Yield)^N - 1$$

Where: *Yield* is the period yield from selling the covered call (or period cost for buying a protective put)
N is the number of periods in a calendar year.

For example, in Chapter 10 we discussed selling a 30-day to expiration covered call for $4.00 when the underlying was priced at $77.00. We calculated an estimate of the annual yield as 62.40 percent (4.00/77.00 * 12). A more precise calculation would generate an annualized yield of 83.7 percent:

$$0.837 = (1 + 0.052)^{12} - 1$$

The significant difference between the quick method and the more accurate method is a function of the period yield. If this period yield was lower the difference between the results generated by the two methods would be lower.

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